BACHELOR OF SCIENCE (HONS.)

MATHEMATICS

Detailed Syllabus

Programme Code:MTHB
Duration: 3 Years

EFFECTIVE FROM SESSION: 2019-2020

Department of Basic Sciences
Faculty of Science
CHHATRAPATI SHIVAJI MAHARAJ UNIVERSITY
PANVEL, NAVI MUMBAI

About the Programme

The B. Sc. (Hons.) Mathematics programme is aimed at imparting knowledge on the fundamental principles of Mathematics. This programme is beneficial for the students in the area of higher studies, career opportunities in both private and public sectors.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOS):

The programme educational objectives of the B. Sc. (Hons.) Mathematics programme are:

PEO1. Basic Knowledge will apply for identification, formulation, creation, solution, design, development and optimization of various problems related to various fields of Mathematics.

PEO2. Theskills and knowledge acquired during the course period will apply in the industry.

PEO3. To be prepared for the successful pursuit of graduate studies and shall have abilities to engage in lifelong learning in various field and will understand the challenges of a dynamically and globalised changing world adapting their skills through continuous learning and self improvement.

PEO4. To demonstrate the ability of measurement of the impact of computing on society, and possess knowledge of ethical, social and professional implications and responsibilities of their work.

PEO5. The graduates will work and communicate effectively in inter-disciplinary environment, either independently or in a team, and demonstrate leadership qualities.

PEO6. The graduates will become successful professionals by demonstrating logical and analytical thinking abilities.

PROGRAMME OUTCOMES (PO):

After completion of the B. Sc. (Hons.) Mathematics programme students will be able to:

PO1. Create a hypothesis and appreciate how it relates to broader theories.

PO2. Evaluate hypotheses, theories, methods and evidence within their proper contexts.

PO3. Solve complex problems by critical understanding, analysis and synthesis.

PO4. Demonstrate engagement with current research and developments in the subject.

PO5. Critically interpret data, write reports and apply the basics of rules and evidence.

PO6. Use the means of information technology and communicate effectively by oral, written, and graphical means

SEMESTER I

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB1010	Algebra	5	1	0	30	70	100	6
DSC	MTHB1020	Numerical Methods	5	1	0	30	70	100	6
GE	**	General Elective - I	4	0	0	30	70	100	4
AECC	ENGG1000	English Communication	2	0	0	15	35	50	2
GE	**	General Elective - I Lab	0	0	4	15	35	50	2
		Total	**16**	**2**	**4**	**120**	**280**	**400**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	Offering Department	Course Code	Course Name	(L-T-P)	Credits
I	English	ENGG1000	English Communication	2-0-0	2

MTHB1010	Algebra	5L:1T:0P	6 Credits

Course objectives:
The objectives of this course are
1. To understand the students concept of complex number.
2. To make student learn of set & functions.
3. To familiarize students with system of linear equations.
4. To impart the knowledge of linear transformation & eigenvalues,e igen vectors .

Unit I:Complex Number L:15
Polar representation of complex numbers, nth roots of unity, De Moivre's theorem for rational indices and its applications.

Unit II:Set & Functions: L : 20

Equivalence relations, Functions, Composition of functions, Invertible functions, One to onecorrespondence and cardinality of a set, Well-ordering property of positive integers, Divisionalgorithm, Divisibility and Euclidean algorithm, Congruence relation between integers,Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.
Unit III:Systems of linear equations: L:20

Systems of linear equations, row reduction and echelon forms, vector equations, the matrix equation Ax=b, solution sets of linear systems, applications of linear systems, linearindependence

Unit IV:Linear transformations: L: 20

Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix,characterizations of invertible matrices. Subspaces of R^n, dimension of subspaces of $R^n$and rank of a matrix, Eigen values, Eigen Vectors and Characteristic Equation of a matrix.

Text /Reference Books:

1. Titu Andreescu and Dorin Andrica, Complex Numbers from A to Z, Birkhauser, 2006.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3rd Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005**.**
3. David C. Lay, Linear Algebra and its Applications,3rd Ed., Pearson Education Asia, Indian Reprint, 2007.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand and apply the complex number in problems.

2. understand the concept of set & functions & how to solve the problems .

3. How to solve linear equations using matrix.

4. Understand the concept of linear transformations.

MTHB1020	NumericalMethods	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. To learn how to solve DE using Euler's method. Runge-Kutta methods .
2. To impart the knowledge of interpolation.
3. To learn how to solve definite integral using Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule etc.
4. To understand the concept of system of linear algebraic equations.
5. How to solve Transcendental and Polynomial equations.

Unit I:Ordinary Differential Equations :L:13

Euler's method.Runge-Kutta methods of orders two and four.

Unit II:Interpolation: L:16

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

Unit III:Numerical Integration: L: 17

Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule, Boole's Rule. Midpoint rule, Composite Trapezoidal rule, Composite Simpson's rule.

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Unit IV:System of linear algebraic equations: L:16

Gaussian Elimination and Gauss Jordan methods.Gauss Jacobi method, Gauss Seidel method and their convergence analysis.

Unit V:Transcendental and Polynomial equations: L: 13

Bisection method, Newton's method, Secant method.Rate of convergence of these methods.

Reference Books:

1. Brian Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. M.K. Jain, S.R.K. Iyengar and R.K. Jain, Numerical Methods for Scientific and EngineeringComputation, 6th Ed., New age International Publisher, India, 2007.
3. C.F. Gerald and P.O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 2008.
4. Uri M. Ascher and Chen Greif, A First Course in Numerical Methods, 7th Ed., PHI LearningPrivate Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, Numerical Methods using Matlab, 4th Ed., PHILearning Private Limited, 2012.

Course Outcomes:

1. Able to solve DE using Euler's method. Runge-Kutta methods
2. Able to apply the knowledge of interpolation
3. Able to solve Transcendental and Polynomial equations .
4. Learn to solve system of linear algebraic equations
5. Learn to solve definite integral using Trapezoidal rule, Simpson's rule, Simpsons 3/8th rule etc.

SEMESTER II

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB2010	Differential Calculus & Vector Calculus	5	1	0	30	70	100	6
DSC	MTHB2020	Group Theory I	5	1	0	30	70	100	6
GE	**	Generic Elective - II	4	0	0	30	70	100	4
AECC	AECC201T	Environmental Science	2	0	0	15	35	50	2
GE	**	Generic Elective - II Lab	0	0	4	15	35	50	2
		Total	**16**	**2**	**4**	**120**	**280**	**400**	**20**

Ability Enhancement Compulsory Courses (AECC)

Semester	Offering Department	Course Code	Course Name	(L-T-P)	Credits
II	Basic Sciences	EVSG2000	Environmental Studies	2-0-0	2

MTHB2010	Differential Calculus & Vector Calculus	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of successive differentiation.
2. To make student learn series expansion & indeterminate forms.
3. To impart the knowledge of partial derivative.
4. To impart the knowledge of vector calculus.

Unit I:Successive differentation: L:15

nth order derivative of standard functions :y= $(ax+b)^m$, y= e^{ax} ,y= a^{mx} ,y= $\frac{1}{(ax+b)}$,y=log(ax+b) ,y=sin(ax+b),y =cos(ax+b), y= $e^{ax}\sin(ax+b)$, y= $e^{ax}\cos(ax+b)$,Leibnitz's Theorem. Examples.

Unit II:SeriesexpansionsandIndeterminate forms: L: 20

Taylor's Theorem, Maclaurin's Theorem, Series expansions of some standard functions: e^x , sinx, cosx ,tanx ,$(1+x)^n$,log(1+x), Indeterminate forms :$\frac{0}{0}$,$\frac{\infty}{\infty}$,$0.\infty$, L'Hospitals Rule (Statement only).

Unit III:Functions of two variables: L: 20

Functions of two variables, Limit of a function of two variables, Continuity of a function of two variables ,Partial derivatives of first order, Partial derivatives of Higher order.Total derivative, Composite function , Implicit function. Homogeneous functions of two variables. Euler's Theorem on Homogeneous functions of two variables.

Unit IV:Vector calculus: L: 20

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, modeling ballistics and planetary motion, Kepler's second law.

Text /Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) P.Ltd. (Pearson Education), Delhi, 2007.
3. H. Anton, I. Bivens and S. Davis, Calculus, 7th Ed., John Wiley and Sons (Asia) P. Ltd.,Singapore, 2002.
4. R. Courant and F. John, Introduction to Calculus and Analysis(Volumes I & II), Springer-Verlag, New York, Inc., 1989.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the ideas of successive differentiation
2. Able to expand functions & finding the limits of indeterminate forms.
3. Able to find partial derivatives of different types of functions.

4. Perform vector calculus problems.

MTHB2020	Group Theory I	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of the basic groups.
2. To make students learn the concept of cyclic group.
3. To impart the knowledge of abelian group
4. To convey the basic concepts Group homomorphisms.

Unit I:Groups: L:20

Symmetries of a square, Dihedral groups, definition and examples of groups including permutation groups and quaternion groups (illustration through matrices), elementary properties of groups.Subgroups and examples of subgroups, centralizer, normalizer, center of a group, product of two subgroups.

Unit II:Cyclic groups: L:20

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

Unit III:Abelian groups: L:15

External direct product of a finite number of groups, normal subgroups, factor groups, Cauchy'stheorem for finite abelian groups.

Unit IV:Group homomorphisms: L:20

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties ofisomorphisms, First, Second and Third isomorphism theorems.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, New Delhi, 1999.
4. Joseph J. Rotman, An Introduction to the Theory of Groups, 4th Ed., Springer Verlag, 1995.
5. I.N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of group.
2. Understand basic concepts of cyclic group.
3. Understand the concept ofabeliangroup .
4. Understand the concept Group homomorphisms.

SEMESTER III

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB3010	Differential Equation	5	1	0	30	70	100	6
DSC	MTHB3020	PDE and System of ODE	5	1	0	30	70	100	6
DSC	MTHB3030	Theory of Real Functions	5	1	0	30	70	100	6
GE	**	Generic Elective - III	4	0	0	30	70	100	4
SEC	CSEG3210	Computer graphics	2	0	0	15	35	50	2
GE	**	Generic Elective - III Lab	0	0	4	15	35	50	2
		Total	**21**	**3**	**4**	**150**	**350**	**500**	**26**

MTHB3010	Differential Equation	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of ordinary Differentialequations
2. To make students learn the application of Differentialequations.
3. To impart the knowledge of higher order differential equation
4. To convey the concepts predatory-prey model and its analysis

Unit I:Introduction ofDifferential equations:L:20

.Differential equations and mathematical models, General, particular, explicit, implicit andsingular solutions of a differential equation.Exact differential equations and integrating factors,separable equations and equations reducible to this form, linear equation and Bernoulliequations, special integrating factors and transformations.

Unit II: Application ofdifferential equations:L:20

Introduction to compartmental model, exponential decay model, lake pollution model (case studyof Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of acourse of cold pills), exponential growth of population, limited growth of population, limitedgrowth with harvesting.

Unit III:Homogeneous equation:L:20

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

Unit IV:Analysis of models:L:15

Equilibrium points, Interpretation of the phase plane, predatory-prey model and its analysis,epidemic model of influenza and its analysis, battle model and its analysis.

Reference Books:

1. Belinda Barnes and Glenn R. Fulford, Mathematical Modeling with Case Studies, A
2. Differential Equation Approach using Maple and Matlab, 2nd Ed., Taylor and Francis group, London and New York, 2009.
3. C.H. Edwards and D.E. Penny, Differential Equations and Boundary Value problems Computing and Modeling, Pearson Education India, 2005.
4. S.L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons, India, 2004.
5. Martha L Abell, James P Braselton, Differential Equations with MATHEMATICA, 3rd Ed.Elsevier Academic Press, 2004.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept ordinary Differentialequations
2. Students will be familiar with theapplication of Differentialequations
3. Able to solve higher order differential equation .
4. Understand the concept Group predatory-prey model and its analysis.

MTHB3020	PDE and System of ODE	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of Partial Differential Equations
2. To make students learn the Method of solvingPartial Differential Equations.
3. To impart the knowledge of non-homogeneous boundary conditions problems
4. To convey the basic concept of system of linear differential equations.

Unit I: Introduction of Partial Differential Equations:L:20

Partial Differential Equations – Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Classification, Construction and Geometrical Interpretation. Method ofCharacteristics for obtaining General Solution of Quasi Linear Equations. Canonical Forms ofFirst-order Linear Equations.

