

**B. Sc. (Honours) Mathematics**

**Under the Framework of Honours School System**

**PANJAB UNIVERSITY, CHANDIGARH**  
**OUTLINES OF TESTS, SYLLABI AND COURSES OF READING FOR**  
**CHOICE BASED CREDIT SYSTEM B.Sc. (HONOURS) MATHEMATICS UNDER**  
**THE FRAMEWORK OF HONOURS SCHOOL SYSTEM**  
**(SEMESTER SYSTEM) EXAMINATION, 2017-2018**

**OUTLINES OF TESTS**

**OBJECTIVE OF THE COURSE**

To teach the fundamental concepts of Mathematics and their applications. The syllabus pertaining to B.Sc. (Honours) Mathematics (3 Year course & 6 Semesters) in the subject of Mathematics under Honours School Framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. Honours (Mathematics).

**Semester I**

**CORE COURSE (MATHEMATICS)**

**Theory Papers:**

Core Course-1 (MAT -C1):	Calculus	100 Marks (4 credits)
Core Course-2 (MAT-C2):	Algebra	150 Marks (6 credits)

**Practical:**

Core Course-1 Practical (MAT-C1):	Calculus	50 Marks (2 credits)
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**GENERIC ELECTIVE (MATHEMATICS)**

Each student from other disciplines may opt any two of the generic electives offered by the Science Departments of Panjab University out of following:

**GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of Bio-Medical Sciences***

**Semester-I**

1. MAT-GE1-BM: Algebra and Geometry	150 Marks (6 Credits)
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**GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of Physical Sciences***

**Semester-I**

1. MAT-GE1-PS: Advanced Calculus and Geometry 150 Marks (6 Credits)

**EVALUATION**

1. There shall be one Mid Term Examination of 20% Marks in each semester.
2. End-semester examination will be of 80% of total marks.
3. Each practical examination shall be of 3 hours duration.
4. There shall be continuous internal assessment for practicals of 20% marks.
5. The final examination will be of 80% marks

**Pattern of end-semester question paper**

- (i) Nine questions in all with equal weightage. The candidate will be asked to attempt five questions
- (ii) One Compulsory question (consisting of short answer type questions) covering whole syllabus. There will be no choice in this question.
- (iii) The remaining eight questions will have **Four Units** comprising two questions from each Unit.
- (iv) Students will attempt one question from each unit and the compulsory question.

**ABILITY ENHANCEMENT COMPULSORY COURSE FOR MATHEMATICS STUDENTS**

Each student of Mathematics Department has to opt one Ability Enhancement Compulsory Course of the following:

1. English Communication (2 credits)
2. Environmental Science (2 credits)

## **PREAMBLE**

To teach the fundamental concepts of Mathematics and their applications. The syllabus pertaining to B.Sc. (Honours) Mathematics (3 Year course & 6 Semesters) in the subject of Mathematics under Honours School framework has been upgraded as per provision of the UGC module for CHOICE BASED CREDIT SYSTEM and demand of the academic environment. The syllabus contents are duly arranged unit wise and contents are included in such a manner so that due importance is given to requisite intellectual skills according to UGC module for CHOICE BASED CREDIT SYSTEM pertaining to B.Sc. (Honours School) Mathematics.

## COURSE STRUCTURE

SEMESTER I		SEMESTER II	
<b>C1</b>	<b>MAT-C1: Calculus</b>	<b>C3</b>	<b>MAT-C3: Real Analysis</b>
<b>C2</b>	<b>MAT-C2: Algebra</b>	<b>C4</b>	<b>MAT-C4: Differential Equations</b>
<b>AECC1</b>	<b>MAT-AECC1: English/ MIL Communications/ Environment Science</b>	<b>AECC2</b>	<b>MAT-AECC2: English/ MIL Communications/ Environment Science</b>
<b>GE1*</b>	<b>MAT-GE1 MAT-GE2</b>	<b>GE2*</b>	<b>MAT-GE3 MAT-GE 4</b>

