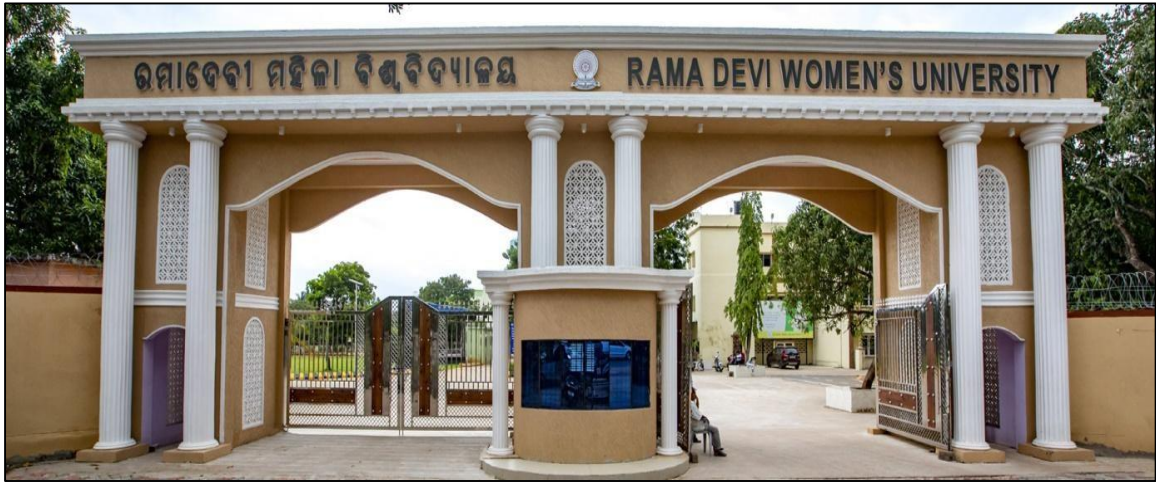


# DEPARTMENT OF MATHEMATICS

## SYLLABUS OF UG PROGRAMME (B.Sc./ B.A)



**RAMA DEVI WOMEN'S UNIVERSITY**  
Vidya Vihar, Bhubaneswar-751022, Odisha  
Website: <https://rdwu.ac.in>

**Course Structure**  
**Of**  
**Bachelor of Arts/Science (MATHEMATICS)**



**RAMA DEVI WOMEN'S UNIVERSITY**  
**VIDYA VIHAR, BHOI NAGAR, BHUBANESWAR-22**

*K. S. Panda*  
12.10.23

Controller of Examinations  
R.D. Women's University  
Bhubaneswar

### **Programme Outcomes (POs):**

**PO.1:** Develop mental, analytical, employability and strategic skills through comprehensive studies to meet the challenges of contemporary trends.

**PO.2:** Proficiency with the ability to qualify competitive and professional examinations.

**PO.3:** Enhance ability to develop the business in banking sector.

**PO.4:** Prepare students for cross-country professional courses.

**PO.5:** Pursue advance research by applying critical thinking and analytical reasoning in some specific field of science like meteorology and astrology.

**PO.6:** Application of information technology and digital tools to satisfy the everchanging demands of the software companies.

**PO.7:** Enable students to have research in different field of science specifically to advance in space research.

**PO.8:** Holistic development of students to create responsible citizenry through social, moral, ethical and professional code of conduct.

**PO.9:** Encourage in designing and drawing in different fields of engineering and science.

**PO.10:** Bridging the gap between academia and its application to enhance learners ability through problems solving skills to face the challenges and achieve excellence.

### **Programme Specific Outcomes (PSOs):**

**PSO.1:** Students can go for higher studies and they can choose academics as Mathematics is a basic subject.

**PSO.2:** Acquired passion for research in various fields like Optimization, Numerical Analysis, Transportation, Sum ability, Operator Theory, and Number Theory.

**PSO.3:** Students can opt for banking service/Administrative jobs/work in meteorological department etc.

**PSO.4:** Professional courses like MCA/CS can be taken as further studies.

### RDWU UG Syllabus structure

Semester-I								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	AECC	AECC-I		4	4	20	80	100
2.	CORE	C-I	Calculus-I	4	6	20	80	100
3.	CORE	C-II	Algebra-I	4	6	20	80	100
4.	GE	GE-A1	Calculus & Differential Equations	4	6	20	80	100
	Total				22	80	320	400

Semester-II								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	AECC	AECC-II		4	4	20	80	100
2.	CORE	C-III	Real Analysis (Analysis-I)	4	6	20	80	100
3.	CORE	C-IV	Differential equations	4	6	20	80	100
4.	GE	GE-A2	Algebra	4	6	20	80	100
	Total				22	80	320	400

Semester-III								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	CORE	C-V	Theory of Real functions (Analysis-II)	4	6	20	80	100
2.	CORE	C-VI	Group Theory (Algebra-II)	4	6	20	80	100
3.	CORE	C-VII	Partial differential equations and system of ODEs	4	6	20	80	100
4.	GE	GE-B1	Calculus & Differential Equations	4	6	20	80	100
5.	SEC	SEC-I		4	4	20	80	100
	Total		3		28	100	400	500

Semester-IV								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	CORE	C-VIII	Numerical Methods	4	6	20	80	100
2.	CORE	C-IX	Riemann Integration and Series of functions (Analysis-III)	4	6	20	80	100
3.	CORE	C-X	Ring Theory and Linear (Algebra-I)	4	6	20	80	100
4.	GE	GE-B2	Algebra	4	6	20	80	100
5.	SEC	SEC-II	Quantitative & Logical Thinking	4	4	20	80	100
	Total				28	100	400	500

Semester-V								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	CORE	C-XI	Multivariate Calculus (Calculus-II)	4	6	20	80	100
2.	CORE	C-XII	Programming in C++	4	6	20	80	100
3.	DSE	DSE-I	Discrete Mathematics	4	6	20	80	100
4.	DSE	DSE-II	Number Theory	4	6	20	80	100
	Total				24	80	320	400

Semester-VI								
Sl. No.	Nature of Course	Course Code	Paper Title	Units	Credits	Marks		
						Mid Sem	End Sem	Total
1.	CORE	C-XIII	Metric Spaces and Complex analysis (Analysis-IV)	4	6	20	80	100
2.	CORE	C-XIV	Linear Programming	4	6	20	80	100

3.	DSE	DSE-III	Differential Geometry	4	6	20	80	100
4.	DSE	DSE-IV	Project/Probability & Statistics	4	6	20	80	100
		Total			24	80	320	400

### Summary

CORE	14 × 100	1400
Generic Elective (GE)	4 × 100	400
Skill Enhancement Course (SEC)	2 × 100	200
Discipline Specific Elective (DSE)	4 × 100	400
Ability Enhancement Compulsory Course (AECC)	2 × 100	200
Total Marks		2600

### Summary

Semester	Credits	Total Marks
SEM-I	22	400
SEM-II	22	400
SEM-III	28	500
SEM-IV	28	500
SEM-V	24	400
SEM-VI	24	400
Total	148	2600

## Semester-I

### Core Course: Calculus-I (C-I)

#### Course Outcomes:

On completion of the course, a student will be able to

- a) Calculate the higher order derivatives and limits in indeterminate form by repeated use of L'Hospital rule.
- b) acquire the concept of asymptotes and envelopes;
- c) determine concavity and convexity of a function from its graph and from its second derivative;
- d) explain the properties of two and three dimensional shapes and trace a curve.
- e) solve first order ordinary differential equations utilizing the standard techniques for separable, exact, linear, homogeneous or Bernoulli cases.

## **UNIT-I**

Hyperbolic functions, higher order derivatives, Leibnitz rule and its applications to problems of the type  $e^{ax+b}\sin x$ ,  $e^{ax+b}\cos x$ ,  $(ax + b)^n \sin x$ ,  $(ax + b)^n \cos x$ , curvature, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, L'Hospital's rule.

## **UNIT-II**

Reduction formulae, derivations and illustrations of reduction formulae of the type of  $\int \sin^n x dx$ ,  $\int \cos^n x dx$ ,  $\int \tan^n x dx$ ,  $\int \sec^n x dx$ ,  $\int (\log x)^n dx$ ,  $\int \sin^n x \cos^n x dx$ , Volumes by sling, disk and washer's methods & volumes by cylindrical shell.

## **UNIT-III**

Parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution, techniques of sketching conics, reflection properties of conics, rotation of axes and second degree equations, classification into conics using the discriminant, polar equations of conics, sphere, cone & cylinder.

## **UNIT-IV**

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.

### **LIST OF PRACTICALS**

**(To be performed using Computer with aid of MATLAB or such software)**

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

### **BOOKSRECOMMENDED:**

1. H. Anton, I. Bivens and S. Davis, *Calculus*, 10<sup>th</sup> Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002. Chapter-5 (5.2-5.5), 6 (6.8), 10 (10.1), 12 (12.1-12.3)
2. Shanti Narayan, Text Book of Calculus-Part-II, S. Chand, Chapter 8 & 10.
3. Shanti Narayan, Text Book of Calculus-Part-III, S. Chand, Chapter 1, 3.5, 6
4. Analytical Geometry of Quadratic Surfaces, B. P. Acharya and D. C. Sahu, Kalyani Publishers, New Delhi, Ludhiana, Chapter 1, 2 & 3.