Unit II:First order partial differential equations:L:15

Method of Separation of Variables for solving first order partialdifferential equations.Derivation of Heat equation, Wave equation and Laplace equation. Classification of second orderlinear equations as hyperbolic, parabolic or elliptic. Reduction of second order Linear Equationsto canonical forms.

Unit III:Application of Partial Differential Equations:L:20

The Cauchy problem, the Cauchy-Kowaleewskaya theorem, 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 non-homogeneous boundary conditions, Non-Homogeneous Wave Equation. Method of separation of variables, Solving the Vibrating StringProblem, Solving the Heat Conduction problem

Unit IV:Systems of linear differential equations:L:20

Systems of linear differential equations, types of linear systems, differential operators, anoperator method for linear systems with constant coefficients, Basic Theory of linear systems innormal form, homogeneous linear systems with constant coefficients: Two Equations in twounknown functions, The method of successive approximations, the Euler method, the modifiedEuler method, The Runge-Kutta method.

Reference Books:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equations for Scientists and Engineers, 4th edition, Springer, Indian reprint, 2006.
2. S.L. Ross, Differential equations, 3rd Ed., John Wiley and Sons, India, 2004.
3. Martha L Abell, James P Braselton, Differential equations with MATHEMATICA, 3rd Ed.,Elsevier Academic Press, 2004.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1.Understand the concept of Partial Differential Equations

2. Able to solve different types of Partial Differential Equations

3. Understand the concept non-homogeneous boundary conditions problems

4.Able to solve system of linear differential equations

MTHB3030	Theory of Real Functions	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of the basic limits & continuity of functions.
2. To make students learn the concept ofDifferentiability.
3. To impart the knowledge of Taylor's theorem
4. To convey the basic concepts expansion of function.

Unit I:Limits& Continuity:L:20

Limits of functions , sequential criterion for limits, divergence criteria. Limittheorems, one sided limits. Infinite limits and limits at infinity. Continuous functions, sequentialcriterion for continuity and discontinuity. Algebra of continuous functions. Continuous functionson an interval, intermediate value theorem, location of roots theorem, preservation of intervalstheorem. Uniform continuity, non-uniform continuity criteria, uniform continuity theorem.

Unit II:Differentiability:L:20

Differentiability of a function at a point and in an interval, Caratheodory's theorem, algebra ofdifferentiable functions.Relative extrema, interior extremum theorem.Rolle's theorem, Meanvalue theorem, intermediate value property of derivatives, Darboux's theorem. Applications ofmean value theorem to inequalities and approximation of polynomials,

Unit III:Taylor's& Cauchy's theorem:L:20

Taylor's theorem toinequalities.Cauchy's mean value theorem.Taylor's theorem with Lagrange's form of remainder, Taylor'stheorem with Cauchy's form of remainder, application of Taylor's theorem to convex functions,relative extrema.

Unit IV:Expansions of functions: L:15

Taylor's series and Maclaurin's series expansions of exponential andtrigonometric functions, $\ln(1 + x)$, $1/ax+b$ and $(1 +x)^n$.

Reference Books:

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

3. A. Mattuck, Introduction to Analysis, Prentice Hall, 1999.
4. S.R. Ghorpade and B.V. Limaye, A Course in Calculus and Real Analysis, Springer,

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of limits & continuity
2. Understand basic concepts of differentiability
3. Understand the concept of Taylor's theorem & its application .
4. Able to find the expansion of different types function.

SEMESTER IV

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB4010	Real Analysis I	5	1	0	30	70	100	6
DSC	MTHB4020	Riemann Integration and Series of Functions	5	1	0	30	70	100	6
DSC	MTHB4030	Ring Theory and Linear Algebra I	5	1	0	30	70	100	6
GE	**	Generic Elective - IV	4	0	0	30	70	100	4
SEC	CSEG4210	Operating System: Linux	2	0	0	15	35	50	2
GE	**	Generic Elective - IV Lab	0	0	4	15	35	50	2
		Total	**21**	**3**	**4**	**150**	**350**	**500**	**26**

MTHB4010	Real Analysis I	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of countable & uncountable sets of R.
2. To make students learn the concept ofBolzano-Weierstrass theorem for sets .
3. To impart the knowledge of sequence.
4. To convey the basic concepts Infinite series, convergence and divergence of infinite series.

Unit I:Properties of R:L:15

Review of Algebraic and Order Properties of *R*, δ-neighborhood of a point in *R*, Idea ofcountable sets, uncountable sets and uncountability of *R*. Bounded above sets, Bounded belowsets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of *R*,

Unit II:The Archimedean Property:L:15
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 III:Sequences:L:20
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 IV:Infinite series:L:20
Infinite series, convergence and divergence of infinite series, Cauchy Criterion, Tests forconvergence: Comparison test, Limit Comparison test, Ratio Test, Cauchy's nth root test, Integraltest, Alternating series, Leibniz test, Absolute and Conditional convergence.

Reference Books:

1. R.G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, An Introduction to Analysis, 2nd Ed., Jones & Bartlett, 2010.
3. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.
4. S.K. Berberian, A First Course in Real Analysis, Springer Verlag, New York, 1994.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of countable & uncountable sets of R.
2. Understand basic concepts of Bolzano-Weierstrass theorem for sets .
3. Understand the concept of sequence.
4. Understand the concept Infinite series, convergence and divergence of infinite series.

MTHB4020	**Riemann Integration and Series of Functions**	**5L:1T:0P**	**6 Credits**

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of the Riemann integration .
2. To make students learn the concept Fundamental theorems of Calculus.
3. To impart the knowledge of derivability and integrability.
4. To convey the basic concepts Power series, radius of convergence.

Unit I:Riemann integration:L:20
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.

Unit II:Fundamental theorems of Calculus:L:20

Intermediate Value theorem for Integrals; Fundamental theorems of Calculus.Improper integrals; Convergence of Beta and Gamma functions.Pointwise and uniform convergence of sequence of functions.

Unit III:Theorems on continuity,derivability:L:20
Theorems on continuity,derivability and integrability of the limit function of a sequence of functions. 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 IV:Power series:L:15
Limit superior and Limit inferior. Power series, radius of convergence, Cauchy HadamardTheorem, Differentiation and integration of power series; Abel's Theorem; WeierstrassApproximation Theorem.

Reference 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 Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
3. Charles G. Denlinger, Elements of Real Analysis, Jones & Bartlett (Student Edition),

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of the Riemann integration.
2. Understand basic concepts of cyclic concept Fundamental theorems of Calculus.
3. Understand the concept of derivability and integrability .
4. Understand the concept Power series, radius of convergence.

MTHB4030	Ring Theory and Linear Algebra I	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of the rings.
2. To make students learn the concept of Ring homomorphisms .
3. To impart the knowledge of Vector spaces.
4. To convey the basic concepts Linear transformations.

Unit I: Rings:L:20
Definition and examples of rings, properties of rings, subrings, integral domains and fields,characteristic of a ring. Ideal, ideal generated by a subset of a ring, factor rings, operations onideals, prime and maximal ideals.

Unit II:Ring homomorphisms:L:15
Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III,field of quotients.

Unit III:Vector spaces:L:20
Vector spaces, subspaces, algebra of subspaces, quotient spaces, linear combination of vectors,linear span, linear independence, basis and dimension, dimension of subspaces.

Unit IV:Linear transformations:L:20
Linear transformations, null space, range, rank and nullity of a linear transformation, matrixrepresentation of a linear transformation, algebra of linear transformations.Isomorphisms,Isomorphism theorems, invertibility and isomorphisms, change of coordinate matrix.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
2. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, NewDelhi, 1999.
4. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
5. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
6. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India,1999.
7. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd., 1971.
8. D.A.R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd.,

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of rings.
2. Understand basic concepts of Ring homomorphisms.
3. Understand the concept of Vector spaces.
4. Understand the concept Linear transformations.

SEMESTER V

Course Type	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB5010	Multivariate Calculus	5	1	0	30	70	100	6
DSC	MTHB5020	Group Theory II	5	1	0	30	70	100	6
DSE	**	Discipline Specific Elective-I	5	1	0	30	70	100	6
DSE	**	Discipline Specific Elective-II	5	1	0	30	70	100	6
		Total	**20**	**4**	**00**	**120**	**280**	**400**	**24**

MTHB5010	Multivariate Calculus	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of the partial differentiation.
2. To make students learn the concept of double integration.
3. To impart the knowledge of triple integration.
4. To convey the basic concepts line integral & its application.

Unit I:Partial differentiation:L:20

Functions of several variables, limit and continuity of functions of two variables Partialdifferentiation, total differentiability and differentiability, sufficient condition fordifferentiability. Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes, Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl

Unit II:Double integration:L:20

Double integration over rectangular region, double integration over non-rectangular region,Double integrals in polar co-ordinates

Unit III:Triple integration:L:20
Triple integrals, Triple integral over a parallelepiped and solid regions. Volume by triple integrals, cylindrical and spherical co-ordinates.Change of variables in double integrals and triple integrals.

Unit IV: Vector Integration:L:15
Line integrals, Applications of line integrals: Mass and Work. Fundamental theorem for line integrals, conservative vector fields, independence of path.Green's theorem, surface integrals, integrals over parametrically defined surfaces.Stoke'stheorem, The Divergence theorem.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.
2. M.J. Strauss, G.L. Bradley and K. J. Smith, Calculus, 3rd Ed., Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2007.
3. E. Marsden, A.J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE), Indian reprint, 2005.
4. James Stewart, Multivariable Calculus, Concepts and Contexts, 2nd Ed., Brooks /Cole, Thomson Learning, USA, 2001

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of partial differentiation.
2. Understand basic concepts of double integration.
3. Understand the concept of triple integration .
4. Understand the concept line integral & its application.

MTHB5020	Group Theory II	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of the automorphism groups
2. To make students learn the concept of internal & external direct products.
3. To impart the knowledge of abelian group
4. To convey the basic concepts Group actions.

Unit I:Automorphism groups:L:20
Automorphism, inner automorphism, automorphism groups, automorphism groups of finite andinfinite cyclic groups, applications of factor groups to automorphism groups, Characteristicsubgroups, Commutator subgroup and its properties.

Unit II:Direct products:L:20
Properties of external direct products, the group of units modulo n as an external direct product, internal direct products, Fundamental Theorem of finite abelian groups.

Unit III:Group actions:L:20
Group actions, stabilizers and kernels, permutation representation associated with a given group action, Applications of group actions: Generalized Cayley's theorem, Index theorem.
Groups acting on themselves by conjugation,

Unit IV:Consequences:L:15
Class equation and consequences, conjugacy in Sn,*p*-groups, Sylow's theorems and consequences, Cauchy's theorem, Simplicity of An for $n \geq 5$,

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
4. David S. Dummit and Richard M. Foote, Abstract Algebra, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
5. J.R. Durbin, Modern Algebra, John Wiley & Sons, New York Inc., 2000.
6. D. A. R. Wallace, Groups, Rings and Fields, Springer Verlag London Ltd., 1998.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of automorphismgroup.
2. Understand concepts of internal& external direct products.
3. Understand the concept ofabeliangroup .
4. Understand the concept Group actions.

SEMESTER VI

Course Code	Course Code	Course Name	L	T	P	IA	UE	Total Marks	Credits
DSC	MTHB6010	Metric Spaces and Complex Analysis	5	1	0	30	70	100	6
DSC	MTHB6020	Ring Theory and Linear Algebra II	5	1	0	30	70	100	6
DSE	**	Discipline Specific Elective-III	5	1	0	30	70	100	6
DSE	**	Discipline Specific Elective-IV	5	1	0	30	70	100	6
		Total	**20**	**4**	**0**	**120**	**280**	**400**	**24**

MTHB6010	Metric Spaces and Complex Analysis	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of Metric spaces.
2. To make students learn the concept of Continuous mappings.
3. To impart the knowledge of Analytic functions
4. To convey the basic concepts Taylor's & Laurent's series.

UNIT I:Metric space:L:15

Metric spaces: definition and examples. Sequences in metric spaces, Cauchy sequences.Complete Metric Spaces. Open and closed balls, neighbourhood, open set, interior of a set. Limit point of a set, closed set, diameter of a set, Cantor's theorem. Subspaces, dense sets, separable spaces.

UNIT II:Properties of continuity:L:15

Continuous mappings, sequential criterion and other characterizations of continuity.Uniformcontinuity. Homeomorphism, Contraction mappings, Banach Fixed point Theorem.Connectedness, connected subsets of R.

UNIT III:Functions of complex variable:L:20
Limits, Limits involving the point at infinity, continuity.Properties of complex numbers, regionsin the complex plane, functions of complex variable, mappings. Derivatives, differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric function, derivatives of functions, definite integrals of functions.