SEMESTER III		SEMESTER IV	
<b>C5</b>	<b>MAT-C5: Theory of Real Functions</b>	<b>C8</b>	<b>MAT-C8: Numerical Methods</b>
<b>C6</b>	<b>MAT-C6: Group Theory I</b>	<b>C9</b>	<b>MAT-C9: Riemann Integration and series of Functions</b>
<b>C7</b>	<b>MAT-C7: PDE and system of ODE</b>	<b>C10</b>	<b>MAT-C10: Ring Theory and Linear Algebra I</b>
<b>SEC1</b>		<b>SEC2</b>	
<b>GE3*</b>	<b>MAT-GE5</b>	<b>GE4*</b>	<b>MAT-GE6</b>

SEMESTER V		SEMESTER VI	
<b>C11</b>	<b>MAT-C11: Multivariate Calculus</b>	<b>C13</b>	<b>MAT-C13: Metric Spaces and complex Analysis</b>
<b>C12</b>	<b>MAT-C12: Group Theory II</b>	<b>C14</b>	<b>MAT-C14: Ring Theory and Linear Algebra II</b>
<b>DSE1</b>		<b>DSE3</b>	
<b>DSE2</b>		<b>DSE4</b>	

**C: Core Courses; GE: General Elective; AECC: Ability Enhancement Compulsory Courses; SEC: Skill Enhancement Courses; DSE: Discipline Specific Elective**

**\*: GE subjects are to be selected by the students from the pool of GE Subjects offered by various Departments of the University.**

**\*\*SKILL ENHANCEMENT COURSES (any one per semester in semesters 3-4)**

1. MAT-SEC1: Logic and Sets
2. MAT-SEC2: LaTeX and HTML
3. MAT-SEC3: Graph Theory
4. MAT-SEC4: Computer Algebra systems and Related Software

**\*\*DISCIPLINE SPECIFIC ELECTIVE COURSES (any two per semester in semesters 5-6)**

1. MAT-DSE1: Number Theory
2. MAT-DSE2: Probability and Statistics
3. MAT-DSE3: Discrete Mathematics
4. MAT-DSE4: Statics
5. MAT-DSE5: Linear Programming
6. MAT-DSE6: Dynamics
7. MAT-DSE7: Differential Geometry
8. MAT-DSE8 : Mathematical Modeling

**\*\*Courses under these will be offered only if a minimum of 10 students opt for the same**

**\*GENERIC ELECTIVE SUBJECTS (any two per semester in semesters I-II and one per semester in Semester III-IV )**

**The Core courses MAT- C1, MAT- C2, MAT-C-3 and MAT-C4 of semester I-II may be the generic elective subjects of other departments.**

**GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) for students of departments of Bio-Medical Sciences**

**Semester-I**

1. MAT-GE1-BM: Algebra and Geometry
2. MAT-GE2-BM: Algebra and Geometry

**Semester-II**

1. MAT-GE3-BM: Calculus
2. MAT-GE4-BM: Calculus

**Semester-III**

1. MAT-GE5-BM: Matrices

### **Semester-IV**

1. MAT-GE6-BM: Vector Analysis, Differential Equations and Transform

### **GENERIC ELECTIVE SUBJECTS (Offered by Mathematics Department) *for students of departments of Physical Sciences***

#### **Semester-I**

1. MAT-GE1-PS: Advanced Calculus and Geometry
2. MAT-GE2-PS: Advanced Calculus and Geometry

#### **Semester-II**

1. MAT-GE3-PS: Linear Algebra
2. MAT-GE4-PS: Linear Algebra

#### **Semester-III**

1. MAT-GE5-PS: Differential Equations and Fourier Series

#### **Semester-IV**

1. MAT-GE6-PS: Integral Transforms and complex Analysis

# **B. Sc. (Honours) in Mathematics**

**Under the Framework of Honours School System**

**Semester I - IV**



## Semester I

### MAT-C1: Calculus

#### THEORY

4 hrs.per week  
[Max. Marks: 100]  
(Final-80+Internal Assessment-20)  
Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 40**

**Credits: 4**

**Objective:** Calculus is one of the major branches of mathematics that finds application in almost all the fields of science. This course is an introduction to calculus. Students will be introduced to the hyperbolic functions, curve tracing, applications of integration and vector functions.