### **BOOKSFORREFERNCE:**

1. Shanti Narayan & P. K. Mittal – Analytical Solid Geometry, S. Chand & Co, New Delhi
2. G. B. Thomas and R. L. Finney, *Calculus*, 9<sup>th</sup> Ed., Pearson Education, Delhi, 2005.

3. R. Courant and F-John, Introduction to calculus and Analysis (Volume I & II), Springle-Veilag, New York, Inc., 1989.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	2	2	2	2	2	4
CO2	4	4	4	4	4	2	2	4	2	2
CO3	4	4	2	4	2	2	4	2	4	2
CO4	4	4	2	2	2	2	4	2	5	2
CO5	4	4	4	4	2	2	2	2	4	2

**Core Course: Algebra-I (C-II)**

**Course Outcomes:**

On completion of the course, a student will be able to

- Find the inverse of a square matrix.
- Solve the matrix equation  $Ax = b$  using row operations and matrix operations.
- Find the determinant of a product of square matrices, of the transpose of a square matrix, and of the inverse of an invertible matrix
- Find the characteristic equation, eigenvalues and corresponding eigenvectors of a given matrix.
- Determine if a given matrix is diagonalizable.

**UNIT-I**

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

**UNIT-II**

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

**UNIT-III**

Systems of Linear equation, row reduction and echelon forms, vector equation, the matrix equation  $Ax=b$ , solution sets of linear systems, applications of linear systems, linear independence.

**UNIT-IV**



Introduction to linear transformations, matrix of a linear transformation, inverse of a matrix. Characterizations of invariable matrices, subspaces of  $\mathbb{R}^n$ , dimension of subspaces of  $\mathbb{R}^n$  and rank of a matrix Eigen values, Eigen vectors and characteristic equation of a matrix.

**BOOKSRECOMMENDED:**

1. Edgar G. Goodaire and Michael M. Parmenter, Discrete Mathematics with Graph Theory, 3<sup>rd</sup> Ed., Pearson Education (Singapore) P. Ltd., Indian Reprint, 2005, Chapters 2 (2.4), 3, 4 (4.1-4.1.6, 4.2-4.2.11, 4.4.1-4.4.8, 4.3-4.3.9), 5 (5.1-5.1.4).
2. Titu Andreescu and Dorin Andrica, Complex numbers from A to Z, Birkhausle, 2006 chapter-2
3. David C. Lay, Linear Algebra and its Application, 3<sup>rd</sup> Ed, Pearson Education Asia, Indian Reprint 2007, chapters 1(1.1-1.9), 2(2.1-2.3,2.8,2.9), 5(5.1,5.2).

**BOOKSEORREFERENCE:**

1. J.L. Mott, A. Kendel and T. P. Baker: Discrete Mathematics for Computer Scientists and Mathematicians, Prentice Hall of India Pvt Ltd, 2008.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	2	2	2	2	2
CO2	2	4	4	2	2	2	4	2	2	2
CO3	2	4	4	2	2	2	4	2	2	2
CO4	2	4	4	2	2	2	4	2	2	2
CO5	2	4	4	2	2	2	2	2	2	2

**GE A1 (Calculus & Differential Equations)**

**Course Outcomes:**

On completion of the course, a student will be able to

- a) calculate the higher order derivatives and limits in indeterminate form by repeated use of L'Hospital rule.
- b) acquire the concept of asymptotes and envelopes
- c) solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- d) student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.
- e) how to set up and solve optimization problems involving several variables with or without constraints.

**UNIT-I:**

Curvature.Asymptotes.Rectification, Quadrature.Volume and surface area of solids of revolution.

**UNIT-II:**

Explicit and Implicit functions: Limit and Continuity of functions of several variables. Partial derivatives.Partial derivatives of higher orders. Homogeneous functions. Change of variables. Mean

value theorem, Taylors theorem and Maclaurin's theorem for functions of two variables (statements & applications).

### **UNIT-III**

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear), Equations of order one but higher degree.

### **UNIT-IV**

Second order linear equations with constant coefficients, homogeneous forms. Second order equations with variable coefficients.

### **BOOKS RECOMMENDED:**

1. Shanti Narayan, Text Book of Calculus, Part-II Chapter 8 (Art 24,25.26)
2. Shanti Narayan. Text Book of Calculus, Part-III Chapter-1 (Art 1, 2). 4 (Art 10-12 ),5 (Art 13)
3. S.C. Mallik and S. Arora- Mathematical Analysis, New Age International Publications. Chapter 15 (1-5, 8,9)
4. J. Sinharoy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, Chapters2 (2.1-2.7), 3,4 (4.1-4.4)

### **BOOK FOR REFERENCES:**

1. Anton, I. Bivens and S. Davis, Calculus, 10<sup>th</sup> Ed., John Wiley and Sons (Asia)P. Ltd., Singapore, 2002.
2. Shanti Narayan and P. K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi.
3. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.  
B. P. Acharya and D. C. Sahu: Analytical Geometry of Quadratic Surfaces, Kalyani Publishers.

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	2	2	2	2	2	4
CO2	5	5	5	5	5	2	2	4	2	2
CO3	5	5	5	5	2	2	2	2	4	2
CO4	5	5	5	5	2	4	4	2	4	2
CO5	5	5	5	5	2	2	2	2	2	2

### **AECC - I**

#### **Environmental studies and disaster management**

#### **COURSE OUTCOME (COs)**

After completion of the course the students shall be able to:

1. Students understand about problems of environmental pollution and Impact of pollution on human and ecosystem and control measures.

2. Students will learn about increase in population growth and understand the issues of use of resources in proper manner leading to sustainable development.
3. Learn about causes and impacts of Disasters and Case studies of National and Global disasters and risk reduction approaches of Disasters with safety issues in mitigating Industrial disasters.
4. Basic idea about the mode of transmission and course of some communicable and non-communicable diseases and knowledge on the Importance and methods of prevention of epidemics and pandemics

### **Unit-I(Environment)**

**The Environment:** The Atmosphere, Lithosphere, Hydrosphere, Biosphere (01 period)

**Ecosystem:** Energy flow in the ecosystem (01 period)

**Biogeochemical Cycle:** Water Cycle, Carbon Cycle, Nitrogen Cycle (02 periods)

**Pollution:** Water Pollution, Air Pollution, Soil Pollution, Radiation Pollution, Industrial Pollution, Light Pollution, Sound Pollution (05 periods)

**Environmental Laws** (Water Act 1974, Air Act 1981, The Wildlife Protection Act 1972, The Environment Protection Act 1986), The Forest Conservation Act 1980 (04 periods)

### **Unit-II(Climate Change & Sustainable Development)**

**Population Ecology:** Individuals, Species, Population, Community (01 period)

Human Population Growth, Population Control Methods (01 period)

Urbanization and its effect on society (01 period)

**Climate Change:** Causes, effect, Global Warming, Carbon footprint and environmental protection (05 periods)

**Steps taken towards sustainable development:** Ban of single-use plastics, Automobile Scrapping Policy, Promotion of Electrical Vehicles (03periods)

**Brief idea on Sustainable Development** Goals (SDGs), Agenda 21 of Rio Earth Summit (02 periods)

### **Unit-III(Disaster Management)**

**Disaster Management:** Types of disasters (Natural and Man-made) and their causes and effect) (02 periods)

**Vulnerability Assessment and Risk Analysis:** Vulnerability to various disasters (Flood, Cyclone, Earthquake, Heat waves and Lightning)(02 periods)

**Institutional Framework:** Institutional arrangements for disaster management (National Disaster Management Authority (NDMA), State Disaster Management Authority (SDMA), District Disaster Management Authority (DDMA), National Disaster Response Force (NDRF) and Odisha Disaster Rapid Action Force (ODRAF) (02 periods)

**Preparedness Measures:** Disaster Management Cycle, Early Warning System, Pre-Disaster and Post-Disaster Preparedness, Strengthening of SDMA and DDMA, Community Preparedness, Stakeholder participation, Corporate Social Responsibility (CSR) (05 periods)

**Survival Skills:** Survival skills adopted during and after disaster (Flood

### **Unit-IV(Public Health Management)**(13 periods x 45min)

**Brief idea on Epidemics and Pandemics** (01 period)

**Non-communicable diseases** with special reference to Cardiovascular diseases, Cancer, Diabetes, Hypertension and Obesity and their prevention (02 periods)

**Communicable diseases** with special reference to Covid-19, Flu, Hepatitis, AIDS and Tuberculosis and their transmission (02 periods)

**Dynamics of Disease Transmission:** Mode of transmission (Direct/Indirect), Events after infection: Immunity (Active vrs Passive, Innate vrs Acquired, Herd Immunity), Incubation Period (02 periods)

**Prevention of Epidemics/Pandemics Diseases:** Preventing Measures (Quarantine, Sanitization, Personal Protective measures such as Hand washing and use of protective devices, Vaccination);

Control Measures (Surveillance, Isolation, Contact Tracing) (03 Periods)

**Life Style management** (Diet, Physical Exercise, Yoga and sleeping habit) (02 periods)

**Role of Different Sectors in Managing Health Disaster:** Role of Government (Centre and State), Community, Civil Society, Student mass, NGOs (01 period)