UNIT IV:Cauchy integral formula:L:10
Contours, Contour integrals and its examples, upper bounds for moduli of contour integrals.Cauchy- Goursat theorem, Cauchy integral formula.

UNIT V:Taylor's& Laurent series:L:15
Liouville's theorem and the fundamental theorem of algebra. Convergence of sequences and series, Taylor series and its examples.Laurent series and its examples, absolute and uniform convergence of power series.

Reference Books:

1. SatishShirali and Harikishan L. Vasudeva, Metric Spaces, Springer Verlag, London, 2006.
2. S. Kumaresan, Topology of Metric Spaces, 2nd Ed., Narosa Publishing House, 2011.
3. G.F. Simmons, Introduction to Topology and Modern Analysis, McGraw-Hill, 2004.
4. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications, 8th Ed., McGraw – Hill International Edition, 2009.
5. Joseph Bak and Donald J. Newman, Complex Analysis, 2nd Ed., Undergraduate Texts in Mathematics, Springer-Verlag New York, Inc., NewYork, 1997.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of Metric spaces.
2. Understand basic concepts of Continuous mappings.
3. Understand the concept of Analytic functions.
4. Students will able to expand function in the form of Taylor's & Laurent's series

MTHB6020	Ring Theory and Linear Algebra II	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of properties of integer.
2. To make students learn the concept of Dual spaces, dual basis.
3. To impart the knowledge of Inner product spaces and norms.
4. To convey the basic concepts Orthogonal projections and Spectral theorem

UNIT I:Properties of integers:L:20
Polynomial rings over commutative rings, division algorithm and consequences, principal ideal domains, factorization of polynomials, reducibility tests, irreducibility tests, Eisenstein criterion, unique factorization in Z[x]**.** Divisibility in integral domains, irreducibles, primes, unique factorization domains, Euclidean domains.

UNIT II:Eigen values&Eigen vectors:L:20
Dual spaces, dual basis, double dual, transpose of a linear transformation and its matrix in the dual basis,annihilators, Eigen spaces of a linear operator, diagonalizability, invariantsubspaces and Cayley-Hamilton theorem, the minimal polynomial for a linear operator.

UNITIII:Inner product spaces:L:20
Inner product spaces and norms, Gram-Schmidt orthogonalisation process, orthogonalcomplements, Bessel's inequality, the adjoint of a linear operator, Least Squares Approximation

UNIT IV:Solutions of linear equations:L:15
minimal solutions to systems of linear equations, Normal and self-adjoint operators, Orthogonal projections and Spectral theorem.

Reference Books:

1. John B. Fraleigh, A First Course in Abstract Algebra, 7th Ed., Pearson, 2002.
2. M. Artin, Abstract Algebra, 2nd Ed., Pearson, 2011.
3. Joseph A. Gallian, Contemporary Abstract Algebra, 4th Ed., Narosa Publishing House, 1999.
4. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, Linear Algebra, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
5. S. Lang, Introduction to Linear Algebra, 2nd Ed., Springer, 2005.
6. Gilbert Strang, Linear Algebra and its Applications, Thomson, 2007.
7. S. Kumaresan, Linear Algebra- A Geometric Approach, Prentice Hall of India, 1999.
8. Kenneth Hoffman, Ray Alden Kunze, Linear Algebra, 2nd Ed., Prentice-Hall of India Pvt. Ltd.,1971.
9. S.H. Friedberg, A.L. Insel and L.E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd.,2004.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of properties of integer.
2. Able to Understand basic concepts of Dual spaces, dual basis.
3. Understand the concept of Inner product spaces and norms.
4. Able to find Orthogonal projections & related problems

Ability Enhancement Compulsory Course (AECC)

ENGG1000	**English Communication**	**2L:0T:0P**	**2 Credits**

Course Objectives.

1. To acquaint the students with appropriate language skills with the purpose of improving the existing ones – LSRW.
2. To make the learners understand the importance and effective use of non-verbal communication.
3. To make the learner proficient in public speaking and presentation skills.
4. To guide and teach the students to utilize the principles of professional business and technical writing for effective communication in the global world.
5. To deploy technology to communicate effectively in various situations.

Unit I : Communication and Communication Process:

Introduction to Communication, Forms and functions of Communication, Barriers to Communication ((linguistic and semantic, psychological, physical, mechanical, cultural), and overcoming them, Types of communication: verbal and non-verbal communication.

Reading: Introduction to Reading, Barriers to Reading, Types of Reading: Skimming, Scanning, Fast Reading, Strategies for Reading, Comprehension.

Listening : Importance of Listening, Types of Listening, Barriers to Listening.

Unit II :

Writing Skills, Reading Skills & Listening Skills: Features of Good Language, Technical Style of writing, Writing Emails and it's etiquettes, Technical Reports: Report Writing: Types, Format and Structure of reports.

Unit III :

Letter Writing: Types of letters: Job application letter, complaint letter, enquiry letter, reply to enquiry, sales letter. Essential and non-essential parts of letters, formats of letters.

Unit IV :

Grammar: Types of sentences, Antonyms and Synonyms, Use of Auxiliaries and Modal Auxiliaries, Synonyms and Antonyms, Pairs of confused words, Common Errors in sentences.

Unit V :

Soft Skills: Body language, Team work and skills, Decision making ability, Negotiation skills and Interview skills.

Unit VI :

Dialogues Writing and Speaking: Greeting someone and responding to greet, Thanking someone and responding to thanks, Making inquiry and responding to enquiry on telephone, Making request and responding to request.

References:

1. Communication in Organizations by Dalmar Fisher, Jaico Publishing House
2. Communication Skills by Meenakshi Raman &Sangeeta Sharma, Oxford University Press.
3. Business Correspondence & Report-writing by R.C. Sharma& Krishna Mohan, Tata McGraw-Hill Education.
4. Effective Technical Communication by Ashraf Rizvi, Tata McGraw-Hill.
5. Technical Writing & Professional Communication for non-native speakers of English by Thomas N. Huckin& Leslie A. Olsen, McGraw –Hill.
6. Mastering Communication by Nicky Stanton, Palgrave Master Series
7. www.buisnesscommunicationskills.com
8. www.kcitraing.com
9. www.mindtools.com
10. Journal of Business Communication.

Course Outcomes.

The students will be able to-

1. Understand and evaluate information they listen to and express their ideas with greater clarity.
2. Speak and respond effectively along the various channels of communication in a business organization.
3. Speak convincingly before an audience with the help of an expanded vocabulary and enhanced digital content.
4. Communicate through result oriented writing both within and outside the organization.
5. Write a set of effective and easy to understand technical description, instructions.

EVSG2000	**Environment Studies**	**2L:0T:0P**	**2 Credits**

Course Objectives:

1. To consider how the natural and built environments shape and are shaped by multiple socio-cultural and political factors.
2. To think across and beyond existing disciplinary boundaries, mindful of the diverse forms of knowledge and experience that arise from human interactions with the world around them.

Course Outcome :

The Environmental Studies major prepares students for careers as leaders in understanding and addressing complex environmental issues from a problem-oriented, interdisciplinary perspective. Students:

1. Master core concepts and methods from ecological and physical sciences and their application in environmental problem solving.
2. Master core concepts and methods from economic, political, and social analysis as they pertain to the design and evaluation of environmental policies and institutions.
3. Appreciate the ethical, cross-cultural, and historical context of environmental issues and the links between human and natural systems.
4. Understand the transnational character of environmental problems and ways of addressing them, including interactions across local to global scales.
5. Apply systems concepts and methodologies to analyze and understand interactions between social and environmental processes.
6. Reflect critically about their roles and identities as citizens, consumers and environmental actors in a complex, interconnected world.
7. Demonstrate proficiency in quantitative methods, qualitative analysis, critical thinking, and written and oral communication needed to conduct high-level work as interdisciplinary scholars and/or practitioners.

Unit I: Introduction to environmental studies :L:2

Multidisciplinary nature of environmentalstudies;Scope and importance; Concept of sustainability and sustainabledevelopment.

UnitII:EcosystemsL:8Ecosystem, Structure and function of ecosystem; Energy flow in an ecosystem:food chains, food webs and ecological succession. Case studies of the following ecosystems: Forestecosystem, Grasslandecosystem, Desertecosystem, Aquatic ecosystems (ponds, streams, lakes, rivers, oceans,estuaries)

Unit III : Natural Resources : Renewable andNon-renewable Resources L:8

Land resources and landuse change; Land degradation, soil erosion anddesertification.
Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribalpopulations.Water : Use and over-exploitation of surface and ground water,floods, droughts, conflicts overwater(international & inter-state).Energy resources : Renewable and non renewable energy sources, use of alternate energy sources,growing energy needs, casestudies.

Unit IV : Biodiversity and ConservationL:8

Levels of biological diversity : genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspotsIndia asa mega-biodiversity nation; Endangered and endemic speciesof India.Threatsto biodiversity :Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions, Conservation of biodiversity : In-situ and Ex-situ conservation of biodiversity.
Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

UnitV :Environmental PollutionL:8

5.1 Environmental pollution : types, causes, effects and controls; Air, water, soil and noise pollution
5.2 Nuclear hazards and human healthrisks
5.3 Solid waste management : Control measures of urban and industrialwaste.
5.4 Pollution casestudies.

Unit VI : Environmental Policies & PracticesL:8
Climate change, global warming, ozone layer depletion, acid rain and impacts on human communities andagriculture**,**Environment Laws **,**Environment Protection Act; Air (Prevention & Control of Pollution) Act; Water (Prevention and control of Pollution) Act; Wildlife Protection Act; Forest Conservation Act. International agreements: Montreal and Kyoto protocols and Convention on Biological Diversity (CBD).**,**Nature reserves, tribal populations and rights, and human wildlife conflicts in Indian context.

Unit VII : Human Communities and the EnvironmentL:6
Human population growth: Impacts on environment, human health and welfare.Resettlement and rehabilitation of project affected persons; case studies. Disaster management : floods, earthquake, cyclones and landslides. Environmental movements :Chipko, Silent valley, Bishnois of Rajasthan.
Environmental ethics: Role of Indian and other religions and cultures in environmental conservation.
Environmental communication and public awareness, case studies (e.g., CNG vehicles in Delhi).

Unit VIII : Field Work L:6
Visit to an area to document environmental assets: river/ forest/ flora/fauna, etc**.**Visit to a local polluted site---Urban/Rural/Industrial/Agricultural.Study of common plants, insects, birds and basic principles of identification.Study of simple ecosystems---pond, river, Delhi Ridge, etc

References:

1. Gadgil, M., &Guha, R. 1993. This Fissured Land: An Ecological History of India. Univ. of California Press.
2. Gleeson, B. and Low, N. (eds.) 1999. Global Ethics and Environment, London, Routledge.
3. Gleick, P. H. 1993. Water in Crisis. Pacific Institute for Studies in Dev., Environment & Security. Stockholm Env. Institute, Oxford Univ. Press.
4. Groom, Martha J., Gary K. Meffe, and Carl Ronald Carroll. Principles of Conservation Biology. Sunderland: Sinauer Associates, 2006.
5. Grumbine, R. Edward, and Pandit, M.K. 2013. Threats from India's Himalaya dams. Science, 339: 36-37.
6. McCully, P. 1996. Rivers no more: the environmental effects of dams (pp. 29---64). Zed Books.
7. McNeill, John R. 2000. Something New Under the Sun: An Environmental History of the Twentieth Century.
8. Odum, E.P., Odum, H.T. & Andrews, J. 1971. Fundamentals of Ecology. Philadelphia: Saunders.
9. Pepper, I.L., Gerba, C.P. &Brusseau, M.L. 2011. Environmental and Pollution Science. Academic Press.
10. Rao, M.N. &Datta, A.K. 1987. Waste Water Treatment. Oxford and IBH Publishing Co. Pvt. Ltd.
11. Raven, P.H., Hassenzahl, D.M. & Berg, L.R. 2012. Environment. 8th edition. John Wiley & Sons.
12. Rosencranz, A., Divan, S., & Noble, M. L. 2001. Environmental law and policy in India. Tripathi 1992.
13. Sengupta, R. 2003. Ecology and economics: An approach to sustainable development. OUP.
14. Singh, J.S., Singh, S.P. and Gupta, S.R. 2014. Ecology, Environmental Science and Conservation. S. Chand Publishing, New Delhi.
15. Sodhi, N.S., Gibson, L. & Raven, P.H. (eds). 2013. Conservation Biology: Voices from the Tropics. John Wiley & Sons.
16. Thapar, V. 1998. Land of the Tiger: A Natural History of the Indian Subcontinent.
17. Warren, C. E. 1971. Biology and Water Pollution Control. WB Saunders.
18. Wilson, E. O. 2006. The Creation: An appeal to save life on earth. New York: Norton.