#### Unit I

Higher order derivatives, Leibniz rule and its applications, L'Hospital's rule, Derivations and Applications of Reduction Formulae for the Integrals of Trigonometric Functions.

Scope as in [1] Chapter 2, Section 6.6 and [2] Chapter 4.

#### Unit II

Concavity and inflection points, asymptotes, curve tracing in Cartesian coordinates, tracing in polar coordinates of standard curves, 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. Hyperbolic functions and their properties.

Scope as in [1] Sections 3.4, 3.5, 6.10, 9.1, 9.2, 9.3.

#### Unit III

Volumes by slicing, disks and washers methods, volumes by cylindrical shells, parametric equations, parameterizing a curve, arc length, arc length of parametric curves, area of surface of revolution.

Scope as in [1] Sections 5.2 to 5.6

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

Scope as in [1] Sections 10.1 to 10.5, 11.1, 11.3, 11.4, 11.5.

#### **Books Recommended**

1. G.B. Thomas and R.L. Finney, *Calculus*, 9th Ed., Pearson Education, Delhi, 2005.
2. Shanti Narayan, *Integral Calculus*, S. Chand and Company Ltd, 2001.
3. M.J. Strauss, G.L. Bradley and K. J. Smith, *Calculus*, 3rd Ed., Dorling Kindersley (India) P. Ltd. (Pearson Education), Delhi, 2007.
4. H. Anton, I. Bivens and S. Davis, *Calculus*, 7th Ed., John Wiley and Sons (Asia) P. Ltd., Singapore, 2002.
5. R. Courant and F. John, *Introduction to Calculus and Analysis* (Volumes I & II), Springer-Verlag, New York, Inc., 1989

## **MAT-C1: Calculus**

### **PRACTICAL**

**(Using any software)**

**(3 practicals per week )**

**In groups of 15 students**

**[Max. Marks: 50](Final-40+Internal Assessment-10)**

**Time : 3hrs.**

**Total Lectures : 20**

**Credits: 2**

#### **List of Practicals (using any software)**

- (i) Plotting of graphs of function  $eax + b$ ,  $\log(ax + b)$ ,  $1/(ax + b)$ ,  $\sin(ax + b)$ ,  $\cos(ax + b)$ ,  $|ax + b|$  and to illustrate the effect of  $a$  and  $b$  on the graph.
- (ii) Plotting the graphs of polynomial of degree 4 and 5, the derivative graph, the second derivative graph and comparing them.
- (iii) Sketching parametric curves (Eg. Trochoid, cycloid, epicycloids, hypocycloid).
- (iv) Obtaining surface of revolution of curves.
- (v) Tracing of conics in Cartesian coordinates/ polar coordinates.
- (vi) Sketching ellipsoid, hyperboloid of one and two sheets, elliptic cone, elliptic, paraboloid, hyperbolic paraboloid using cartesian coordinates.
- (vii) Matrix operation (addition, multiplication, inverse, transpose).

#### **Books Recommended**

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.

## **MAT-C2: Algebra**

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

### *Note :*

- 1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
- 2. There will be two questions from each unit and the students will be required to answer one question from each unit.**
- 3. All questions carry equal marks.**

**Total Lectures : 60**

**Credits: 6**

**Objective :** The concepts and techniques from linear algebra are of fundamental importance in many scientific disciplines. The main objective is to introduce basic notions in linear algebra that are often used in mathematics and other sciences. The emphasis will be to combine the abstract concepts with examples in order to intensify the understanding of the subject.