### **Books Recommended:**

1. Asthana DK and Asthana M: A Text Book of Environmental Studies, S. Chand, New Delhi
2. Bharucha E: A Text Book of Environmental Studies, New Delhi:UGC
3. Dash MC and Mishra PC: Man and Environment, McMillan, London
4. Disaster Management and Mitigation Plan, 2013 of Dept. of Health& Family Welfare, Govt. of Odisha\*
5. Mishra DD: Fundamental Concepts in Environmental Studies, S. Chand, New Delhi
6. National Policy on Disaster Management, 2009\*
7. National Disaster Management Plan, 2019\*
8. Odum EP: Fundamentals of Ecology, Natraj Publications
9. State Disaster Management Plan, 2019 of Government of Odisha\*
10. Standard Operating Procedure (SOP) issued by Govt. of India and Govt. Of Odisha on Public Health Managements in the websites: [www.mohfw.gov.in](http://www.mohfw.gov.in) and [health.odisha.gov.in](http://health.odisha.gov.in)\*
11. The Disaster Management Act, 2005 of Government of India\*

[Note: Star (\*) marked References, published by the State as well as Central Government are available in the open sources]

### **Mapping Of Course Outcomes With The Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	4	5	5	2	4	5
CO2	5	4	5	4	5	2	4	4	2	5
CO3	5	5	5	2	5	4	5	5	4	5
CO4	5	2	4	2	4	5	5	5	5	5

## **SEMESTER-II**

### **Core Course: Real Analysis (Analysis-I) (C-III)**

#### **Course Outcomes:**

On completion of the course, a student will be able to

- a) describe different properties of the real line  $\mathbb{R}$ .
- b) define and recognize bounded, convergent, divergent, Cauchy, and monotonic sequences and calculate limit superior, limit inferior of bounded sequences.
- c) apply the ratio, root, alternating series and limit comparison tests for convergence and absolute convergence of an infinite series of real numbers.
- d) describe the basic differences between the rational and real number.
- e) apply this sophisticated course to finance.

#### **UNIT-I**

Review of Algebraic and Order Properties of  $\mathbb{R}$ ,  $\delta$ -neighborhood of a point in  $\mathbb{R}$ , Bounded above sets, Bounded below sets, Bounded Sets, Unbounded sets, Suprema and Infima, The Completeness Property of  $\mathbb{R}$ .

#### **UNIT-II**

The Archimedean property, Density of rational and Irrational numbers in  $\mathbb{R}$ , Intervals, Idea of countable sets, uncountable sets and uncountability of  $\mathbb{R}$ .

#### **UNIT-III**

Sequences, Bounded sequence, Convergent sequence, Limit of a sequence Limit Theorems, Monotone sequences, Monotone Convergence Theorem, Subsequence Divergence criteria, Monotone subsequence Theorem (Statement only), Bolzano-Weierstrass Theorem for sequence, Cauchy sequence, Cauchy's Convergence criterion.

#### **UNIT-IV**

Infinite series, convergence and divergence of infinite Series, Cauchy Criterion, Tests for convergence: Comparison test, Cauchy's nth root test, Integral test, Limit Comparison Test, Ratio Test.

#### **BOOKS RECOMMENDED:**

1. G. Das and S. Pattanayak, Fundamentals of Mathematical Analysis, TMH Publishing Co. Chapters 2 (2.1 to 2.4, 2.6), 3 (3.1-3.4), 4 (4.1 to 4.7, 4.10, 4.11)

#### **BOOKS FOR REFERENCE:**

1. S. C. Mallik and S. Arora- Mathematical Analysis, New Age International Publications.
2. A. Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014.
3. Brian S. Thomson, Andrew. M. Bruckner, and Judith B. Bruckner, Elementary Real Analysis, Prentice Hall, 2001.

4. Gerald G. Bilodeau, Paul R. Thie, G. E. Keough, An Introduction to Analysis, Jones & Bartlett, Second Edition, 2010.

### Mapping of Course Outcomes with the Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	2	2	2	2	2	2
CO2	2	4	4	4	2	2	2	2	2	2
CO3	2	4	4	4	2	2	2	2	2	2
CO4	4	4	4	4	2	2	2	2	2	2
CO5	2	4	4	5	2	2	2	2	2	2

### Core Course: Differential equations (C-IV)

#### Course Outcomes:

After the completion of the course, Students will be able to

- a) solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- b) find the complete solution of a nonhomogeneous differential equation as a linear combination of the complementary function and a particular solution.
- c) Do the complete solution of a nonhomogeneous differential equation with constant coefficients by the method of undetermined coefficients.
- d) find the complete solution of a differential equation with constant coefficients by variation of parameters.
- e) Student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.

#### UNIT-I

Differential equations and mathematical models, First order and first degree ODE (variable Separable, homogeneous, exact and linear), Equations of first order but of higher degree.

#### UNIT-II

Second order linear equations (homogeneous and non-homogeneous) with constant coefficients, variation of parameters, method of undetermined coefficients, equations reducible to linear equations with constant coefficients, Euler's equations.

#### UNIT-III

Second order equations with variable coefficients power series solution of second order differential equations.

**UNIT-IV**

Laplace transforms and its applications to solutions of differential equations.

**Practical / Lab work to be performed on a computer:**

Modelling of the following problems using Matlab / Mathematica /Maple etc.

1. Plotting of second order solution family of differential equations.
2. Growth model (exponential case only).
3. Plotting of third order solution family of differential equations.
4. Decay model (exponential case only)
5. Oxygen debt model
6. Economic model.
7. Vibration / Oscillation problems (undammed, damped & forced vibration)

**BOOKS RECOMMENDED:**

1. J. Sinha Roy and S. Padhy: A course of Ordinary and Partial differential equation, Kalyani Publishers, New Delhi. Chapters:1, 2 (2.1 to 2.7), 3, 4 (4.1 to 4.8), 5, 7 (7.1-7.31), 9 (9.1, 9.2, 9.3, 9.4, 9.5, 9.10, 9.11, 9.13)

**BOOKS FOR REFERENCE:**

1. Simmons G. F., Differential equation, Tata Mc Graw Hill, 1991.
2. Martin Braun, Differential Equations and their Applications, Springer International, Student Ed.
3. S. L. Ross, Differential Equations, 3<sup>rd</sup>Edition, John Wiley and Sons, India.
4. C. Y. Lin, Theory and Examples of Ordinary Differential Equations, World Scientific, 2011.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	4	2	4	4	2	2	2
CO2	2	4	4	4	2	4	4	2	2	2
CO3	4	4	4	4	2	4	4	2	2	2
CO4	2	4	4	4	2	4	4	2	2	2
CO5	2	4	4	4	2	4	4	2	4	2

**GE A2 (Algebra)**

**Course Outcomes:**

On completion of the course, a student will be able to

- a) recognize the mathematical objects called groups and link the fundamental concepts of groups and symmetries of geometrical objects.

- b) explain the significance of the notions of cosets, normal subgroups, and factor groups and analyse consequences of Lagrange's theorem.
- c) describe about structure preserving maps between groups and their consequences.
- d) demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples; identify matrices with linear transformations and compute eigenvalues and eigenvectors of linear transformations.

### **UNIT-I**

Group theory, Definition and Examples Subgroups, Normal Subgroups, Cyclic groups.

### **UNIT-II**

Cosets, Quotient Groups, Permutation Groups, Homomorphism.

### **UNIT-III**

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension.

### **UNIT-IV**

Matrices and Linear maps, Rank and nullity of a matrix, Transpose of a matrix, Elementary row operations, Matrix inversion using row operation, Determinant and Rank of Matrices, Eigen values & Eigen vectors.

### **BOOKS RECOMMENDED:**

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Pvt. Ltd. Chapter 2 (2.1-2.6, 2.7 (excluding application)).
2. V. Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd Chapter 3 , 4 (4.1), 5 (5.7-5.9), 6 (6.5-6.8).

### **BOOKS FOR REFERENCE:**

1. David C. Lay, Linear Algebra and its Applications, 3<sup>rd</sup> Ed., Pearson Education Asia, Indian Reprint 2007.
2. B. S.Vatsa and Suchi Vatsa, Theory of Matrices, New age International, third edition, 2010.
3. Ward Cheney, David Kincaid, Linear algebra theory and applications, Jones and Bartlett, 2010.

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	4	4	4	2	4	2
CO2	4	4	4	4	4	4	4	2	4	2
CO3	4	4	4	4	2	2	2	2	4	2
CO4	2	4	4	4	2	2	2	2	2	2
CO5	2	4	4	4	2	2	2	2	2	2



## Ability Enhancement Compulsory Course II

### MIL – Alternative English

#### Course Outcomes

After completion of the course the students shall be able to:

- CO 1: demonstrate high-level proficiency in writing and speaking English
- CO 2: employ effectively the language of their discipline
- CO 3: develop skills in organizing and expressing ideas and viewpoints with clarity and coherence in writing and speech
- CO 4: formulate and defend original arguments
- CO 5: enumerate skills in narration, description, and argumentation
- CO 6: ascertain insight into different cultures
- CO 7: gain good knowledge that includes understanding recent developments in language and literature
- CO 8: to develop an acumen for a better understanding of the diversity of human experiences
- CO 9: acquire an openness to new ideas, perspectives, and ways of thinking
- CO 10: enhance literary and critical thinking

#### UNIT I: Short Story

- i. Jim Corbett-The Fight between Leopards
- ii. Dash Benhur- The Bicycle
- iii. Dinanath Pathy- George V High School
- iv. Alexander Baron- The Man who knew too much
- v. Will f Jenkins- Uneasy Homecoming

#### UNIT II: Prose

- i. Mahatma Gandhi- The way to Equal Distribution
- ii. S Radhakrishnan- A Call to Youth
- iii. C V Raman-Water- The Elixir of Life
- iv. Harold Nicolson- An Educated Person
- v. Claire Needell Hollander- No Learning without Feeling

#### UNIT III:

Comprehension of a passage and answering the questions

#### UNIT IV:

Language exercises-test of vocabulary, usage and grammar

#### Text Books

All Stories and Prose pieces

#### Reference Books

- The Widening Arc: A Selection of Prose and Stories, Ed. A R Parhi, S Deepika, P Jani, Kitab Bhavan, Bhubaneswar. 16
- A Communicative Grammar of English, Geoffrey Leech.
- A University Grammar of English, Randolph Quirk and Sidney Greenbaum

- Developing Reading Skills. F. Grellet. Cambridge: Cambridge University Press, 1981.