World Commission on Environment and Development. 1987. Our Common Future.
Oxford University Press.

LIST OF GENERAL ELECTIVE SUBJECTS

List of Generic Electives Available for students of B.Sc. (Hons.)

Semester	Offering Department	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	Physics	PHYB1010+PHYB1011	Mechanics	4-0-4	6
II	Physics	PHYB2010+PHYB2011	Thermal Physics	4-0-4	6
III	Physics	PHYB3010+PHYB3011	Waves and Optics	4-0-4	6
IV	Physics	PHYB4010+PHYB4011	Elements of Modern Physics	4-0-4	6
I	Chemistry	CHYB1010 + CHYB1011	Inorganic Chemistry	4-0-4	6
II	Chemistry	CHYB2010 + CHYB2011	Organic Chemistry	4-0-4	6
III	Chemistry	CHYB3010 + CHYB3011	Physical Chemistry	4-0-4	6
IV	Chemistry	CHYB4010 + CHYB4011	Basic Analytical Chemistry	4-0-4	6

----------**PHYSICS** ----------

PHYB1010	MECHANICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

6. To impart the knowledge of dynamical laws of motion.
7. To impart the knowledge of rotational dynamics, eleasiticity and fluid motion.
8. To make students learn the theory of gravitation and central forces.
9. To make students learn oscillatory motion and non inertial systems.
10. To impart the knowledge of special theory of relativity.

Unit 1: **Fundamentals of Dynamics:** L:13

Reference frames. Inertial frames; Review of Newton's Laws of Motion.Galilean transformations; Galilean invariance. Momentum of variable- mass system: motion of rocket. Motion of a projectile in Uniform gravitational field Dynamics of a system of particles. Centre of Mass. Principle of conservation of momentum. Impulse.Work and Kinetic Energy Theorem.Conservative and non- conservative forces.Potential Energy.Energy diagram.Stable and unstable equilibrium.Elastic potential energy. Force as gradient of potential energy. Work & Potential energy.Work done by non-conservative forces.Law of conservation of Energy.Elastic and inelastic collisions between particles. Centre of Mass and Laboratory frames.

Unit 2: **Rotational Dynamics, Elasticity and Fluid Motion: L: 17**

Angular momentum of a particle and system of particles.Torque.Principle of conservation of angular momentum.Rotation about a fixed axis.Moment of Inertia.Calculation of moment of inertia for rectangular, cylindrical and spherical bodies.Kinetic energy of rotation.Motion involving both translation and rotation.Relation between Elastic constants.Twisting torque on a Cylinder or Wire. Kinematics of Moving Fluids: Poiseuille's Equation for Flow of a Liquid through a Capillary Tube.

Unit 3: **Gravitation and Central Force Motion:** L:16

Law of gravitation.Gravitational potential energy.Inertial and gravitational mass.Potential and field due to spherical shell and solid sphere.

Motion of a particle under a central force field.Two-body problem and its reduction to one-body problem and its solution. The energy equation and energy diagram. Kepler's Laws.Satellite in circular orbit and applications. Geosynchronous orbits. Weightlessness.Basic idea of global positioning system (GPS).Simple Harmonic Oscillations.Differential equation of SHM and its solution.Kinetic energy, potential energy, total energy and their time-average values.Damped oscillation. Forced oscillations: Transient and steady states; Resonance, sharpness of resonance; power dissipation and Quality Factor.

Unit 4: **Non-Inertial Systems:** L: 4

Non-inertial frames and fictitious forces.Uniformly rotating frame.Laws of Physics in rotating coordinate systems.Centrifugal force.Coriolis force and its applications.Components of Velocity and Acceleration in Cylindrical and Spherical Coordinate Systems.

Unit 5: **Special Theory of Relativity:** L:10

Michelson-Morley Experiment and its outcome.Postulates of Special Theory of Relativity.Lorentz Transformations.Simultaneity and order of events.Lorentz contraction.Time dilation.Relativistic transformation of velocity, frequency and wave number.Relativistic addition of velocities.Variation of mass with velocity.Massless Particles.Mass-energy Equivalence. Relativistic Doppler effect. Relativistic Kinematics.Transformation of Energy and Momentum.

Text /Reference Books:

1. An introduction to mechanics, D. Kleppner, R.J. Kolenkow, 1973, McGraw-Hill.
2. Mechanics, Berkeley Physics, vol.1, C.Kittel, W.Knight, et.al. 2007, Tata McGraw-Hill.
3. Physics, Resnick, Halliday and Walker 8/e. 2008, Wiley.
4. Analytical Mechanics, G.R. Fowles and G.L. Cassiday. 2005, Cengage Learning.
5. Feynman Lectures, Vol. I, R.P.Feynman, R.B.Leighton, M.Sands, 2008, Pearson Education
6. Introduction to Special Relativity, R. Resnick, 2005, John Wiley and Sons.
7. University Physics, Ronald Lane Reese, 2003, Thomson Brooks/Cole.
8. Mechanics, D.S. Mathur, S. Chand and Company Limited, 2000
9. University Physics. F.W Sears, M.W Zemansky, H.D Young 13/e, 1986, Addison Wesley
10. Physics for scientists and Engineers with Modern Phys., J.W. Jewett, R.A. Serway, 2010, Cengage Learning
11. Theoretical Mechanics, M.R. Spiegel, 2006, Tata McGraw Hill.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand concept of centre of mass and different kinds of frames of references.
2. Acquire knowledge of different types of forces of work and energy.
3. Understand the rotational and translational dimensions.
4. Understand the dynamics of oscillations and non inertial systems.
5. Impart the knowledge about theory of relativity and its importance.

PHYB1011	MECHANICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Measurements of length (or diameter) using verniercalipers, screw gauge and travellingmicroscope.
2. To study the random error inobservations.
3. To determine the elastic Constants of a wire by Searle'smethod.
4. To determine Coefficient of Viscosity of water by Capillary Flow Method (Poiseuille's method).
5. To determine the Moment of Inertia of aFlywheel.
6. To determine the value of g using BarPendulum.
7. To determine the value of g using Kater'sPendulum.
8. To study the Motion of Spring and calculate (a) Spring constant, (b) **g** and (c) Modulus ofrigidity.
9. TodeterminetheModulusofRigidityofaWirebyMaxwell'sneedle.
10. To determine**g**andvelocityforafreelyfallingbodyusingDigitalTimingTechnique.
11. TodeterminetheYoung'sModulusofaWirebyOpticalLeverMethod.

PHYB2010	THERMAL PHYSICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

5. Impart the knowledge of the basic laws of thermodynamics
6. To make students learn the concept of entropy and free energies.
7. To impart the knowledge of thermodynamic relations and kinetic theroy of gases.
8. To impart the knowledge of heat through molecular collisions.
9. To convey the basic concepts related to behavior of real gasses.

Unit 1: **Introduction to Thermodynamics:** L:10

Zeroth and First Law of Thermodynamics: Extensive and intensive Thermodynamic Variables, Thermodynamic Equilibrium, Zeroth Law of Thermodynamics & Concept of Temperature, Concept of Work & Heat, State Functions, First Law of Thermodynamics and its differential form, Internal Energy, First Law & various processes, Applications of First Law: General Relation between CP and CV, Work Done during Isothermal and Adiabatic Processes, Compressibility and Expansion Co-efficient.

Unit 2: **Second Law of Thermodynamics:** L:8

Reversible and Irreversible process with examples.Conversion of Work into Heat and Heat into Work.Heat Engines.Carnot's Cycle, Carnot engine & efficiency. Refrigerator

&coefficient of performance, 2nd Law of Thermodynamics: Kelvin-Planck and Clausius Statements and their Equivalence. Carnot's Theorem. Applications of Second Law of Thermodynamics: Thermodynamic Scale of Temperature and its Equivalence to Perfect Gas Scale.

Unit 3: **Entropy and Thermodynamic Potentials:** L:14

Concept of Entropy, Clausius Theorem.Clausius Inequality, Second Law of Thermodynamics in terms of Entropy.Entropy of a perfect gas.Principle of Increase of Entropy. Entropy Changes in Reversible and Irreversible processes with examples. Entropy of the Universe.Entropy Changes in Reversible and Irreversible Processes.Principle of Increase of Entropy. Temperature–Entropy diagrams for Carnot's Cycle. Third Law of Thermodynamics.Unattainability of Absolute Zero. Thermodynamic Potentials: Internal Energy, Enthalpy, Helmholtz Free Energy, Gibb's Free Energy. Their Definitions, Properties and Applications.Surface Films and Variation of Surface Tension with Temperature. Magnetic Work, Cooling due to adiabatic demagnetization, First and second order Phase Transitions with examples, ClausiusClapeyron Equation and Ehrenfest equations.

Unit 4: **Maxwell's Thermodynamic Relations:** L:10

Derivations and applications of Maxwell's Relations, Maxwell's Relations:(1) ClausiusClapeyron equation, (2) Values of Cp-Cv, (3) TdS Equations, (4) Joule-Kelvin coefficient for Ideal and Van der Waal Gases, (5) Energy equations, (6) Change of Temperature during Adiabatic Process.

Unit 5**: Kinetic Theory of Gases:** L:20

Maxwell-Boltzmann Law of Distribution of Velocities in an Ideal Gas and its Experimental Verification.Mean, RMS and Most Probable Speeds. Degrees of Freedom. Law of Equipartition of Energy (No proof required). Specific heats of Gases.Mean Free Path. Collision Probability.Estimates of Mean Free Path. Transport phenomenon in Ideal Gases. Brownian Motion and its Significance. Behavior of Real Gases: Deviations from the Ideal Gas Equation. The Virial Equation.Boyle Temperature. Van der Waal's Equation of State for Real Gases. Values of Critical Constants.Law of Corresponding States.Comparison with Experimental Curves.P-V Diagrams. Free Adiabatic Expansion of a Perfect Gas. Joule-Thomson Effect.

Text /Reference Books:

1. Heat and Thermodynamics, M.W. Zemansky, Richard Dittman, 1981, McGraw-Hill.
2. A Treatise on Heat, MeghnadSaha, and B.N.Srivastava, 1958, Indian Press
3. Thermal Physics, S. Garg, R. Bansal and Ghosh, 2nd Edition, 1993, Tata McGraw-Hill
4. Modern Thermodynamics with Statistical Mechanics, Carl S. Helrich, 2009, Springer.

5. Thermodynamics, Kinetic Theory & Statistical Thermodynamics, Sears & Salinger. 1988, Narosa.
6. Concepts in Thermal Physics, S.J. Blundell and K.M. Blundell, 2nd Ed., 2012, Oxford University Press
7. Thermal Physics, A. Kumar and S.P. Taneja, 2014, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

5. Understand different laws of thermodynamics.
6. Understand basic concepts of entropy and enthalpy.
7. Understand the concept of free energies and thermodynamics potential.
8. Understand the kinetic Theory of Gases.
9. Possess sound knowledge of theories for ideal and real gases.

PHYB2011	THERMAL PHYSICS LAB	0L:0T:4P	4 Credits

LIST OF EXPERIMENTS:

1. To study the variation of Thermo-Emf of a Thermocouple with Difference of Temperature of its Two Junctions.
2. Newtons law of cooling.
3. Stefan's constant.
4. To determine Mechanical Equivalent of Heat, J, by Callender and Barne's constant flow method.
5. To determine the Coefficient of Thermal Conductivity of a bad conductor by Lee and Charlton's disc method.
6. To determine the Temperature Coefficient of Resistance by Platinum Resistance Thermometer (PRT).
7. To calibrate a thermocouple to measure temperature in a specified Range using Null Method

PHYB3010	WAVES AND OPTICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of collinear harmonic oscillator and wave motion.
2. To make students learn about superposition of harmonic waves
3. To make students learn the theories of interference and various interferometers.
4. To impart the knowledge of diffraction and diffractometers.

5. To impart the knowledge of holography.

Unit 1: **Superposition of Harmonic oscillations:** L:9

Linearity and Superposition Principle. Superposition of two collinear oscillations having (1) equal frequencies and (2) different frequencies (Beats). Superposition of N collinear Harmonic Oscillations with (1) equal phase differences and (2) equal frequency differences.Graphical and Analytical Methods.Lissajous Figures with equal an unequal frequency and their uses.