### **UNIT I (15 hrs)**

Polar representation of complex numbers,  $n^{\text{th}}$  roots of unity, De Moivre's theorem for rational indices and its applications. Equivalence relations, Functions, Composition of functions, Invertible functions, One to one correspondence and cardinality of a set, Well-ordering property of positive integers.

### **UNIT II (15 hrs)**

General properties of polynomials, Descartes's rule of signs, positive and negative rule, Relation between the roots and the coefficients of equations, Algebraic solutions of the cubic and biquadratic, Division algorithm, Divisibility and Euclidean algorithm, Congruence relation between integers, Principles of Mathematical Induction, statement of Fundamental Theorem of Arithmetic.

### **UNIT III (15 hrs)**

Systems of linear equations, matrices, rank, Gaussian elimination, Determinants and their properties, Cramer's Rule, Vector spaces, subspaces, bases and dimension, the null space and the column space of a matrix and their dimension.

### **UNIT IV (15 hrs)**

Linear transformations, representation of linear transformations by matrices, change of basis, rank-nullity theorem, Applications to difference equations and Markov

chains, Eigenvalues and eigenvectors, characteristic polynomials, minimal polynomials, Cayley-Hamilton Theorem, triangulation

**References:**

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*, 3<sup>rd</sup> 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.
4. S.H. Friedberg, A.J. Insel and L.E. Spence: *Linear Algebra*, Prentice Hall, 2003.
5. K. Hoffman and R. Kunze: *Linear Algebra*, 2<sup>nd</sup> Edition, Prentice-Hall of India, 1989.
6. S. Lang: *Linear Algebra*, Undergraduate Texts in Mathematics, Springer-Verlag, New York, 1989.
7. P. Lax, *Linear Algebra*, John Wiley & Sons, New York. Indian Ed. 1997

## Semester II

### MAT-C3: Real Analysis

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** The aim of this course is to make the students learn about the completeness property of  $\mathbb{R}$ , sequences and series of real terms and various tests of convergence along with the cardinality of sets.

#### Unit I

Reals and Extended Real Numbers Systems, The Completeness Property of Reals, The Archimedean Property, Density of Rational Numbers in  $\mathbb{R}$ , Decimal and General Expansions of Reals, Definition of Real Powers of positive real numbers.

Scope as in [1] Sections 2.3, 2.4. and [2] 1.21, 1.22, 1.23

Sequences, Subsequences, Bounded sequence, Convergence of a sequence, Divergence of a sequence, Limit Theorems.

Scope as in [1] Sections 3.1, 3.2

#### Unit II

Monotone Sequences, Monotone Subsequence Theorem, Cauchy sequence, Cauchy Criterion for Convergence, Limit Superior and limit inferior of a sequence, Limit points of a Set, Bolzano-Weierstrass Theorem for Sequences and for Sets, Nested Interval Theorem.

Scope as in [1] Sections 3.3, 3.4, 3.5.

#### Unit III

Equivalent Sets, Finite Sets. Countable Sets, Uncountable Sets, Cardinality of a Set, Schroder-Bernstein Theorem, Cardinality of Reals and Rationals, The Cantor Set and its Uncountability, Limit Points of the Cantor set.

Scope as in [3] 2.1 to 2.16

#### Unit IV

Convergence and Divergence of Infinite Series, Cauchy Criterion, Comparison Test, Limit Comparison Test, Ratio Test, Root Test, Generalized Root Test, Integral Test, Alternating series, Leibniz Test, Absolute and Conditional convergence, Addition and Multiplication of Series, Rearrangement of a Series.