### **Mapping of Course Outcomes with the Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	4	5	5	5	5	5
CO2	5	5	5	4	5	5	5	5	4	5
CO3	5	5	5	5	5	4	5	5	4	5
CO4	5	5	4	5	4	5	5	2	5	5

### **SEMESTER-III**

#### **Core Course: THEORY OF REAL FUNCTIONS (Analysis-II) (C-V)**

#### **Course Outcomes:**

On completion of the course, a student will be able to

- (a) examine and calculate the limit, and investigate the continuity of a function at a point.
- (b) describe with different properties of a continuous and uniformly continuous functions.
- (c) describe the consequences of various mean value theorems for differentiable functions.
- (d) describe the basic definition and topology of metric spaces.
- (e) identify complete and incomplete metric spaces.

#### **UNIT-I**

Limits of functions ( $\epsilon$ - $\delta$  approach), sequential Criterion for limits, divergence Criteria, Limit Theorems, One sided limits, infinite limits and limits at infinity, continuous functions, sequential Criterion for continuity and discontinuity.

#### **UNIT-II**

Algebra of continuous functions, continuous functions on an interval, intermediate value theorem, location of roots theorem, preservation of intervals theorem, Uniform Continuity, non-uniform continuity criteria, uniform continuity theorem, Differentiability of a function at a point and in an interval, algebra of differentiable functions.

#### **UNIT-III**

Roles theorem, Mean value theorem, intermediate value property of derivatives, Darboux Theorem, Applications of mean value theorem to inequalities and approximation of polynomials, Taylor's Theorem to inequalities.

#### **UNIT-IV**

Cauchy's mean value theorem, Taylor's theorem with Lagranges form of remainder, Taylor's theorem with cauchy's form of remainder, application of Taylor's Theorem to convex functions, relative extreme, Taylors Series and Maclaurins series expansions of exponential and trigonometric functions.

#### **BOOKS RECOMMENDED:**

1. G. Das and S. Pattanayak, Fundamentals of mathematics analysis, TMH Publishing Co. Chapters 6 (6.1-6.9), 7(7.1-7.7), 9(9.7).

**BOOK FOR REFERENCES:**

1. Kumar, S. Kumaresan, A basic course in Real Analysis, CRC Press, 2014
2. K. A. Ross, Elementary analysis: the theory of calculus, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004
3. A. Mattuck, Introduction to Analysis, Prentice Hall
4. Charles G. Denlinger, Elements of real analysis, Jones and Bartlett (Student Edition), 2011.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	2	2	2	2	2
CO2	2	4	4	2	2	2	2	2	2	2
CO3	2	4	4	2	2	2	2	2	2	2
CO4	2	4	4	2	2	2	2	2	2	2
CO5	2	4	4	2	2	2	2	2	2	2

**Core Course: Group Theory (Algebra-II) (C-VI)**

**Course Outcomes:**

On completion of the course, a student will be able to

- a) recognize the mathematical objects called groups.
- b) link the fundamental concepts of groups and symmetries of geometrical objects.
- c) explain the significance of the notions of cosets, normal subgroups, and factor groups.
- d) analyse consequences of Lagrange's theorem.
- e) describe about structure preserving maps between groups and their consequences.

**UNIT-I**

Definition and examples of groups including permutation groups, elementary properties of groups, Subgroups and examples of subgroups, centralizer, normalizer, center of a group, Product of two groups.

**UNIT-II**

Properties of cyclic groups, classification of subgroups of cyclic groups, Cycle notation for permutations, properties of permutations, even and odd permutations, Properties of cosets, Lagranges theorem and consequences including Fermat's Little theorem.

**UNIT-III**

Normal subgroups, factor groups, Cauchy's theorem for finite abelian groups.

**UNIT-IV**

Group homomorphisms, properties of homomorphisms, Cayley's theorem, properties of

isomorphisms, first, second and third isomorphism theorems (Statement only).

### **BOOKS RECOMMENDED:**

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited India, 1975 (Chapters 2 (2.1-2.7, 2.9. 2.10)

### **BOOK FOR REFERENCES:**

1. M. Artin, Abstract Algebra, 2<sup>nd</sup> Ed., Pearson, 2011.
2. Joseph I. Rotman, An Introduction to the Theory of Groups, 4<sup>th</sup> Ed., Springer Verlag, 1995.

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	4	4	4	2	4	2
CO2	4	4	4	4	4	4	4	2	4	2
CO3	2	4	2	4	2	2	2	2	2	2
CO4	2	4	4	4	2	2	2	2	2	2
CO5	4	4	4	4	2	2	2	2	4	2

### **Core Course: Partial differential equations & system of ODEs (C-VII)**

#### **Course Outcomes:**

After the completion of the course, Students will be able to

- a) classify partial differential equations and transform into canonical form
- b) solve linear partial differential equations of both first and second order
- c) apply partial derivative equation techniques to predict the behaviour of certain phenomena.
- d) apply specific methodologies, techniques and resources to conduct research and produce innovative results in the area of specialisation.
- e) extract information from partial derivative models in order to interpret reality.

#### **UNIT-I**

Partial Differential Equations - Basic concepts and Definitions, Mathematical Problems. First-Order Equations: Simultaneous linear first order equations in 3 variables, methods of solution, Pfaffian differential equations, methods of solutions of Pfaffian differential equations in 3 variables.

#### **UNIT-II**

Formation of first order partial differential equations, Linear and non-linear partial differential equations of first order, special types of first-order equations, solutions of partial differential equations of first order satisfying given conditions. 19

#### **UNIT-III**

Linear partial differential equations with constant coefficients, Equations reducible to linear

partial differential equations with constant coefficients and with variable coefficients.

#### **UNIT-IV**

Monge's method of integrating  $Rr + Ss + Tt = V$ . Laplace equation, Solution of Laplace equation by separation of variables. One dimensional wave equation, solution of the wave equation (method of separation of variables), Diffusion equation, solution of one-dimensional diffusion equation, method of separation of variables.

#### **LIST OF PRACTICALS (USING ANY SOFTWARE)**

- To find the general solution of the non-homogeneous system of the form:  
 $\frac{dx}{dt} = a_1x + b_1y + f_1(t)$ ,  $\frac{dy}{dt} = a_2x + b_2y + f_2(t)$  with given conditions.
- Plot the integral surfaces of a given first order PDE with initial data.
- Solution of wave equation  $\frac{\partial^2 u}{\partial t^2} - c \frac{\partial^2 u}{\partial x^2} = 0$  for the following associated conditions
  - $u(x,0) = \phi(x)$ ,  $u_t(x,0) = \psi(x)$ ,  $x \in R$ ,  $t > 0$
  - $u(x,0) = \phi(x)$ ,  $u_t(x,0) = \psi(x)$ ,  $u(0,t) = 0$ ,  $x \in (0, \infty)$ ,  $t > 0$
  - $u(x,0) = \phi(x)$ ,  $u_t(x,0) = \psi(x)$ ,  $u_x(0,t) = 0$ ,  $x \in (0, \infty)$ ,  $t > 0$
  - $u(x,0) = \phi(x)$ ,  $u_t(x,0) = \psi(x)$ ,  $u(0,t) = 0$ ,  $u(l,t) = 0$ ,  $0 < x < l$ ,  $t > 0$

#### **BOOKS RECOMMENDED:**

- J Sinha Roy and S Padhy: A course of Ordinary and Partial differential equations, Kalyani Publishers, New Delhi, Ludhiana, 2012, Chapters 11, 12, 13 (13.1-13.5, 13.7), 15 (15.1,15.5), 16 (16.1, 16.1.1), 17 (17.1, 17.2, 17.3)

#### **BOOK FOR REFERENCES:**

- J Sinha Roy and S Padhy: A course of Ordinary and Partial differential equation Kalyani Publishers, New Delhi,
- Martha L Abell, James P. Braselton, Differential equations with MATHEMATICA, 3<sup>rd</sup> Ed., Elsevier Academic Press, 2004.
- Robert C. McOwen: Partial Differential Equations, Pearson Education Inc.
- T Amarnath: An Elementary Course in Partial Differential Equations, Narosa Publication

#### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	2	4	2	2	2	2	2	2
CO2	2	4	2	4	2	2	2	2	2	2
CO3	2	4	2	4	2	2	2	2	2	2
CO4	2	4	2	4	2	2	2	2	2	4
CO5	4	4	2	4	2	2	2	2	2	4

## **Course Outcomes:**

On completion of the course, a student will be able to

- a) calculate the higher order derivatives and limits in indeterminate form by repeated use of L'Hospital rule.
- b) acquire the concept of asymptotes and envelopes
- c) solve first order differential equations utilizing the standard techniques for separable, exact, linear, homogeneous, or Bernoulli cases.
- d) Student will have a working knowledge of basic application problems described by second order linear differential equations with constant coefficients.
- e) how to set up and solve optimization problems involving several variables with or without constraints.