Unit 2: **Wave Motion:** L:8

Plane and Spherical Waves.Longitudinal and Transverse Waves.Plane Progressive (Travelling) Waves.Wave Equation.Particle and Wave Velocities.Differential Equation.Pressure of a Longitudinal Wave.Energy Transport.Intensity of Wave. Water Waves: Ripple and Gravity Waves. Velocity of Transverse Vibrations of Stretched Strings.Velocity of Longitudinal Waves in a Fluid in a Pipe.Newton's Formula for Velocity of Sound.Laplace's Correction.

Unit 3: **Superposition of Two Harmonic Waves:** L:10

Standing (Stationary) Waves in a String: Fixed and Free Ends.Analytical Treatment.Phase and Group Velocities.Changes with respect to Position and Time.Energy of Vibrating String.Transfer of Energy.Normal Modes of Stretched Strings. Plucked and Struck Strings. Melde's Experiment.Longitudinal Standing Waves and Normal Modes.Open and Closed Pipes.Superposition of N Harmonic Waves.Electromagnetic nature of light.Definition and properties of wave front.Huygens Principle.Temporal and Spatial Coherence.

Unit 4: **Interference:** L:13

Division of amplitude and wavefront. Young's double slit experiment. Lloyd's Mirror and Fresnel's Biprism. Phase change on reflection: Stokes' treatment. Interference in Thin Films: parallel and wedge-shaped films. Fringes of equal inclination (Haidinger Fringes); Fringes of equal thickness (Fizeau Fringes). Newton's Rings: Measurement of wavelength and refractive index. Michelson Interferometer-(1) Idea of form of fringes (No theory required), (2) Determination of Wavelength, (3) Wavelength Difference, (4) Refractive Index, and (5) Visibility of Fringes. Fabry-Perot interferometer.

Unit 5: **Diffraction:** L:20

Kirchhoff's Integral Theorem, Fresnel-Kirchhoff's Integral formula. (Qualitative discussion only) Fraunhofer diffraction: Single slit. Circular aperture, Resolving Power of a telescope.Double slit. Multiple slits. Diffraction grating.Resolving power of grating. Fresnel Diffraction: Fresnel's Assumptions. Fresnel's Half-Period Zones for Plane Wave.

Explanation of Rectilinear Propagation of Light. Theory of a Zone Plate: Multiple Foci of a Zone Plate. Fresnel's Integral, Fresnel diffraction pattern of a straight edge, a slit and a wire.Principle of Holography.Recording and Reconstruction Method.Theory of Holography as Interference between two Plane Waves.Point source holograms.

Text /Reference Books:

1. Waves: Berkeley Physics Course, vol. 3, Francis Crawford, 2007, Tata McGraw-Hill.
2. Fundamentals of Optics, F.A. Jenkins and H.E. White, 1981, McGraw-Hill
3. Principles of Optics, Max Born and Emil Wolf, 7th Edn., 1999, Pergamon Press.
4. Optics, AjoyGhatak, 2008, Tata McGraw Hill
5. The Physics of Vibrations and Waves, H. J. Pain, 2013, John Wiley and Sons.
6. The Physics of Waves and Oscillations, N.K. Bajaj, 1998, Tata McGraw Hill.
7. Fundamental of Optics, A. Kumar, H.R. Gulati and D.R. Khanna, 2011, R. Chand Publications.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand wave motion and theories of superposition of harmonic oscillations.
2. Understand superposition of harmonic waves and wave optics.
3. Understand theories of interference.
4. Possess sound knowledge of diffraction methods.
5. Understand principle of holography.

PHYB3011	WAVES AND OPTICS LAB	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Familiarization with: Schuster`s focusing; determination of angle of prism.
2. To determine refractive index of the Material of a prism using sodium source.
3. To determine the dispersive power and Cauchy constants of the material of a prism using mercury source.
4. To determine the wavelength of sodium source using Michelson's interferometer.
5. To determine wavelength of sodium light using Fresnel Biprism.
6. To determine wavelength of sodium light using Newton's Rings.
7. To determine wavelength of (1) Na source and (2) spectral lines of Hg source using plane diffraction grating.
8. To determine dispersive power and resolving power of a plane diffractiongrating.

9. To study Lissajous Figures.

10. To determine the frequency of an electric tuning fork by Melde's experiment and verify λ^2 –T law.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Take measurements using various optical benches, interferometers, diffractometers.
2. Determine angle, refrective index and dispersive power of a prism using various techniques.
3. Determine wavelength of a light source using various optical techniques.
4. Determine dispersive power and resolving power of diffraction gratings.
5. Study and understand lissajous figures.

PHYB4010	ELEMENTS OF MODERN PHYSICS	4L:0T:0P	4 Credits

Course learning objectives:

The objectives of this course are

1. To impart the knowledge of quantum theory of radiation
2. To impart the knowledge of basic quantum mechanics
3. To make student learn elements of nuclear physics
4. To impart the knowledge on lasers and their applications

Unit 1: **Quantum theory of Radiation:** L:14

Planck's quantum law, Planck's constant and light as a collection of photons; Blackbody, Quantum theory of Light; Photo-electric effect and Compton scattering.De Broglie wavelength and matter waves; Davisson-Germer experiment.Wave description of particles by wave packets.Group and Phase velocities and relation between them. Two-Slit experiment with electrons. Probability. Wave amplitude and wave functions.Position measurement-gamma ray microscope thought experiment; Wave-particle duality,

Unit 2: **Quantum Mechanics:** L:19

Heisenberg uncertainty principle (Uncertainty relations involving Canonical pair of variables): Derivation from Wave Packets, impossibility of a particle following a trajectory; Estimating minimum energy of a confined particle using uncertainty principle; Energy-time uncertainty principle- application to virtual particles and range of an interaction. Two slit interference experiment with photons, atoms and particles; linear superposition principle as a consequence; Matter waves and wave amplitude; Schrodinger equation for non-relativistic

particles; Momentum and Energy operators; stationary states; physical interpretation of a wave function, probabilities and normalization; Probability and probability current densities in one dimension. One dimensional infinitely rigid box- energy eigenvalues and eigenfunctions, normalization; Quantum dot as example; Quantum mechanical scattering and tunneling in one dimension-across a step potential & rectangular potential barrier.

Unit 3: **Nuclear Physics:**L:12

Size and structure of atomic nucleus and its relation with atomic weight; Impossibility of an electron being in the nucleus as a consequence of the uncertainty principle. Nature of nuclear force, NZ graph, Liquid Drop model: semi-empirical mass formula and binding energy, Nuclear Shell Model and magic numbers.Radioactivity**:** stability of the nucleus; Law of radioactive decay; Mean life and half-life; Alpha decay; Beta decay- energy released, spectrum and Pauli's prediction of neutrino; Gamma ray emission, energy-momentum conservation: electron-positron pair creation by gamma photons in the vicinity of a nucleus.

Unit 4: **Fission and fusion:**L:8

Mass deficit, relativity and generation of energy; Fission - nature of fragments and emission of neutrons. Nuclear reactor: slow neutrons interacting with Uranium 235; Fusion and thermonuclear reactions driving stellar energy (brief qualitative discussions).

Unit 5: **Lasers:**L:8

Einstein’s A and B coefficients.Metastable states. Spontaneous and Stimulated emissions. Optical Pumping and Population Inversion.Three-Level and Four-Level Lasers.Ruby Laser and He-Ne Laser.Basic lasing.

Text /Reference Books:

1. Concepts of Modern Physics, Arthur Beiser, 2002, McGraw-Hill.
2. Introduction to Modern Physics, Rich Meyer, Kennard, Coop, 2002, Tata McGraw Hill
3. Introduction to Quantum Mechanics, David J. Griffith, 2005, Pearson Education.
4. Physics for scientists and Engineers with Modern Physics, Jewett and Serway, 2010, Cengage Learning.
5. Modern Physics, G.Kaur and G.R. Pickrell, 2014, McGraw Hill
6. Quantum Mechanics: Theory & Applications, A.K.Ghatak&S.Lokanathan, 2004, Macmillan
7. Modern Physics, J.R. Taylor, C.D. Zafiratos, M.A. Dubson, 2004, PHI Learning.
8. Theory and Problems of Modern Physics, Schaum`s outline, R. Gautreau and W. Savin, 2nd Edn, Tata McGraw-Hill Publishing Co. Ltd.
9. Quantum Physics, Berkeley Physics, Vol.4. E.H.Wichman, 1971, Tata McGraw-Hill Co.

10. Basic ideas and concepts in Nuclear Physics, K.Heyde, 3rd Edn., Institute of Physics Pub.

11. Six Ideas that Shaped Physics: Particle Behave like Waves, T.A.Moore, 2003, McGraw Hill

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand quantum theory of radiation
2. Possess knowledge of introductory quantum mechanics
3. Understand the fundamentals of nuclear physics.
4. Understand the working principle and applications of lasers.

PHYB4011	**ELEMENTS OF MODERN PHYSICS LAB**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

1. To determine the wavelength of laser source using diffraction of single slit.
2. To determine the wavelength of laser source using diffraction of double slits.
3. To determine (1) wavelength and (2) angular spread of He-Ne laser using plane diffraction grating
4. Measurement of Planck's constant using black body radiation and photo-detector.
5. Photo-electric effect: photo current versus intensity and wavelength of light; maximum energy of photo-electrons versus frequency of light
6. To determine work function of material of filament of directly heated vacuum diode.
7. To determine the Planck's constant using LEDs of at least 4 different colours.
8. To determine the wavelength of H-alpha emission line of Hydrogen atom.
9. To determine the ionization potential of mercury.
10. To determine the absorption lines in the rotational spectrum of Iodine vapour.
11. To determine the value of e/m by (a) Magnetic focusing or (b) Bar magnet.
12. To setup the Millikan oil drop apparatus and determine the charge of an electron.

To show the tunneling effect in tunnel diode using I-V characteristics.

----------CHEMISTRY----------

CHYB1010	**Inorganic Chemistry**	**4L:0T:0P**	**4 Credits**

Course Learning Objectives:

The objective of this course is:
1. To make student learn about wave mechanics.
2. To study about periodic properties of S,P,D& F block elements
3. To impart knowledge of covalent and ionic bond.
4. To impart knowledge of metallic bonds and weak Chemical Forces
5. To make student learn about oxidation and reduction.

Unit 1: **Atomic Structure:** L:14

Bohr's theory, its limitations and atomic spectrum of hydrogen atom. Wave mechanics: de Broglie equation, Heisenberg's Uncertainty Principle and its significance, Schrödinger's wave equation, significance of ψ and ψ^2. Quantum numbers and their significance.Normalized and orthogonal wave functions. Sign of wave functions. Radial and angular wave functions for hydrogen atom. Radial and angular distribution curves. Shapes of *s, p, d* and *f* orbitals. Contour boundary and probability diagrams. Pauli's Exclusion Principle, Hund's rule of maximum multiplicity, Aufbau's principle and its limitations, Variation of orbital energy with atomic number.

Unit 2: **Periodicity of Elements:** L:16
s, p, d, f block elements, the long form of periodic table. Properties of the elements with reference to *s*&*p*-block. (a) Effective nuclear charge, shielding or screening effect, Slater rules, variation of effective nuclear charge in periodic table. (b) Atomic radii (van der Waals) Ionic and crystal radii. Covalent radii (octahedral and tetrahedral) Ionization enthalpy, Successive ionization enthalpies and factors affecting ionization energy. Applications of ionization enthalpy. Electron gain enthalpy, trends of electron gain enthalpy. Electronegativity, Pauling's/ Mulliken's/Allred Rachow's/ and Mulliken-Jaffé's electronegativity scales. Variation of electronegativity with bond order, partial charge, hybridization, group electronegativity.Sanderson's electron density ratio.

Unit 3: **Chemical Bonding I:** L:16
Ionic bond: General characteristics, types of ions, size effects, radius ratio rule and its limitations. Packing of ions in crystals.Born-Landé equation with derivation and importance of Kapustinskii expression for lattice energy.Madelung constant, Born-Haber cycle and its application, Solvation energy.