Scope as in [2] 3.21 to 3.26, 3.38, 3.33 to 3.35, 3.42, 3.43, 3.45 to 3.55

#### Books Recommended

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. W. Rudin. Principles of Mathematical Analysis, 3rd edition. McGraw Hill, 1976.
3. N. L. Carothers, *Real Analysis*, Cambridge University Press 2000.
4. Brian S. Thomson, Andrew. M. Bruckner and Judith B. Bruckner, *Elementary Real Analysis*, Prentice Hall, 2001.
5. Gerald G. Bilodeau , Paul R. Thie, G.E. Keough, *An Introduction to Analysis*, 2nd Ed., Jones & Bartlett, 2010.
6. S. C. Malik and Savita Arora, *Mathematical Analysis*, 3<sup>rd</sup> Edition, New Age International Publishers, 2008.
7. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
8. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis*, 2<sup>nd</sup> Edition, Springer Verlag, Indian Reprint, 2004.
9. C. C. Pugh, *Real Mathematical Analysis*, Springer Verlag, New York, 2001.
10. S. Abbott, *Understanding Analysis*, Springer Verlag, New York, 2008.
11. T. M. Apostol, *Mathematical Analysis*, 2<sup>nd</sup> Edition, Narosa Publishing House, Reprint 2002.

# MAT-C4: Differential Equations

## THEORY

[4 hrs/per week]  
[Max. Marks: 100]  
(Final-80+Internal Assessment-20)  
Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 40**

**Credits: 4**

**Objective:** *To exhibit the techniques for obtaining solutions to ordinary differential equations and the basic ideas and theory behind those techniques.*

### UNIT I (10 hrs)

Differential equations and mathematical models. General, particular, explicit, implicit and singular solutions of a differential equation. Introduction to compartmental model, exponential decay model, lake pollution model (case study of Lake Burley Griffin), drug assimilation into the blood (case of a single cold pill, case of a course of cold pills), exponential growth of population, limited growth of population, limited growth with harvesting. (Scope as in Chapters 1, 3.3 of S.L.Ross)

### UNIT II (10 hrs)

Exact differential equations and integrating factors, separable equations and equations reducible to this form, linear equation and Bernoulli equations, special integrating factors and transformations. (Scope as in Chapter 2 of S.L. Ross)

### UNIT III (10 hrs)

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. (Scope as in Chapter 4.1, 4.2 of S.L. Ross)

### UNIT IV (10 hrs)

Power Series solution about an ordinary point, solutions about singular points, The method of Frobenius, Bessel's equation and Bessel function. (Scope as in Chapter 6 of S.L. Ross)

### **References:**

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



4. Martha L. Abell, James P. Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.
5. E. A. Coddington, *An introduction to ordinary differential equation*, Prentice-Hall of India.
6. W. E. Boyce and R. C. DiPrima, *Elementary differential equations and boundary value problems*.
7. Earl D. Rainville and P. E. Benedict, *Elementary differential equations*, Seventh edition, Macmillan, Publishing Company, 1989.

# MAT-C4: Differential Equations

## PRACTICAL

(3 practicals per week )

In groups of 15 students

[Max. Marks: 50](Final-40+Internal Assessment-10)

Time : 3hrs.

**Total Lectures: 20**

**Credits: 2**

### List of Practicals (using any software)

1. Plotting of second order solution family of differential equation.
2. Plotting of third order solution family of differential equation.
3. Growth model (exponential case only).
4. Decay model (exponential case only).
5. Lake pollution model (with constant/seasonal flow and pollution concentration).
6. Case of single cold pill and a course of cold pills.
7. Limited growth of population (with and without harvesting).
8. Some other applications of the topics in the course.

### References:

1. Belinda Barnes and Glenn R. Fulford, *Mathematical Modeling with Case Studies, A Differential Equation Approach using Maple and Matlab*, 2nd Ed., Taylor and Francis group, London and New York, 2009.
2. C.H. Edwards and D.E. Penny, *Differential Equations and Boundary Value problems Computing and Modeling*, Pearson Education India, 2005.
3. S.L. Ross, *Differential Equations*, 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential Equations with MATHEMATICA*, 3rd Ed., Elsevier Academic Press, 2004.
5. E. A. Coddington, *An introduction to ordinary differential equation*, Prentice-Hall of India.
6. W. E. Boyce and R. C. Diprima, *Elementary differential equations and boundary value problems*.
7. Earl D. Rainville and P. E. Benediet, *Elementary differential equations*, Seventh edition, Macmillan, Publishing Company, 1989.