## **UNIT-I:**

Curvature, Asymptotes, Rectification, Quadrature, Volume and surface area of solids of revolution.

## **UNIT-II:**

Explicit and Implicit functions: Limit and Continuity of functions of several variables, Partial derivatives, Partial derivatives of higher orders, Homogeneous functions, Change of variables, Mean value theorem, Taylors theorem and Maclaurin's theorem for functions of two variables (statements & applications).

## **UNIT-III**

Ordinary Differential Equations of order one and degree one (variables separable, homogeneous, exact and linear), Equations of order one but higher degree.

## **UNIT-IV**

Second order linear equations with constant coefficients, homogeneous forms, Second order equations with variable coefficients.

## **BOOKS RECOMMENDED:**

1. Shanti Narayan, Text Book of Calculus, Part-II Chapter 8 (Art 24, 25, 26)
2. Shanti Narayan, Text Book of Calculus, Part-III Chapter-1 (Art 1, 2), 4 (Art 10-12 ), 5 (Art 13)
3. S. C. Mallik and S. Arora - Mathematical Analysis, New Age International Publications. Chapter 15 (1-5, 8, 9)
4. J. Sinha Roy and S. Padhy: A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, Chapters 2 (2.1-2.7), 3, 4 (4.1-4.4)

## **BOOK FOR REFERENCES:**

4. Anton, I. Bivens and S. Davis, Calculus, 10<sup>th</sup> Ed., John Wiley and Sons (Asia)P. Ltd., Singapore, 2002.
5. Shanti Narayan and P. K. Mittal-Analytical Solid Geometry, S. Chand & Company Pvt. Ltd., New Delhi. 21
6. Martin Braun-Differential Equations and their Applications-Martin Braun, Springer International.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	2	2	2	2	2	4
CO2	5	5	5	5	5	2	2	4	2	2
CO3	5	5	5	5	2	2	2	2	4	2
CO4	5	5	5	5	2	4	4	2	4	2
CO5	5	5	5	5	2	2	2	2	2	2

**Skill Enhancement Course-I (English)**

**Course Outcomes:**

After completion of the course the students shall be able to:

CO 1: enhance their ability to build and enrich their communication skills

CO 2: be able to build up the four primary skills in students in the academic as well as in the wider domains of use like public offices.

CO 3: acquire analytical and comprehension reading skills

CO 4: identify basic principles of communication

CO 5: build speaking and listening skills

CO 6: learn beyond the conventional syllabus and be prepared to meet challenges while seeking a job

CO 7: be able to synthesize knowledge and use it creatively to better understand and improvise themselves

CO 8: be able to communicate effectively through written reports, presentations, and discussions

CO 9: develop a neutral accent and improve general standard of pronunciation

CO 10: speak globally intelligible English

**UNIT-I- BUSINESS COMMUNICATION AND GRAMMAR**

1. Why English Communication is Essential and How to Improve the Skills?
2. Introduction to Voice and Accent
  - Why do we have such different accents?
  - Accent Training Consequences
  - Voice and accent in the Enterprise Industry
  - Globally Comprehensible Accent
  - Introduction to Phonetics
  - International Phonetic Alphabet
3. Consonant Sounds
4. Vowels
5. Diphthongs
6. A Few Phonic Rules
7. Word Stress: Syllables
8. Intonation

- Intonation and Stress
- 9. Pacing and Chunking
  - Common Patterns of Pacing
  - Importance of Chunking
- 10. Fluency
- 11. Indianisms
  - Error relating to Grammar
  - Vocabulary

## **UNIT-II: GRAMMAR**

1. English: Spoken Versus Written Communication
2. Nouns
  - 2.1 Kinds of Nouns
  - 2.2 Activity 3: Noun Ping-pong
  - 2.3 Nouns-Number
  - 2.4 Noun-Gender
  - 2.5 Countable and Uncountable Nouns
3. Pronouns
  - 3.1 Reflexive Pronouns
  - 3.2 Relative Pronouns
  - 3.3 Demonstrative Pronouns
  - 3.4 Interrogative Pronouns
  - 3.5 Indefinite Pronouns
  - 3.6 Activity 4: Sentence Auction
4. Adjectives
  - 4.1 Activity 5: Picture Perfect
  - 4.2 Positioning of adjectives
  - 4.3 Comparative Degrees of Adjectives
  - 4.4 Order of Adjectives
5. Adverbs
  - 5.1 Kinds of Adverb
  - 5.2 Degree of Comparison
  - 5.3 Word Order with Adverbs
  - 5.4 Activity 6: Relay Race
6. Prepositions
  - 6.1 Activity 7: Treasure Hunt
  - 6.2 Activity 8: Route Map
  - 6.3 Prepositions with Adjectives, Nouns and Verbs
7. Conjunctions
  - 7.1 Coordinating Conjunctions
  - 7.2 Subordinating Conjunctions
  - 7.3 Correlative Conjunctions
  - 7.4 Connecting Adverbs
  - 7.5 Activity 9: The Socks Story
8. Verbs



- 8.1 Verb Classification
- 8.2 List of irregular verbs
- 8.3 Activity 10: Word Search
- 9. Subject and verb agreement
  - 9.1 Activity 11: Tossed Word Salad
  - 9.2 Activity 12: The Sentence Pageant
- 10. Determiners and Modifiers
  - 10.1 Kinds of Determiners
  - 10.2 The Definite and the Indefinite Article
  - 10.3 Definite article: The
  - 10.4 Activity 13: Proof Reading
- 11. Tenses
  - 11.1 Reference Table
  - 11.2 Present Tense
  - 11.3 Activity 14: Instruction Manual
  - 11.4 Activity 15: Commentary
  - 11.5 Past Tense
  - 11.6 Activity 16: The Chain List
  - 11.7 Activity 17: Transcription
  - 11.8 Future Tense
  - 11.9 Activity 18: This Week for You
  - 11.10 Activity 19: Verb Grand Prix
- 12. Punctuation
  - Forms of Punctuation

### **UNIT-III: READING COMPREHENSION**

- Reading - A 7 Step Process
- Techniques to enhance students' reading skills
- Types of reading skills
  - Skimming
  - Scanning
  - Extensive reading
  - Intensive reading
- Three levels of Reading
- Improving your reading speed
- Reading Comprehension Practice Exercises

#### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	5	5	5	5	4	5	5	5	5	5
CO2	5	5	5	4	5	5	5	5	4	5
CO3	5	5	5	5	5	4	5	5	4	5
CO4	5	5	4	5	4	5	5	2	5	5

### **SEMESTER-IV**

#### **Core Course: Numerical Methods (C-VIII)**

## **Course Outcomes:**

On completion of the course, a student will be able to

- a) obtain numerical solutions of algebraic and transcendental equations
- b) find numerical solutions of system of linear equations and check the accuracy of the solutions
- c) describe various interpolating and extrapolating methods
- d) solve initial and boundary value problems in differential equations using numerical methods
- e) apply various numerical methods in real life problems.

### **UNIT-I**

Rate of convergence, Errors: Relative, Absolute, Round off, Truncation. Numerical solution of non-linear equations: Transcendental and polynomial equations, Bisection method, Regula-Falsi method, Secant method, Newton-Raphson method, Rate of convergence of these methods.

### **UNIT-II**

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

### **UNIT-III**

Polynomial interpolation: Existence uniqueness of interpolating polynomials, Lagrange and Newton's divided difference interpolation, Error in interpolation, Finite difference operators.

### **UNIT-IV**

Numerical Integration: Some simple quadrature rules, Newton-Cotes rules, Trapezoidal rule, Simpsons rule, Simpsons  $3/8th$  rule, Mid-point Rule, composite Trapezoidal Rule, composite Simpson's rule, Ordinary differential Equations, Euler's method.

### **PRACTICAL / LAB WORK TO BE PERFORMED ON A COMPUTER:**

Use of computer aided software (CAS), for example Matlab/Mathematica/Maple/Maxima etc., for developing the following Numerical programs:

1. Bisection Method
2. Newton Raphson Method
3. Secant Method
4. Regula Falsi Method
5. Newton Interpolation
6. Compound Trapezoidal Rule
7. Compound Simpson's Rule.

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

### **BOOKSRECOMMENDED:**

1. B. P. Acharya and R. N. Das : A course on Numerical Analysis, Kalyani Publishers, New Delhi, Ludhiana, Chapters 0 (0.2), 1 (1.8), 2 (2.1-2.4, 2.6-2.9), 3 (3.1- 3.4, 3.6,3.9), 6 (6.1-6.5), 7(7.3,7.4), 8(8.1,8.2)

### **BOOKFORREFERENCES:**

1. B. Bradie, A Friendly Introduction to Numerical Analysis, Pearson Education, India, 2007.
2. Kendall E. Atkinson: An Introduction to Numerical Analysis
3. C. F. Gerald and P. O. Wheatley, Applied Numerical Analysis, Pearson Education, India, 7<sup>th</sup> Edition, 2008
4. S. D. Conte & S. de Boor: Elementary Numerical Analysis: An Algorithmic Approach.