Covalent bond: Lewis structure, Valence Bond theory (Heitler-London approach). Energetics of hybridization, equivalent and non-equivalent hybrid orbitals.Bent's rule, Resonance and resonance energy, Molecular orbital theory. Molecular orbital diagrams of diatomic and simple polyatomic molecules N_2, O_2, C_2, B_2, F_2, CO, NO, and their ions; HCl, BeF_2, CO_2, (idea of s-p mixing and orbital interaction to be given). Formal charge, Valence shell electron pair repulsion theory (VSEPR), shapes of simple molecules and ions containing lone pairs and bond

pairs of electrons, multiple bonding (σ and π bond approach) and bond lengths. Covalent character in ionic compounds, polarizing power and polarizability.Fajan's rules and consequences of polarization. Ionic character in covalent compounds: Bond moment and dipolemoment.

Unit 4: **Chemical Bonding II:** L:10
Metallic Bond: Qualitative idea of valence bond and band theories. Semiconductors and insulators, defects in solids.
Weak Chemical Forces: van der Waals forces, ion-dipole forces, dipole-dipole interactions, induced dipole interactions, Instantaneous dipole-induced dipole interactions. Repulsive forces, Hydrogen bonding (theories of hydrogen bonding, valence bond treatment) Effects of chemical force, melting and boiling points, solubility energetics of dissolution process.

Unit 5:**Oxidation-Reduction:** L:4
Redox equations, Standard Electrode Potential and its application to inorganic reactions.

Text/Reference Books:

- Lee, J.D. Concise Inorganic Chemistry, ELBS, 1991.
- Douglas, B.E. and Mc Daniel, D.H., Concepts & Models of Inorganic Chemistry, Oxford, 1970
- Atkins, P.W. & Paula, J. Physical Chemistry, Oxford Press, 2006.
- Day, M.C. and Selbin, J. Theoretical Inorganic Chemistry, ACS Publications 1962.

Course Outcomes:

At the end of this course students will be able to:

1. Understand the concept of wave mechanics.
2. Know the variations of periodic properties in S, P, D and F block elements.
3. Have knowledge of different types of bond nature.
4. Understand the weak chemical forces interactions.
5. To solve problems related to oxidation and reduction.

CHYB1010	Inorganic Chemistry Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

(A) Titrimetric Analysis

(i) Calibration and use of apparatus
(ii) Preparation of solutions of different Molarity/Normality of titrants

(B) Acid-Base Titrations

(i) Estimation of carbonate and hydroxide present together in mixture.
(ii) Estimation of carbonate and bicarbonate present together in a mixture.
(iii) Estimation of free alkali present in different soaps/detergents

(C) Oxidation-Reduction Titrimetry

(i) Estimation of Fe(II) and oxalic acid using standardized $KMnO_4$ solution.
(ii) Estimation of oxalic acid and sodium oxalate in a given mixture.
(iii) Estimation of Fe(II) with $K_2Cr_2O_7$ using internal (diphenylamine, anthranilic acid) and external indicator.

Reference text:

1. Vogel, A.I. A Textbook of Quantitative Inorganic Analysis, ELBS.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To have knowledge of calibration of different glassware's.
2. To prepare different normal and molar solution.
3. To have knowledge of acid base reaction.
4. To Estimate free alkali present in different soaps/detergents.
5. Understand concept of oxidation and reduction based reactions.

CHYB2010	Organic Chemistry	4L:0T:0P	4 Credits

Course Learning Objectives:

The objective of this course is:
1. To impart knowledge of hybridization, Electronic Displacements reactions.
2. To make students learn about chemistry of alkanes.
3. To make students understand carbon-carbon pi bonds.
4. To impart knowledge of cycloalkanes and conformational Analysis.
5. To make students understand aromatic character of cyclic compounds.

Unit 1: **Organic Compounds:** L: 16
Classification, and Nomenclature, Hybridization, Shapes of molecules, Influence of hybridization on bond properties.
Electronic Displacements: Inductive, electromeric, resonance and mesomeric effects, hyperconjugation and their applications; Dipole moment; Organic acids and bases; their relative strength. Homolytic and Heterolytic fission with suitable examples.Curly arrow rules, formal charges; Electrophiles and Nucleophiles; Nucleophlicity and basicity; Types, shape and their relative stability of Carbocation's, Carbanion, Free radicals and Carbenes.
Introduction to types of organic reactions and their mechanism: Addition, Elimination and Substitution reactions.

Unit 2: **Carbon-Carbon sigma bonds::** L: 8

Chemistry of alkanes: Formation of alkanes, Wurtz Reaction, Wurtz-Fittig Reactions, Free radical substitutions: Halogenation -relative reactivity and selectivity.

Unit 3: **Carbon-Carbon pi bonds::**L: 14
Formation of alkenes and alkynes by elimination reactions, Mechanism of E1, E2, E1cb reactions.Saytzeff and Hofmann eliminations.
Reactions of alkenes: Electrophilic additions their mechanisms (Markownikoff/ Anti Markownikoff addition), mechanism of oxymercuration-demercuration, hydroborationoxidation, ozonolysis, reduction (catalytic and chemical), syn and anti-hydroxylation (oxidation). 1,2-and 1,4-addition reactions in conjugated dienes and, Diels-Alder reaction; Allylic and benzylicbromination and mechanism, e.g. propene, 1-butene, toluene, ethyl benzene.
Reactions of alkynes: Acidity, Electrophilic and Nucleophilic additions. Hydration to form carbonyl compounds, Alkylation of terminal alkynes.

Unit 4: **Cycloalkanes and Conformational Analysis** : L: 10
Types of cycloalkanes and their relative stability, Baeyer strain theory, Conformation analysis of alkanes: Relative stability: Energy diagrams of cyclohexane: Chair, Boat and Twist boat forms; Relative stability with energy diagrams.

Unit 5: **Aromaticity:** L: 12
Hückel's rule, aromatic character of arenes, cyclic carbocations/carbanions and heterocyclic compounds with suitable examples. Electrophilic aromatic substitution: halogenation, nitration, sulphonation and Friedel-Craft's alkylation/acylation with their mechanism. Directing effects of the groups.

Text/Reference Books:

- Morrison, R. N. & Boyd, R. N. Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 1), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Finar, I. L. Organic Chemistry (Volume 2: Stereochemistry and the Chemistry of Natural Products), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
- Eliel, E. L. &Wilen, S. H. Stereochemistry of Organic Compounds; Wiley: London, 1994.
- Kalsi, P. S. Stereochemistry Conformation and Mechanism; New Age International, 2005.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Apply the knowledge of hybridization and molecular displacements in molecular modeling.

2. Learn the preparation and properties of alkanes.
3. Have knowledge of chemical reactions of alkenes and alkynes.
4. Understand the concept of Conformation analysis of alkanes.
5. Understand concept of aromaticity.

CHYB2011	Organic Chemistry Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Checking the calibration of the thermometer
2. Purification of organic compounds by crystallization using the following solvents:

a. Water
b. Alcohol
c. Alcohol-Water

3. Determination of the melting points of above compounds and unknown organic compounds (Kjeldahl method and electrically heated melting point apparatus)
4. Effect of impurities on the melting point – mixed melting point of two unknown organic compounds
5. Determination of boiling point of liquid compounds. (boiling point lower than and more than 100 °C by distillation and capillary method)
6. Chromatography

a. Separation of a mixture of two amino acids by ascending and horizontal paper chromatography
b. Separation of a mixture of two sugars by ascending paper chromatography
c. Separation of a mixture of o-and p-nitrophenol or o-and p-aminophenol by thin layer chromatography (TLC)

Reference Books

- Mann, F.G. & Saunders, B.C. Practical Organic Chemistry, Pearson Education (2009)
- Furniss, B.S.; Hannaford, A.J.; Smith, P.W.G.; Tatchell, A.R. Practical Organic Chemistry, 5th Ed., Pearson (2012)

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To purify organic compounds by crystallization.
2. To determine the melting points of unknown organic compounds.
3. To determine mixed melting point of two unknown organic compounds
4. To determine boiling point of liquid compounds.
5. Separate a mixture of various compounds by the help of chromatography.

CHYB1020	Physical Chemistry	4L:0T:0P	4 Credits

Course Learning Objectives:

The objective of this course is:

1. To impart knowledge of phase and binary solutions.
2. Students will learn about molecularity, rate laws and kinetics of complex reactions.
3. To gain knowledge of collision theory of reaction rates and temperature dependence of reaction rates.
4. To impart knowledge of enzyme catalysis.
5. To make students learn about surface chemistry.

Unit 1: **Phase Equilibria:** L:28

Concept of phases, components and degrees of freedom, liquid-vapour and solid-vapour equilibria, phase diagram for one component systems, two and three component systems.

Binary solutions: Gibbs-Duhem-Margules equation, its derivation and applications to fractional distillation of binary miscible liquids (ideal and nonideal), azeotropes, lever rule, partial miscibility of liquids, CST, miscible pairs, steam distillation. Nernst distribution law: its derivation and applications.

Unit 2: **Chemical Kinetics I:** L:10

Order and molecularity of a reaction, rate laws in terms of the advancement of a reaction, differential and integrated form of rate expressions up to second order reactions, experimental methods of the determination of rate laws, kinetics of complex reactions (integrated rate expressions up to first order only): (i) Opposing reactions (ii) parallel reactions and (iii) consecutive reactions and their differential rate equations (steady-state approximation in reaction mechanisms) (iv) chain reactions.

Unit 3: **Chemical Kinetics II:** L:8

Temperature dependence of reaction rates; Arrhenius equation; activation energy. Collision theory of reaction rates, Lindemann mechanism, qualitative treatment of the theory of absolute reaction rates.

Unit 4: **Catalysis:**L:8

Types of catalyst, specificity and selectivity, mechanisms of catalyzed reactions at solid surfaces; effect of particle size and efficiency of nanoparticles as catalysts.Enzyme catalysis, Michaelis-Menten mechanism, acid-base catalysis.

Unit 5: **Surface chemistry:**L:6

Physical adsorption, chemisorption, adsorption isotherms.nature of adsorbed state.

Text/Reference Books:

- Peter Atkins & Julio De Paula, Physical Chemistry9th Ed., Oxford University Press (2010).
- Castellan, G. W. Physical Chemistry, 4th Ed., Narosa (2004).

- McQuarrie, D. A. & Simon, J. D., Molecular Thermodynamics, Viva Books Pvt. Ltd.: New Delhi (2004).

- Engel, T. & Reid, P. Physical Chemistry 3rd Ed., Prentice-Hall (2012).
- Assael, M. J.; Goodwin, A. R. H.; Stamatoudis, M.; Wakeham, W. A. & Will, S. Commonly Asked Questions in Thermodynamics. CRC Press: NY (2011).
- Zundhal, S.S. Chemistry concepts and applicationsCengage India (2011).
- Ball, D. W. Physical ChemistryCengage India (2012).
- Mortimer, R. G. Physical Chemistry3rd Ed., Elsevier: NOIDA, UP (2009).
- Levine, I. N. Physical Chemistry6th Ed., Tata McGraw-Hill (2011).
- Metz, C. R. Physical Chemistry2nd Ed., Tata McGraw-Hill (2009).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Students will learn about phase equilibria and binary solutions.
2. Will have idea of molecularity and rate laws.
3. Students will have idea about collision theory of reaction rates.
4. Students will understand about enzyme catalytic reaction.
5. Solve problems related to surface chemistry.

CHYB1021	**Physical Chemistry Lab**	**0L:0T:4P**	**2 Credits**

LIST OF EXPERIMENTS:

I. Determination of critical solution temperature and composition of the PHBEnol-water system and to study the effect of impurities on it.

II. Phase equilibria: Construction of the phase diagram using cooling curves or ignition tube method:

a. simple eutectic and

b. congruently melting systems.

III. Distribution of acetic/ benzoic acid between water and cyclohexane.

IV. Study the equilibrium of at least one of the following reactions by the distribution method:

(i) $I_2(aq) + I^- \rightarrow I_3^-(aq)$

(ii) $Cu^{2+}(aq) + n NH_3 \rightarrow Cu(NH_3)_n$

V. Study the kinetics of the following reactions.

1.Initial rate method: Iodide-persulphatereaction 2.Integrated rate method:

a. Acid hydrolysis of methyl acetate with hydrochloric acid.

b. Saponification of ethyl acetate. Compare the strengths of HCl and H_2SO_4 by studying kinetics of hydrolysis of methyl acetate.

VI. Adsorption

Verify the Freundlich and Langmuir isotherms for adsorption of acetic acid on activated charcoal.

Text/Reference Books:

- Khosla, B. D.; Garg, V. C. &Gulati, A. Senior Practical Physical Chemistry, R. Chand & Co.: New Delhi (2011).
- Garland, C. W.; Nibler, J. W. & Shoemaker, D. P. Experiments in Physical Chemistry8th Ed.; McGraw-Hill: New York (2003).
- Halpern, A. M. &McBane, G. C. Experimental Physical Chemistry3rd Ed.; W.H. Freeman & Co.: New York (2003).