# GENERIC ELECTIVE SUBJECTS

## GE1 COURSES

### MAT-GE1-BM: Algebra and Geometry

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150](Final-120+Internal Assessment-30)

Time : 3hrs.

- Note :**
1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
  2. There will be two questions from each unit and the students will be required to answer one question from each unit.
  3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** The objective of this course is to study the basics of various topics of Mathematics which is a foundation for further learning in Mathematics, Physics, Statistics etc.

#### UNIT I (15 hrs )

Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations. [Scope as in Chapters 3 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

Complex Numbers and Quadratic Equations, Permutations and combinations, Binomial Theorem, sequences and series. Exponential and Logarithmic series.

[Scope as in Chapters 5,7,8, 9, Appendix 1 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

#### UNIT II (15 hrs )

Matrices, Operations on Matrices, Determinants, singular and non-singular matrices, Adjoint and inverse of a matrix [Scope as in Chapters 3 , 4 of a Text book- ‘Mathematics’ for Class XII, NCERT.Part I]

#### UNIT III (15 hrs )

Co-ordinate Geometry: Rectangular Coordinate system. Straight lines. Circles and family of circles. Parabola, Ellipse and Hyperbola-their equations in standard form. [Scope as in Chapters 10, 11 of a Textbook- ‘Mathematics’ for Class XI, NCERT.]

#### **UNIT IV (15 hrs )**

Three dimensional space, Coordinates of a point in three dimensional space. Distance between two points. Section Formula [Scope as in Chapter 12 of a Text book – ‘Mathematics’ for Class XI, NCERT.]

#### **Suggested Readings**

1. Mathematics, A Text book for Class XI and XII, NCERT, 2003 New Delhi.
2. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.

## MAT-GE1-PS: Advanced Calculus and Geometry

[6 hrs/per week (including Tutorials)]  
[Max. Marks: 150](Final-120+Internal Assessment-30)  
Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

### UNIT I (15 hrs )

Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradient vectors and tangent planes, Double integrals. Fubini's Theorem without proof, Change of order of integration in double integrals, double integrals in polar form (Chapters 11 Secs. 11.1, 11.3, Chapter 12.1-12.3, 12.7 and 13.1-13.3 of 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.

### UNIT II (15 hrs )

Triple integrals in rectangular, spherical and cylindrical coordinates, substitution in multiple integrals. [Scope as in Sections 13.4, 13.6, 13.7 of Chapter 13 in the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.]

Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only). [Scope as in Sections 14.1, 14.3, 14.4, 14.5, 14.7 of Chapter 14 of the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.]

### UNIT III (15 hrs )

Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation  $S = Ax^2 + Bxy + Cy^2 + Dx + Ey + f = 0$  into simpler forms by transformation of coordinate axes (without proof). Identification of curves represented by  $S = 0$ . Invariance

of discriminant and trace  $t$ . Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

[Scope as in Chapters 1, 6(Sections 6.1-6.4), 7(Sections 7.1-7.8, 7.11-7.15) from Plane Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

#### **UNIT IV (15 hrs )**

Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

[Scope as in Chapters 1(Sections 1.1-1.6, 1.11-1.14), 2(Sections 2.1-2.5, 2.12, 2.13), 3(Sections 3.1-3.3), 4(Sections 4.6, 4.7, 4.10, 4.11) from Solid Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

#### **Suggested Readings**

1. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.
2. Shanti Narayan: Analytic Geometry.
3. J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra : New Pattern Vector Algebra and Geometry, International Publishers, New Edition(2004).
4. Schaum’s Outlines, Vector Analysis, Tata McGraw-Hill Publishers, 2<sup>nd</sup> Edition.
5. Calculus and Analytical Geometry by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.