### Mapping of Course Outcomes with the Program Outcomes

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	4	4	4	4	2	2	2
CO2	4	4	4	4	4	4	4	2	2	2
CO3	2	4	4	4	4	4	4	2	2	2
CO4	4	4	4	4	4	4	4	2	2	2
CO5	4	4	4	4	4	4	4	2	2	4

### Core Course: Riemann Integration and Series of Functions (Analysis-III) (C-IX)

#### Course Outcomes:

On completion of the course, a student will be able to

- a) list some of the properties of Riemann integrable functions, and apply the fundamental theorems of integration;
- b) identify and test the convergence of an improper integral;
- c) calculate Fourier transforms of functions belonging to  $L^1(\mathbb{R})$  class of functions;
- d) explain Parseval's identity, Plancherel's theorem, and applications of Fourier transforms to boundary value problems;
- e) find Fourier series, prove Bessel's inequality, and find term by term differentiation and integration of Fourier series.

#### UNIT-I

Riemann integrations, inequalities of upper and lower sums, Riemann conditions of integrability, Riemann sums and definition of Riemann integral through Riemann sums, equivalence of two definitions, Riemann integrability of monotone and continuous functions, Properties of the Riemann integral, definition and integrability of piecewise continuous and monotone functions, Intermediate value theorem for Integrals, Fundamental Theorem of Calculus.

#### UNIT-II

Improper Integrals: Convergence of Beta and Gamma Functions.

#### UNIT-III

Pointwise and Uniform convergence of sequence of functions, Theorems on continuity, derivability and integrability of the limit of a sequence of functions, series of functions,

Theorems on the continuity and derivability of the sum function of a series of functions, Cauchy's criteria for uniform convergence and Weierstrass M-Test.

#### **UNIT-IV**

Power series, radius of convergence, Cauchy Hadamard Theorem, Differentiation and Integration of Powerseries. Abels Theorem, Weierstrass Approximation Theorem.

#### **BOOKSRECOMMENDED:**

1. G. Das and S. Pattnayak, Fundamentals of Mathematics Analysis, TMH Publishing Co. Chapters 8 (8.1-8.6), 9(9.1-9.8)
2. S. C. Mallick & S. Arora – Mathematical Analysis, New Age International, Publishers

#### **Mapping of Course Outcomes with the Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	2	2	2	2	2
CO2	2	4	4	2	2	2	2	2	2	2
CO3	2	4	4	2	2	2	2	2	2	2
CO4	2	4	4	2	2	2	2	2	2	2
CO5	2	4	4	2	2	2	2	2	2	2

#### **Core Course: Ring Theory and Linear Algebra -I (C-X)**

##### **Course Outcomes:**

On completion of the course, a student will be able to

- a) describe the fundamental concepts in ring theory such as of the ideals, quotient rings, integral domains, and fields;
- b) demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples;
- c) identify matrices with linear transformations and compute eigenvalues and eigenvectors of linear transformations.
- d) describe the concept of minimal polynomial and develop an idea about inner product space and proceed to normed linear spaces;
- e) use Gram-Schmidt process to find orthogonal set of non-null vectors from any arbitrary set of vectors.

#### **UNIT-I**

Definition and examples of rings, properties of rings, subrings, integral domains and fields, characteristic of a ring, Ideals, ideal generated by a subset of a ring, factor rings, operations on ideals, prime and maximal ideals.

#### **UNIT-II**

Ring homomorphisms, properties of ring homomorphisms, field of quotients of an integral domain.

#### **UNIT-III**

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

#### **UNIT-IV**

Linear transformations, null space, range, rank and nullity of a linear transformation, matrix representation of a linear transformation, algebra of linear transformations.

#### **BOOKS FOR RECOMMENDED:**

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Limited, India, 1975. Chapter-3 (3.1-3.6)
2. V. Krishnamurthy, V. P. Mainra, J. L. Arora - An Introduction to Linear Algebra, Affiliated East West Press Pvt Ltd, New Delhi Chapter-3(Ex. 3.4), 4(4.1-4.3), 5(5.1,5.2)

#### **BOOK FOR REFERENCES:**

1. M. Artin, Abstract Algebra, 2<sup>nd</sup> Ed., Pearson, 2011.
2. Joseph I. Rotman, An Introduction to the Theory of Groups, 4<sup>th</sup> Ed., Springer Verlag, 1995.

#### **Mapping of Course Outcomes with the Program Outcomes**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	2	2	2	2	2	2	2	2
CO2	2	4	4	4	2	2	2	2	2	2
CO3	2	4	4	4	2	2	2	2	2	2
CO4	2	4	2	2	2	2	2	2	2	2
CO5	2	4	2	2	2	2	2	2	2	2

#### **GE B2 (Algebra)**

#### **Course Outcomes:**

On completion of the course, a student will be able to

- a) recognize the mathematical objects called groups and link the fundamental concepts of groups and symmetries of geometrical objects.
- b) explain the significance of the notions of cosets, normal subgroups, and factor groups and analyse consequences of Lagrange's theorem.
- c) describe about structure preserving maps between groups and their consequences.
- d) demonstrate the concepts of vector spaces, subspaces, bases, dimension and their properties with examples; identify matrices with linear transformations and compute eigenvalues and eigenvectors of linear transformations.

#### **UNIT-I**

Group theory, Definition and Examples Subgroups, Normal Subgroups, Cyclic groups.

#### **UNIT-II**

Cosets, Quotient Groups, Permutation Groups, Homomorphism.

#### **UNIT-III**

Vector spaces and subspaces, examples, linear independence, linear dependence, basis, dimension.

#### **UNIT-IV**

Matrices and Linear maps, Rank and nullity of a matrix, Transpose of a matrix, Elementary row operations, Matrix inversion using row operation, Determinant and Rank of Matrices, Eigen values & Eigen vectors.

**BOOKS RECOMMENDED:**

1. I. N. Herstein, Topics in Algebra, Wiley Eastern Pvt. Ltd. Chapter 2 (2.1-2.6, 2.7 (excluding application)).
2. V. Krishna Murthy, V. P. Mainra, J. L. Arora, An Introduction to Linear Algebra, Affiliated East-West Press Pvt. Ltd Chapter 3 , 4 (4.1), 5 (5.7-5.9), 6 (6.5-6.8).

**BOOKS FOR REFERENCE:**

1. David C. Lay, Linear Algebra and its Applications, 3<sup>rd</sup> Ed., Pearson Education Asia, Indian Reprint 2007.
2. B. S. Vatsa and Suchi Vatsa, Theory of Matrices, New age International, third edition, 2010.
3. Ward Cheney, David Kincaid, Linear algebra theory and applications, Jones and Bartlett, 2010.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	4	4	4	2	4	2
CO2	4	4	4	4	4	4	4	2	4	2
CO3	4	4	4	4	2	2	2	2	4	2
CO4	2	4	4	4	2	2	2	2	2	2
CO5	2	4	4	4	2	2	2	2	2	2

**SEC-II (Mathematics)**

**Course Outcomes:**

**I. QUANTITATIVE APTITUDE & DATA INTERPRETATION**

The student will be able to

- a) Use their logical thinking and analytical abilities to solve Quantitative aptitude questions from company specific and other competitive tests.
- b) Solve questions related to Time and distance and time and work etc. from company specific and other competitive tests.
- c) Understand and solve puzzle related questions from specific and other competitive tests.
- d) Solve questions related to permutation & combinations and probabilities from company specific and other competitive tests.

**II. LOGICAL REASONING**

The student will be able to

- a) Detect errors of grammar and usage in a given sentence/text and rectify them by making appropriate changes.
- b) Solve questions based on critical reasoning.
- c) Analyze reading passages and quickly find out the correct responses to questions asked by using reading skills like skimming, scanning, reading between the lines, etc.
- d) To use idiomatic expressions in writing and speaking and to solve questions based on them.

## **QUANTITATIVE APTITUDE & DATA INTERPRETATION**

**Unit - 1:** Whole numbers, Integers, Rational and irrational numbers, Fractions, Square roots and Cube roots, Surds and Indices, Problems on Numbers, Divisibility Steps of Long Division Method for Finding Square Roots:

**Unit -2:** Basic concepts, Different formulae of Percentage, Profit and Loss, Discount, Simple interest, Ratio and Proportion, Mixture

**Unit- 3:** Time and Work, Pipes and Cisterns, Basic concepts of Time, Distance and Speed ; relationship among them

**Unit - 4:** Concept of Angles, Different Polygons like triangles, rectangle, square, right angled triangle, Pythagorean Theorem, Perimeter and Area of Triangles, Rectangles, Circles

**Unit - 5:** Raw and Grouped Data, Bar Graphs, Pie charts, Mean, Median and Mode, Events and Sample Space, Probability

## **II. LOGICAL REASONING**

**Unit-I :** Analogy basing on kinds of relationships, Simple Analogy: Pattern and Series of Numbers, Letters, Figures. Coding Decoding of Numbers, Letters, Symbols (Figures), Blood relations

**Unit-II:** Logical Statements - Two premise argument, More than two premise argument using connectives

**Unit-III:** Venn Diagrams, Mirror Images, Problems on Cubes and Dices

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	2	4	2	2	4	2
CO2	4	4	4	4	2	4	2	2	4	2
CO3	4	4	4	4	2	4	2	2	4	2
CO4	4	4	4	4	2	4	2	2	4	2
CO5	4	4	4	4	2	4	2	2	4	2

## **SEMESTER-V**

### **Core Course: Multivariate Calculus (Calculus-II) (C-XI)**

#### **Course Outcomes:**

In single variable calculus you study functions of a single independent variable  $y=f(x)$ . In multivariable calculus we study functions of two or more independent variables,  $z=f(x, y)$  or  $w=f(x,y,z)$ .