CHYB2020	Basic Analytical Chemistry	4L:0T:0P	4 Credits

Course Learning Objectives:

The objective of this course is:

1. To introduce students about analytical chemistry and its concept.
2. To impart knowledge of analysis of soil and water.
3. To make students study about food products and preservatives.
4. To make students learn about chromatography and constituents of cosmetics.
5. To study the use spectrophotometer and flame photometer for performing different experiments.

Unit 1: **Introduction:** L: 5

Introduction to Analytical Chemistry and its interdisciplinary nature.Concept of sampling.Importance of accuracy, precision and sources of error in analytical measurements.Presentation of experimental data and results, from the point of view of significant figures.

Unit 2: **Analysis of soil and water:**L: 7 Composition of soil, Concept of pH and pH measurement, Complexometric titrations, Chelation, Chelating agents, use of indicators

Determination of pH of soil samples.Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration. Analysis of water: Definition of pure water, sources responsible for contaminating water, water sampling methods, water purification methods.Determination of pH, acidity and alkalinity of a water sample.Determination of dissolved oxygen (DO) of a water sample.

Unit 3: **Analysis of food products**: L:6

Nutritional value of foods, idea about food processing and food preservations and adulteration.

Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.

Unit 4: **Analysis of preservatives and colouring matter:** L: 6

Ion-exchange: Column, ion-exchange chromatography etc. Determination of ion exchange capacity of anion / cation exchange resin (using batch procedure if use of column is not feasible). Analysis of cosmetics: Major and minor constituents and their function. Analysis of deodorants and antiperspirants, Al, Zn, boric acid, chloride, sulphate.Determination of constituents of talcum powder: Magnesium oxide, Calcium oxide, Zinc oxide and Calcium carbonate by Complexometric titration.

Unit 5: **Suggested Applications(Any one):** L:6

To study the use of PHBEnolphthalein in trap cases.
To analyze arson accelerants.
To carry out analysis of gasoline.
Suggested Instrumental demonstrations:
Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

Text/ Reference Books:

1. Willard, H. H. Instrumental Methods of Analysis, CBS Publishers.
2. Skoog&Lerry. Instrumental Methods of Analysis, Saunders College Publications, New York.
3. Skoog, D.A.; West, D.M. & Holler, F.J. Fundamentals of Analytical Chemistry 6th Ed., Saunders College Publishing, Fort Worth (1992).
4. Harris, D. C. Quantitative Chemical Analysis, W. H. Freeman.
5. Dean, J. A. Analytical Chemistry Notebook, McGraw Hill.
6. Day, R. A. & Underwood, A. L. Quantitative Analysis, Prentice Hall of India.
7. Freifelder, D. Physical Biochemistry 2nd Ed., W.H. Freeman and Co., N.Y. USA (1982).
8. Cooper, T.G. The Tools of Biochemistry, John Wiley and Sons, N.Y. USA. 16 (1977).
9. Vogel, A. I. Vogel's Qualitative Inorganic Analysis 7th Ed., Prentice Hall.
10. Vogel, A. I. Vogel's Quantitative Chemical Analysis6th Ed., Prentice Hall.
11. Robinson, J.W. Undergraduate Instrumental Analysis 5th Ed., Marcel Dekker, Inc., New York (1995).

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To develop the knowledge of analytical chemistry.
2. To analyse composition and concepts of soil and water.
3. To understand some food products and identification of some common food items.
4. To develop the knowledge of ion exchange chromatography.
5. Handle flame photometer and spectrophotometer.

CHYB2021	Basic Analytical Chemistry Lab	0L:0T:4P	2 Credits

LIST OF EXPERIMENTS:

1. Determination of pH of soil samples.
2. Estimation of Calcium and Magnesium ions as Calcium carbonate by Complexometric titration.
3. Determination of pH, acidity and alkalinity of a water sample.
4. Determination of dissolved oxygen (DO) of a water sample.
5. Identification of adulterants in some common food items like coffee powder, asafoetida, chilli powder, turmeric powder, coriander powder and pulses, etc.
6. Estimation of macro nutrients: Potassium, Calcium, Magnesium in soil samples by flame photometry.
7. Spectrophotometric determination of Iron in Vitamin / Dietary Tablets.
8. Spectrophotometric Identification and Determination of Caffeine and Benzoic Acid in Soft Drink.

List of Generic Electives offered by Department for students in B.Sc. (Hons.) in Allied Programmes (Chemistry, Physics, Geology, Psychology etc.)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
I	MTHB1010	Algebra	5-1-0	6
II	MTHB2010	Differential Calculus & Vector Calculus	5-1-0	6
III	MTHB3010	Differential Equation	5-1-0	6
IV	MTHB4010	Real Analysis	5-1-0	6

*** Detailed Syllabus for these courses are the same as the courses of the same names and codes offered as DSC courses of the B.Sc. (Hons.) Physics Programme.**

Department-Specific Electives offered by the Department for students in B.Sc. (PCM)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	MTHB5010	Multivariate Calculus	5-1-0	6
V	MTHB5020	Group Theory II	5-1-0	6
VI	MTHB6010	Metric Spaces and Complex Analysis	5-1-0	6
VI	MTHB6020	Ring Theory and Linear	5-1-0	6

		Algebra II		

*** Detailed Syllabus for these courses are the same as the courses of the same names and codes offered as DSC courses of the B.Sc. (Hons.) Mathematics Programme.**

List of Discipline Specific Elective Papers: (Credit: 06 each)

Semester	Course Code (T+P)	Course Name	(L-T-P)	Credits
V	MTHB5310	Probability and Statistics	5-1-0	6
V	MTHB5320	Analytical Geometry	5-1-0	6
V	MTHB5330	Theory of Equations	5-1-0	6
V	MTHB5340	Industrial Mathematics	5-1-0	6
VI	MTHB6310	Linear Programming	5-1-0	6
VI	MTHB6320	Boolean Algebra and Automata Theory	5-1-0	6
VI	MTHB6330	Mathematical Modeling	5-1-0	6
VI	MTHB6340	Mechanics	5-1-0	6

*Optional Dissertation or project work in place of one Discipline Specific Elective paper (DSE-4)(6 credits) in 6th Semester

MTHB5310	Probability and Statistics	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of probability.
2. To make students learn the concept of moments, moment generating function.
3. To impart the knowledge of Joint cumulative distribution function
4. To convey the basic concepts Markov Chains.

UNIT I:Probability function:L:15

Sample space, probability axioms, real random variables (discrete and continuous), cumulative distribution function, probability mass/density functions, mathematical expectation

UNIT II:Probability distributions:L:20

Moments, moment generating function, characteristic function, discrete distributions: uniform, binomial, Poisson, geometric, negative binomial, continuous distributions: uniform, normal, exponential.

UNIT III:Expectation :L:20
Joint cumulative distribution function and its properties, joint probability density functions, marginal and conditional distributions, expectation of function of two random variables, conditional expectations, independent random variables, bivariate normal distribution, correlation coefficient, joint moment generating function (mgf) and calculation of covariance (frommgf), linear regression for two variables.

UNIT IV:Sampling:L:20
Chebyshev's inequality, statement and interpretation of (weak) law of large numbers and strong law of large numbers, Central Limit theorem for independent and identically distributed random variables with finite variance, Markov Chains, Chapman-Kolmogorov equations, classification of states

Reference Books:

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to MathematicalStatistics, Pearson Education, Asia, 2007.
2. Irwin Miller and Marylees Miller, John E. Freund, Mathematical Statistics with Applications, 7th Ed., Pearson Education, Asia, 2006.
3. Sheldon Ross, Introduction to Probability Models, 9th Ed., Academic Press, Indian Reprint, 2007.
4. Alexander M. Mood, Franklin A. Graybill and Duane C. Boes, Introduction to the Theory of Statistics, 3rd Ed., Tata McGraw- Hill, Reprint 2007

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concepts of probability & Student will be able to solve related problem
2. Students will be able to find moment generating function for pdf.
3. Understand the concept of Joint cumulative distribution function.
4. Understand the concept Markov Chains

MTHB5320	Analytical Geometry	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of tracing of quadratic equations.
2. To make students learn the types quadratic equations.
3. To impart the knowledge of quadratic surfaces like cone & ellipsoid.

Unit I :Tracing of Quadratic equations
Techniques for sketching parabola, ellipse and hyperbola. Reflection properties of parabola, ellipse and hyperbola.

Unit II :Classification of quadratic equations
Classification of quadratic equations representing lines, parabola, ellipse and hyperbola.

Unit III :Illustrations of quadric surfaces:
Spheres, Cylindrical surfaces. Illustrations of graphing standard quadric surfaces like cone, ellipsoid.

Reference Books:

1. G.B. Thomas and R.L. Finney, Calculus, 9th Ed., Pearson Education, Delhi, 2005.

2. H. Anton, I. Bivens and S. Davis, Calculus, John Wiley and Sons (Asia) Pvt. Ltd. 2002.
3. S.L. Loney, The Elements of Coordinate Geometry, McMillan and Company, London.
4. R.J.T. Bill, Elementary Treatise on Coordinate Geometry of Three Dimensions, McMillanIndia Ltd., 1994.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. To trace quadratic equations.
2. Familiar with types ofquadratic equations.
3. Familiar withquadratic surfaces like cone & ellipsoid.

MTHB5330	Theory of Equations	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. Impart the knowledge of the polynomials
2. To make students learn how to solve cubic and bi quadratic equations
3. To impart the knowledge about Strums theorem

UNIT I:Properties of polynomials:L:25
properties of polynomials, Graphical representation of a polynomial, maximum and minimum values of a polynomials, General properties of equations, Descarte's rule of signs positive and negative rule, Relation between the roots and the coefficients of equations. Symmetric functions, Applications of symmetric function of the roots, Transformation of equations. Solutions of reciprocal and binomial equations.

UNIT II:Solutions of algebraic equations:L:25
Algebraic solutions of the cubic and biquadratic.Properties of the derived functions. Symmetric functions of the roots, Newton's theorem on the sums of powers of roots, homogeneous products, limits of the roots of equations. Separation of the roots of equations,

UNIT III:Strums theorem:L:25
Strums theorem, Applications of Strum's theorem, Conditions for reality of the roots of an equation and bi quadratic. Solution of numerical equations.

Reference Books:

1. W.S. Burnside and A.W. Panton, The Theory of Equations, Dublin University Press, 1954.
2. C. C. MacDuffee, Theory of Equations, John Wiley & Sons Inc.,

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept polynomials.
2. Students will be able to solve cubic and bi quadratic equations
3. Understand the concept of Strums theorem & its application.

MTHB5340	Industrial Mathematics	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge of Mathematics of Mathematics of X-ray .
2. To make students learn the concept of CT scan.
3. To impart the knowledge of Radon Transform.
4. To convey the basic conceptsBack Projection.

UNIT I:Medical Imaging and Inverse Problems:L:25

Medical Imaging and Inverse Problems. The content is based on Mathematics of X-ray and CT scan based on the knowledge of calculus, elementary differential equations, complex numbers and matrices.

Introduction to Inverse problems: Why should we teach Inverse Problems? Illustration of Inverseproblems through problems taught in Pre-Calculus, Calculus, Matrices and differentialequations. Geological anomalies in Earth's interior from measurements at its surface (Inverseproblems for Natural disaster) and Tomography.

UNIT II:X-ray:L:25

Introduction, X-ray behavior and Beers Law (The fundament question of imageconstruction) Lines in the place.

UNIT III:Radon Transform:L:25

Radon Transform: Definition and Examples, Linearity, Phantom (Shepp - Logan Phantom - Mathematical phantoms).Back Projection**:** Definition, properties and examples.

UNIT IV:CT Scan:L:25

Revision of properties of Fourier and inverse Fourier transforms and applications oftheir properties in image reconstruction. Algorithms of CT scan machine. Algebraicreconstruction techniques abbreviated as ART with application to CT scan.

Reference Books:

1. Timothy G. Feeman, The Mathematics of Medical Imaging, A Beginners Guide, Springer
2. Under graduate Text in Mathematics and Technology, Springer, 2010.
3. C.W. Groetsch, Inverse Problems, Activities for Undergraduates, The Mathematical Association of America, 1999.
4. Andreas Kirsch, An Introduction to the Mathematical Theory of Inverse Problems, 2nd Ed.,Springer, 2011.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand use of Mathematics inX-ray .
2. understand the concept ofMathematics inCT scan.
3. Understand the concept of Radon Transform.
4. Understand the concept of Back Projection.