## SEMESTER-II

### MAT-GE3-BM: Calculus

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150](Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

#### UNIT I (15 hrs )

**Continuity and Differentiability :** Introduction. Limits. Continuity. Differentiability. Exponential and Logarithmic Differentiation. Derivative of a function in parameter Second order derivative . Mean Value Theorem [Scope as in Chapter 13 of a text book of Mathematics of XI & Chapter 5 of a text book- Mathematics for class XII Part- I NCERT].

#### UNIT II (15 hrs )

**Application of derivative :** increasing and decreasing functions. Maxima and Minima. Rolle's Theorem (without proof). Mean Value Theorem. Tangents and Normals. [Scope as in Chapters 6 of a Text book –'Mathematics' for Class XII, NCERT.] Indeterminate forms, L'Hopital's Rule. Taylor and Maclaurin series(without proofs). [Scope as in Section 6.6 of Chapter 6 and Section 8.9 & 8.10 of Chapter 8 of a book 'Calculus' by Thomas & Finney, 9<sup>th</sup> Edition.]

#### UNIT III (15 hrs )

**Integral Calculus:** Integral as antiderivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions. The definition of integral of a real valued function of real variable as limit of sum motivated by the determination of area. Fundamental theorem of integral calculus.[Scope as in Chapters 7 &8 of a Text book- 'Mathematics' for Class XII, NCERT.Part II]

#### **UNIT IV (15 hrs )**

**Differential Equations :** Introduction & basic concepts. General and particular solutions of a differential Equation. Formation of differential equation.Methods of solving First order, First degree Differential equations [Scope as in Ch 9 of a text book- Mathematics for class XII Part II ]

#### **Suggested Readings**

1. Mathematics, A Text book for Class XI and XII (Parts I & II), NCERT 2003, New Delhi.
2. 'Calculus' by Thomas & Finney, 9<sup>th</sup> Edition, Pearson Education, 2004.
3. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.



## MAT –GE3-PS: Linear Algebra

[6 hrs/per week (including Tutorials)]  
[Max. Marks: 150](Final-120+Internal Assessment-30)  
Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

### UNIT I (15 hrs )

Vector spaces over  $\mathbb{R}$  and  $\mathbb{C}$ , subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and determinantal rank of a matrix. Elementary row and column operations. Elementary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only).

### UNIT II (15 hrs )

Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.

[Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7-5.9) of the book 'Introduction to Linear Algebra' by V. Krishnamurthy, V.P.Mainra and J. L. Arora, East-West Press Pvt. Ltd.]

### UNIT III (15 hrs )

Cayley-Hamilton Theorem. Characteristic roots and characteristic vectors of a square matrix. Nature of roots of different types of matrices, Minimal polynomial of a matrix.

### UNIT IV (15 hrs )

Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian

matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

[Scope as in 11(Sections 11.1-11.5, 11.11-11.13), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of the book 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, 10<sup>th</sup> edition, S. Chand & Co.]

### **References**

1. V. Krishnamurty, V.P. Mainra and J. L. Arora, Introduction to Linear Algebra, East-West Press Pvt. Ltd. 1976.
2. Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2010.
3. Schaum's Outlines, Linear Algebra, Tata McGraw-Hill Publishers, 3<sup>rd</sup> edition.

## GE2 COURSES

### SEMESTER-I

#### MAT-GE2-BM: Algebra and Geometry

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** The objective of this course is to study the basics of various topics of Mathematics which is a foundation for further learning in Mathematics, Physics, Statistics etc.

#### UNIT I (15 hrs )

Review of trigonometric functions, sum and product formulae for trigonometric functions, Trigonometric Equations. [Scope as in Chapters 3 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

Complex Numbers and Quadratic Equations, Permutations and combinations, Binomial Theorem, sequences and series. Exponential and Logarithmic series.

[Scope as in Chapters 5,7,8, 9, Appendix 1 of a Textbook – ‘Mathematics’ for Class XI, NCERT.]