After reading this course a student will be able to know

- a) how to differentiate and integrate functions of several variables.
- b) in single variable calculus the Fundamental Theorem of Calculus relates derivatives to integrals. They will see something similar in multivariable calculus and the capstone to the course will be the three theorems (Green's, Stokes' and Gauss') that do this.
- c) calculate partial derivatives, directional derivatives, extremum values and can calculate double, triple and line integrals.
- d) They will have idea of basic vector calculus including green's theorem, divergence theorem and stokes theorem. They can take courses in calculus on manifolds, Differential geometry and can help in numerical computations involving several variables.
- e) how to set up and solve optimization problems involving several variables with or without constraints.

### **UNIT-I**

Functions of several variables, limit and continuity of functions of two variables, Partial differentiation, total differentiability and differentiability, sufficient condition for differentiability, Chain rule for one and two independent parameters, directional derivatives, the gradient, maximal and normal property of the gradient, tangent planes.

### **UNIT-II**

Extrema of functions of two variables, method of Lagrange multipliers, constrained optimization problems, Definition of vector field, divergence and curl.

### **UNIT-III**

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

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, Stokes' theorem, The Divergence theorem.

### **BOOKS RECOMMENDED:**

1. S. C. Mallik and S. Arora: Mathematical Analysis, New Age International Publications Chapters 15, 17 & 18.

### **BOOK FOR REFERENCES:**

1. G. B. Thomas and R. L. Finney, Calculus, 9<sup>th</sup> Ed., Pearson Education, Delhi, 2005.
2. E. Marsden, A. J. Tromba and A. Weinstein, Basic Multivariable Calculus, Springer (SIE). Indian reprint, 2005.
3. James Stewart, Multivariable Calculus, Concepts and Contexts, 2<sup>nd</sup> Ed., Brooks/Cole, Thomson Learning, USA, 2001.

### **Mapping of Course Outcomes with the Program Outcomes:**



CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	2	2	2	2	2	4
CO2	2	4	4	4	2	2	2	2	2	2
CO3	2	4	4	4	2	2	2	2	2	2
CO4	2	4	4	4	2	2	2	2	2	2
CO5	4	4	4	4	2	2	2	2	2	2

### **Core Course: Programming in C++ (C-XII)**

#### **Course Outcomes:**

After completing this course, you will be able to:

- a) Describe OOPs concepts and use functions and pointers in your C++ program
- b) Understand tokens, expressions, and control structures
- c) Explain arrays and strings and create programs using them
- d) Describe and use constructors and destructors
- e) Understand and employ file management

#### **UNIT-I**

Introduction to structured Programming :Fundamentals of C++, -Simple data types, floating data types, character data types, string data types, arithmetic operators and operator precedence, variables and Constants declaration expressions, input using in C, output using C, preprocessor directives, increment & decrement operations, Creating a C Program, Input/output, relational & logical operators & Expressions.

#### **UNIT-II**

Control Structures: IF, IF ELSE, Nested if, Switch break. Statements, loops, For loop, While loop, do while loops, continue & Go to statements.

#### **UNIT-III**

Arrays, Declaration, One dimensional, two dimensional Sorting Array, Searching Array Element, Arrays of Characters and Strings.

#### **UNIT-IV**

Function – Definition, Types, Prototypes, value returning functions, Value versus reference parameters, local & global variables.

#### **BOOKSRECOMMENDED:**

Object oriented Programming Using C++, Dhanpat Rai & Co (P) Ltd., Educational & Technical Publisher, NewDelhi, Chapters (2, 3, 4,&5)

## Mapping of Course Outcomes with the Program Outcomes:

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	5	4	2	2	2
CO2	2	4	4	2	2	5	4	2	2	2
CO3	2	4	4	2	2	5	4	2	2	2
CO4	2	4	4	2	2	5	4	2	2	2
CO5	2	4	4	2	2	5	4	2	2	2

### Discipline Specific Elective: Discrete Mathematics (DSE-I)

#### Course Outcomes:

After completing this course, you will be able to:

- There are several important reasons for studying discrete mathematics. First, through this course you can develop your mathematical maturity: that is, your ability to understand and create mathematical arguments.
- It is an excellent tool for improving reasoning and problem-solving skills, and is appropriate for all at all levels and of all abilities.
- The importance of discrete mathematics lies in the fact that the modern mathematics deals with sets not numbers or more precisely sets with additional structures because the sets we come across in practice are usually finite.
- The ideas of discrete mathematics are the fundamental to the science and technology specific to the computer age.
- The knowledge of discrete mathematics is the key prerequisite for advanced work in many branches of mathematics and computer science which includes data structure, database theory, compiler design, operating system and many others.

#### UNIT-I

Logic, propositional equivalence, predicates and quantifiers, nested quantifiers & methods of proof.

#### UNIT-II

Boolean functions and their representation, The basic counting, the pigeon `hole principle, Generalized permutations & Combinations.

#### UNIT-III

Recurrence relations, Counting using recurrence relations, Solving linear homogeneous recurrence, relations with constant coefficients, Generating functions, Solving recurrence relations using generating functions, partially ordered sets duality principle.

#### UNIT-IV

Graphs, basic concepts and graph terminology, representing graphs & graph isomorphism, distance in a graph, Cut-vertices & cut edges, Connectivity, Euler & Hamiltonian Path.

#### BOOKS RECOMMENDED:

- Kenneth H. Rosen, Discrete Mathematics & Application, Tata Mc Graw Hill Chapters

1(1.1-1.5), 4 (4.1,4.2,4.4), 6 (6.1, 6.2, 6.4), 8 (8.1-8.5),10 (10.1,10.2)

**BOOKS FOR REFERENCE:**

1. S.Hillier and G. J. Lieberman, Introduction to Operations Research-Concepts and Cases (9thEdition), Tata McGraw Hill, 2010.
2. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, Linear Programming and Network Flows (2nd edition), John Wiley and Sons, India, 2004. Chapters6 (6.1,6.2,6.4), 8 (8.1-8.5), 10(10.1,10.2)
3. G. Hadley, Linear Programming, Narosa Publishing House, New Delhi, 2002.
4. Hamdy A. Taha, Operations Research: An Introduction (10<sup>th</sup> edition), Pearson, 2017.

**Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	4	4	4	4	2	2	2	2	2	2
CO2	4	4	4	4	2	2	2	2	2	2
CO3	2	4	4	4	2	2	2	2	2	2
CO4	2	4	4	4	2	2	2	2	2	2
CO5	2	4	4	4	2	2	2	2	2	2

**Discipline Specific Elective: Number Theory (DSE-II)**

**Course Outcomes:**

On completion of the course, a student will be able to

- a) describe some important results in the theory of numbers including the prime number theorem, Chinese remainder theorem, Wilson's theorem and their consequences;
- b) describe number theoretic functions, modular arithmetic and their applications;
- c) familiarise with modular arithmetic and find primitive roots of prime and composite numbers;
- d) know about open problems in number theory, namely, the Goldbach conjecture and twin prime conjecture.
- e) apply public crypto systems, in particular, RSA.

**UNIT-I**

Divisibility Theorem in integers, Primes and their distributions, Fundamental Theorem of arithmetic, Greatest common divisor, Euclidean algorithm, Modular arithmetics.

**UNIT-II**

Linear Diophantine equation, Prime Counting function, Statement of Prime number theorem, Goldbach Conjecture.

**UNIT-III**

Introduction to congruence Linear congruence, Chinese Remainder Theorem, Polynomial congruences, system of linear congruences, complete set of residues.

**UNIT-IV**

Fermat's little theorem, Wilson's theorem Euler's phi function, Euler's theorem, reduced set of residues, some properties of Euler's phi-function.

### **BOOKS RECOMMENDED:**

1. David M. Burton, Elementary Number Theory (6<sup>th</sup> Edition), Tata Mc Graw-Hill Edition, Indian reprint, 2007. Chapters 2 (2.1–2.5), 3 (3.1-3.3), 4 (4.1-4.4), 5 (5.1-5.3), 7 (7.1-7.4)

### **BOOK FOR REFERENCES:**

1. Thomas Koshy, Elementary Number Theory with Applications (2<sup>nd</sup> Edition), Academic Press, 2007.
2. Neville Robinns, Beginning Number Theory (2<sup>nd</sup> Edition), Narosa Publishing House Pvt. Limited, Delhi, 2007.

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	2	2	2	2	2	2	2	2
CO2	2	4	2	2	2	2	2	2	2	2
CO3	2	4	2	2	2	2	2	2	2	2
CO4	2	4	2	2	2	2	2	2	2	2
CO5	2	4	2	2	2	2	2	2	2	2

### **SEMESTER-VI**

#### **Core Course: Metric Spaces and Complex Analysis (Analysis-IV) (C-XIII)**

#### **Course Outcomes:**

On completion of the course, a student will be able to

- a) describe several standard concepts of metric spaces and their properties like openness, closedness, completeness, Bolzano-Weierstrass property, compactness, and connectedness.
- b) describe the differentiability and analyticity of complex functions leading to the Cauchy-Riemann equations.
- c) apply the Cauchy-Goursat theorem and Cauchy integral formula in evaluation of contour Integrals and apply Liouville's theorem in fundamental theorem of algebra;
- d) evaluate Taylor and Laurent series expansions of analytic functions;
- e) classify the nature of singularity, poles and residues and application of Cauchy Residue theorem.