MTHB6310	Linear Programming	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. To Introduce students about linear programming problem.
2. How to solve linear programming problem using different methods
3. To impart the knowledge of Duality
4. To convey the basic concepts Transportation problem and its mathematical formulation
5. To convey the basic concepts Game theory

UNIT I:Introduction to linear programming problem:L:20

Introduction to linear programming problem, Theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in tableau format, introduction to artificial variables, two-phase method, Big-M method and their comparison.

II:Duality:L:15

Duality, formulation of the dual problem, primal-dual relationships, economic interpretation of the dual.

UNIT III:Transportation problem:L:20

Transportation problem and its mathematical formulation, northwest-corner method least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem, assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

UNIT IV:Game theory:L:20

Game theory: formulation of two person zero sum games, solving two person zero sum games, games with mixed strategies, graphical solution procedure, linear programming solution of games.

Reference Books:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows, 2nd Ed., John Wiley and Sons, India, 2004.
2. F.S. Hillier and G.J. Lieberman, Introduction to Operations Research, 9th Ed., Tata McGraw Hill, Singapore, 2009.
3. Hamdy A. Taha, Operations Research, An Introduction, 8th Ed., Prentice-Hall India, 2006.
4. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concept of linear programming.
2. Students will be able to solve linear programming problems by different methods.
3. Understand the concept of Transportation problem.
4. Understand the concept Game theory.

MTHB6320	Boolean Algebra and Automata Theory	5L:1T:0P	6 Credits

Course learning objectives:
The objectives of this course are

1. To Introduce students about ordered sets.
2. To familiarize students about lattice.
3. To impart the knowledge of languages.
4. To convey the basic concepts Turing Machines

UNIT I: Introduction of ordered sets: L:15
Definition, examples and basic properties of ordered sets, maps between ordered sets, duality principle, lattices as ordered sets, lattices as algebraic structures, sublattices, products and homomorphisms.

UNIT II: Lattices: L:20

Definition, examples and properties of modular and distributive lattices, Boolean algebras,\Boolean polynomials, minimal forms of Boolean polynomials, Quinn-McCluskeymethod,Karnaugh diagrams, switching circuits and applications of switching circuits.

UNIT III: Introduction of Languages: L:20
Introduction: Alphabets, strings, and languages. Finite Automata and Regular Languages:deterministic and non-deterministic finite automata, regular expressions, regular languages andtheir relationship with finite automata, pumping lemma and closure properties of regularlanguages.Context Free Grammars and Pushdown Automata: Context free grammars (CFG), parse trees,ambiguities in grammars and languages, pushdown automaton (PDA) and the language acceptedby PDA, deterministic PDA, Non- deterministic PDA, properties of context free languages;normal forms, pumping lemma, closure properties, decision properties.

UNIT IV:Introduction of Turing Machines: L:20
Turing Machines: Turing machine as a model of computation, programming with a Turing machine, variants of Turing machine and their equivalence.Undecidability: Recursively enumerable and recursive languages, undecidable problems aboutTuring machines: halting problem, Post Correspondence Problem, and undecidability problemsAbout CFGs.

Reference Books:

1. B A. Davey and H. A. Priestley, Introduction to Lattices and Order, Cambridge UniversityPress, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory,(2nd Ed.), Pearson Education (Singapore) P.Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Günter Pilz, Applied Abstract Algebra, 2nd Ed., Undergraduate Texts inMathematics, Springer (SIE), Indian reprint, 2004.
4. J. E. Hopcroft, R. Motwani and J. D. Ullman, Introduction to Automata Theory, Languages,and Computation, 2nd Ed., Addison-Wesley, 2001.
5. H.R. Lewis, C.H. Papadimitriou, C. Papadimitriou, Elements of the Theory of Computation,2nd Ed., Prentice-Hall, NJ, 1997.

6. J.A. Anderson, Automata Theory with Modern Applications, Cambridge University Press,2006.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Understand the concepts ofordered sets..
2. Understand the concepts oflattice.
3. Understand the concepts oflanguages..
4. Understand the conceptsTuring Machines.

MTHB6330	Mathematical Modeling	5L:1T:0P	6 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledge about Power series solution .
2. To make students learn the concept of Laplace transform and inverse transform.
3. To impart the knowledge of Monte Carlo Simulation Modeling
4. To make students familiar of Linear Programming Model.

UNIT I:Power series:L:20

Power series solution of a differential equation about an ordinary point, solution about a regular singular point, Bessel's equation and Legendre's equation,

UNIT II:Laplace transform and inverse transform:L:20

Laplace transform and inverse transform, application to initial value problem up to second order

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UNIT III:Monte Carlo Simulation Modeling:L:20

Simulating deterministic behavior (area under a curve,volume under a surface), Generating Random Numbers: middle square method, linearcongruence, Queuing Models: harbor system, morning rush hour, Overview of optimizationmodeling,

UNIT IV:Linear Programming Model:L:15

Geometric solution algebraic solution, simplex method,sensitivity analysis

Reference Books:

1. TynMyint-U and LokenathDebnath, Linear Partial Differential Equation for Scientists and Engineers, Springer, Indian reprint, 2006.
2. Frank R. Giordano, Maurice D. Weir and William P. Fox, A First Course in Mathematical Modeling, Thomson Learning, London and New York, 2003.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Student will able to solve differential equation using power series method.
2. Student will able to solve differential equation using concept of Laplace transform and inverse transform.
3. Understand the concept of Monte Carlo Simulation Modeling.
4. Student will able to solve linear equation using Linear Programming Model.

MTHB6340	Mechanics	5L:1T:0P	6 Credits

Course Objective:

1. To acquaint the concept of equilibrium in two and three dimensional system.
2. To study and analyze motion of moving bodies.

UNIT I:Resultant of coplanar force system:L:20

Moment of a force about a point and an axis, couple and couple moment, Moment of a couple about a line, resultant of a force system, distributed force system, free body diagram, free bodyinvolving interior sections, general equations of equilibrium, two point equivalent loading,problems arising from structures, static indeterminacy.

UNIT I: Friction:L:20

Laws of Coulomb friction, application to simple and complex surface contact friction problems,transmission of power through belts, screw jack, wedge, first moment of an area and thecentroid, other centers, Theorem of Pappus-Guldinus, second moments and the product of area ofa plane area, transfer theorems, relation between second moments and products of area, polarmoment of area, principal axes.

UNIT I:Kinetics of a Rigid Body: L:20

Conservative force field, conservation for mechanical energy, work energy equation, kinetic energy and work kinetic energy expression based on center of mass, moment of momentum equation for a single particle and a system of particles, translation and rotation of rigid bodies,Chasles' theorem, general relationship between time derivatives of a vector for differentreferences, relationship between velocities of a particle for different references, acceleration ofparticle for different references.

Reference Books:

1. I.H. Shames and G. Krishna Mohan Rao, Engineering Mechanics: Statics and Dynamics, (4thEd.), Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi, 2009.
1. R.C. Hibbeler and Ashok Gupta, Engineering Mechanics: Statics and Dynamics, 11th Ed.,Dorling Kindersley (India) Pvt. Ltd. (Pearson Education), Delhi.

Course Outcomes: Learner will be able to…

1. Illustrate the concept of force, moment and apply the same along with the concept of equilibrium in two and three dimensional systems with the help of FBD.
2. Correlate real life application to specific type of friction and estimate required force to overcome friction.
3. Establish relation between velocity and acceleration of a particle and analyse the motion by plotting the relation
4. Illustrate different types of motions and establish Kinematic relations for a rigid body
5. Analyse body in motion using force and acceleration, work-energy, impulse-momentum principle

List of Skill Enhancement Course (any Two, 1 in each Sem III &Sem IV) (Credit: 02 each)

Semester	Course Code	Course Name	(L-T-P)	Credits
III	CSEG3210	Computer Graphics	2-0-0	2
III	MTHB3220	Logic and Sets	2-0-0	2
IV	CSEG4210	Operating System: Linux	2-0-0	2

CSEG3210	Computer Graphics	2L:0T:0P	2 Credits

Course Objective:

1. To introduce the use of the components of a graphics system and become familiar with building approach of graphics system components and algorithms related with them
2. To be able to discuss the application of computer graphics concepts in the development of computer games, information visualization, and business applications.

UNIT I:Development of computer Graphics: Raster Scan and Random Scan graphics storages, displaysprocessors and character generators, colour display techniques, interactive input/output devices.

UNIT II:Points, lines and curves: Scan conversion, line-drawing algorithms, circle and ellipse generation,conic-section generation,

UNIT III:Polygon: filling anti aliasing. Two-dimensional viewing: Coordinatesystems, linear transformations, line and polygon clipping algorithms.

Reference Books:

1. D. Hearn and M.P. Baker, Computer Graphics, 2nd Ed., Prentice–Hall of India, 2004.
2. J.D. Foley, A van Dam, S.K. Feiner and J.F. Hughes, Computer Graphics: Principals andPractices, 2nd Ed., Addison-Wesley, MA, 1990.
3. D.F. Rogers, Procedural Elements in Computer Graphics, 2nd Ed., McGraw Hill BookCompany, 2001.
4. D.F. Rogers and A.J. Admas, Mathematical Elements in Computer Graphics, 2nd Ed., McGraw Hill Book Company,

Course Outcomes: Learner will be able to…

1. To list the basic concepts used in computer graphics.

2. To implement various algorithms to scan, convert the basic geometrical primitives, transformations, Area filling, clipping.
3. To understand a typical graphics pipeline.

MTHB3220	Logic and sets	2L:0T:0P	2 Credits

Course learning objectives:

The objectives of this course are

1. Impart the knowledgelogical operators.
2. To make students learn the concept ofSets, subsets,
3. To impart the knowledge of Equivalence Relations.

UNIT I:

Introduction, propositions, truth table, negation, conjunction and disjunction. Implications, biconditional propositions, converse, contra positive and inverse propositions and precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations.

UNIT II:

Sets, subsets, Set operations and the laws of set theory and Venn diagrams. Examples of finite and infinite sets. Finite sets and counting principle. Empty set, properties of empty set. Standard set operations. Classes of sets. Power set of a set.

UNIT III:

Difference and Symmetric difference of two sets. Set identities, Generalized union and intersections. Relation: Product set, Composition of relations, Types of relations, Partitions, Equivalence Relations with example of congruence modulo relation, Partial ordering relations, nary relations.

Reference Books:

1. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.
2. P.R. Halmos, Naive Set Theory, Springer, 1974.
3. E. Kamke, Theory of Sets, Dover Publishers, 1950.

Course Outcomes:

At the end of this course students will demonstrate the ability to:

1. Student will able to solve problems with logical operators .
2. Understand the concept ofsets, subsets.
3. Student will able to solve problems related toEquivalence Relations.

CSEG4210	Operating system: Linux	2L:0T:0P	2 Credits

Course Objective:

1. To make students understand the features of Linux operating system
2. To make students learn the components of Linux
3. To learn basic Linux commands and printing Linux documents

UNIT I:Linux : The Operating System: Linux history, Linux features, Linux distributions, Linux'srelationship to Unix,

UNIT II:Overview of Linux architecture: Installation, Start up scripts, systemprocesses (an overview), Linux Security, The Ext2 and Ext3 File systems: General
Characteristics of, The Ext3 File system,

UNIT III:File permissions. User Management: Types of users,the powers of Root, managing users (adding and deleting): using the command line and GUItools.

UNIT IV:Resource Management in Linux: file and directory management, system calls for files ProcessManagement, Signals, IPC: Pipes, FIFOs, System V IPC, Message Queues, system calls forprocesses, Memory Management, library and system calls for memory.

Reference Books:

1. Arnold Robbins, Linux Programming by Examples The Fundamentals, 2nd Ed., Pearson Education, 2008.
2. Cox K, Red Hat **Linux Administrator's Guide**, PHI, 2009.
3. R. Stevens, UNIX Network Programming, 3rd Ed., PHI, 2008.
4. Sumitabha Das, Unix Concepts and Applications, 4th Ed., TMH, 2009.
5. Ellen Siever, Stephen Figgins, Robert Love, Arnold Robbins, Linux in a Nutshell, 6th Ed.,O'Reilly Media, 2009.
6. Neil Matthew, Richard Stones, Alan Cox, Beginning Linux Programming, 3rd Ed.,

Course Outcomes: Learner will be able to…

1. Identify the basic Unix general purpose commands.
2. Apply basic of administrative task.
3. Apply networking Unix commands.

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