#### **UNIT-I**

Metric Spaces: Definition & examples, sequences in metric spaces, Cauchy's sequences, Complete Metric spaces, open and closed balls, neighborhood, open set, interior of a set, limit Point of a set, closed set, diameter of a set, Cantor's theorem.

#### **UNIT-II**

Properties of Complex Numbers, regions in the complex plane, functions of complex variable, mappings, Derivatives, Differentiation formulas, Cauchy-Riemann equations, sufficient conditions for differentiability.

### **UNIT-III**

Analytic functions, examples of analytic functions, exponential function, Logarithmic function, trigonometric functions, derivatives of functions, definite integrals of functions, Contours, Contour integrals and its examples, upper bounds for module of contour integrals. Cauchy-Goursat theorem, Cauchy integral formula.

### **UNIT-IV**

Liouvilles 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.

#### **BOOKS RECOMMENDED:**

1. S. C. Mallik and S. Arora Mathematical Analysis, New Age International Publications, Chapter-19 (1, 2.1-2.6, 3)
2. Complex analysis S. Arumugam, A. Thangapande, Issac & A. Somasundaram, SCITECH Publications (India) Pvt. Ltd. Chapters – 1 (1.1), 2(2.1-2.7), 4(4.4), 6, 7(7.1&7.2)

#### **BOOKS FOR REFERENCE:**

1. James Ward Brown and Ruel V. Churchill, Complex Variables and Applications (Eighth Edition), Mc Graw-Hill International Edition, 2009.
2. G. F. Simmons, Introduction to Topology and Modern Analysis, Mcgraw-Hill, Edition 2004.
3. Joseph Bak and Donald I., Newman, Complex analysis (2<sup>nd</sup> Edition), Under graduate Texts in Mathematics, Springer-Verlag, NewYork, Inc., New York, 1997.

#### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	2	2	2	2	2	2	2	2
CO2	2	4	2	2	2	2	2	2	2	2
CO3	2	4	2	2	2	2	2	2	2	2
CO4	2	4	2	2	2	2	2	2	2	2
CO5	2	4	2	2	2	2	2	2	2	2

#### **Core Course: Linear Programming (C-XIV)**

#### **Course Outcomes:**

On completion of the course, a student will be able to

- a) will be able describe quantitative methods used in decision making.
- b) compares the types of quantitative methods.
- c) explain the applications of linear programming.
- d) constructs linear programming model.

e) applies solution methods for linear programming models.

### **UNIT-I**

Introduction to linear programming problem, theory of simplex method, optimality and unboundedness, the simplex algorithm, simplex method in table format, introduction of artificial variables, two phase method, Big M method.

### **UNIT-II**

Duality, formulation of the dual problem, primal dual relationships.

### **UNIT-III**

Transportation problem and its mathematical formulations north west corner method, least cost method and Vogel approximation method for determination of starting basic solution, algorithm for solving transportation problem.

### **UNIT-IV**

Assignment problem and its mathematical formulation, Hungarian method for solving assignment problem.

### **BOOKS RECOMMENDED:**

1. Kanti Swarup, P. K. Gupta and Man Mohan – Operations Research, S. Chand and Co Pvt. Ltd. Chapters – 4(4.1-4.4), 5(5.1-5.4), 10(10.1-10.3, 10.5, 10.9), 11(11.1-11.3)

### **BOOK FOR REFERENCES:**

1. M. Artin, *Abstract Algebra*, 2<sup>nd</sup> Ed., Pearson, 2011.
2. David S. Dummit and Richard M. Foote, *Abstract Algebra*, 3<sup>rd</sup> Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2004.
3. J. R. Durbin, *Modern Algebra*, John Wiley & Sons, New York Inc., 2000

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	2	2	2	2	2
CO2	2	4	4	2	2	2	2	2	2	2
CO3	2	4	4	4	2	2	2	2	2	2
CO4	2	4	4	2	2	2	2	2	2	2
CO5	4	4	4	2	2	2	2	2	2	2

### **Discipline Specific Elective: Differential Geometry (DSE-III)**

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### **Course Outcomes:**

On completion of the course, a student will be able to

- describe various properties of curves including Serret-Frenet formulae and their applications;
- describe the interpretation of the curvature tensor, Geodesic curvature, Gauss and Weingarten formulae;
- describe the role of Gauss's Theorem Egregium and its consequences;
- apply problem-solving with differential geometry to diverse situations in physics, engineering and in other mathematical contexts.
- compute quantities of geometric interest such as curvature as well as develop a facility to compute in various specialised systems such as semigeodesics.

### **UNIT-I**

Theory of Space Curves: Space curves, Planer curves, Curvature, torsion and Serret-Frenet formulae.

### **UNIT-II**

Osculating circles, Osculating circles and spheres, Existence of space curves, Evolutes and involutes of curves.

### **UNIT-III**

Developable: Developable associated with space curves and curves on surfaces, Minimal surfaces.

### **UNIT-IV**

Theory of surfaces: Parametric curvesion surfaces, Direction coefficients, First and second Fundamental forms, Principal and Gaussian curvature, Euler's theorem, Rodrigues formula.

### **BOOKS RECOMMENDED:**

- C. E. Weatherburn, Differential Geometry of three Dimensions, Cambridge University Press 2003 Chapters 1 (1-4, 7, 8, 10, 11), 2(13,14,16,17), 3, 4(29-31,35)

### **BOOK FOR REFERENCES:**

- A. Pressley, Elementary Differential Geometry, Springer International Edition, 2014.
- O'Neill, Elementary Differential Geometry, 2<sup>nd</sup> Ed., Academic Press, 2006.
- C. E. Weatherburn, Differential Geometry of Three Dimensions, Cambridge University Press 2003.
- D. J. Struik, Lectures on Classical Differential Geometry, Dover Publications, 1988.

### **Mapping of Course Outcomes with the Program Outcomes:**

CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	2	2	2	2	2	2	2	2
CO2	2	4	2	2	2	2	2	2	2	2
CO3	2	4	2	2	2	2	2	2	2	2
CO4	2	4	2	2	2	2	2	2	2	2
CO5	2	4	2	2	2	2	2	2	2	2

### **Discipline Specific Elective: Probability and Statistics (DSE-IV)**

#### **Course Outcomes:**

On completion of the course, a student will be able to 38

- identify distributions in the study of the joint behaviour of two random variables;
- establish a formulation helping to predict one variable in terms of the other, i.e., correlation and linear regression;

- c) prove and apply central limit theorem.
- d) have critical thinking.
- e) gain proficiency in using statistical software for data analysis.

### **UNIT-I**

Probability: Introduction, sample spaces, Events, Probability of events, Examples of probability, Deductions from the axioms, independent events, Arithmetical density, Conditional probability, Basic formulae, Bayes's theorem.

Probability distributions and probability densities: Random variables, Probability distributions, Continuous random variables, Probability density functions, Multivariate distribution and Expectation, Integer valued random variables, Random variables with densities.

### **UNIT-II**

Mathematical Expectation: Introduction, Basic properties of expectation, The density case, Multiplication theorem: Variance and co-variance

Special Probability distribution: Discrete uniform distribution, Binomial distribution, Negative binomial, Models for Poisson distribution, Normal distribution, Law of large numbers.

### **UNIT-III**

Measures of Central value: Arithmetic mean, Geometric mean, Harmonic mean, Median & Mode  
Measures of dispersion: Mean deviation, Standard deviation.

### **UNIT-IV**

Correlation: Introduction, Types of correlation, Scatter Diagram method, Coefficient of correlation, Properties

Regression: Introduction, Uses of regression analysis, Difference between correlation and regression analysis, Regression lines, Regression equations.

### **BOOKS RECOMMENDED:**

1. Elementary Probability theory with stochastic process by Kai Lai Chung, Springer, 3rd edition Ch-2, Ch-4, Ch-5(5.1, 5.2.), Ch-6 (6.1, 6.2.6.3), Ch-7(7.1, 7.4, 7.6)
2. Statistical Methods by S.P Gupta, 5. Chand & Co. 30<sup>th</sup> Edition Ch-7, 8, 10, 11

### **BOOKS FOR REFERENCE:**

1. Robert V. Hogg, Joseph W. McKean and Allen T. Craig, Introduction to Mathematical Statistics, Pearson education. Asia 2007
2. Irwin Miller and Marlyees Miller, John E-Freund's Mathematical Statistics with Application (8<sup>th</sup> Edition). Pearson Asia, 2014
3. Sheldon Ross, Introduction to Probability models (9<sup>th</sup> Edition) academic press, Indian Reprint, 2007
4. Alexandra M. Mood, Franklin, A.Graybill and Duane C. Boes, Introduction to the theory of statistics (3<sup>rd</sup> Edition), Tata Mc Graw Hill, Reprint 2007.

### **Mapping of Course Outcomes with the Program Outcomes:**



CO/PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	4	4	2	2	4	2	2	2	2
CO2	2	4	4	2	2	4	2	2	2	2
CO3	2	4	4	2	2	4	2	2	2	2
CO4	2	4	4	2	2	4	2	2	2	2
CO5	2	4	4	2	2	4	2	2	2	2