#### UNIT II (15 hrs )

Matrices, Operations on Matrices, Determinants, singular and non-singular matrices, Adjoint and inverse of a matrix [Scope as in Chapters 3 , 4 of a Text book- ‘Mathematics’ for Class XII, NCERT.Part I]

#### UNIT III (15 hrs )

Co-ordinate Geometry: Rectangular Coordinate system. Straight lines. Circles and family of circles. Parabola, Ellipse and Hyperbola-their equations in standard form. [Scope as in Chapters 10, 11 of a Textbook- ‘Mathematics’ for Class XI, NCERT.]

#### **UNIT IV (15 hrs )**

Three dimensional space, Coordinates of a point in three dimensional space. Distance between two points. Section Formula [Scope as in Chapter 12 of a Text book – ‘Mathematics’ for Class XI, NCERT.]

#### **Suggested Readings**

3. Mathematics, A Text book for Class XI and XII, NCERT, 2003 New Delhi.
4. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.

## MAT-GE2-PS: Advanced Calculus and Geometry

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

**Note :**

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** The objective of the course is to equip the students with the knowledge of basic concepts and their applications in geometry.

### UNIT I (15 hrs )

Vector-valued function and space curves. Arc length and unit tangent vector. Limit and continuity of multivariable function. Partial derivatives. Directional derivatives, gradient vectors and tangent planes, Double integrals. Fubini's Theorem without proof, Change of order of integration in double integrals, double integrals in polar form (Chapters 11 Secs. 11.1, 11.3, Chapter 12.1-12.3, 12.7 and 13.1-13.3 of 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.

### UNIT II (15 hrs )

Triple integrals in rectangular, spherical and cylindrical coordinates, substitution in multiple integrals. [Scope as in Sections 13.4, 13.6, 13.7 of Chapter 13 in the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.]

Line integrals vector fields. Path independence and surface integrals. Divergence and Stoke's theorem (Applications only). [Scope as in Sections 14.1, 14.3, 14.4, 14.5, 14.7 of Chapter 14 of the book 'Calculus and Analytical Geometry' by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.]

### UNIT III (15 hrs )

Transformation of axes, shifting of origin, reflection and rotation of axes, reduction of the equation  $S = Ax^2 + Bxy + Cy^2 + Dx + Ey + f = 0$  into simpler forms by transformation of coordinate axes (without proof). Identification of curves represented by  $S = 0$ . Invariance of discriminant and trace  $t$ . Condition that a second degree equation should represent a pair of straight lines. Polar coordinates, polar equation of a conic.

[Scope as in Chapters 1, 6(Sections 6.1-6.4), 7(Sections 7.1-7.8, 7.11-7.15) from Plane Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

#### **UNIT IV (15 hrs )**

Sphere, Cone, Cylinder, Equation of paraboloid, ellipsoid and hyperboloid in standard forms. Simple properties of these surfaces. Equation of tangent planes to the above surfaces.

[Scope as in Chapters 1(Sections 1.1-1.6, 1.11-1.14), 2(Sections 2.1-2.5, 2.12, 2.13), 3(Sections 3.1-3.3), 4(Sections 4.6, 4.7, 4.10, 4.11) from Solid Geometry of “New Pattern Vector Algebra and Geometry” by J. P. Mohindru, Mrs. Usha Gupta and A. S. Dogra, International Publishers, Edition 2004.]

#### **Suggested Readings**

3. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.
4. Shanti Narayan: Analytic Geometry.
3. J. P. Mohindru, Mrs. Usha Gupta & A. S. Dogra : New Pattern Vector Algebra and Geometry, International Publishers, New Edition(2004).
6. Schaum’s Outlines, Vector Analysis, Tata McGraw-Hill Publishers, 2<sup>nd</sup> Edition.
7. Calculus and Analytical Geometry by G. B. Thomas and R. L. Finney, 9<sup>th</sup> Edition.

## SEMESTER-II

### MAT-GE4-BM: Calculus

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits:**

6

**Objective:** This course is designed to introduce the fundamental concepts of continuity, differentiation and integration of functions of one variable. Its objective is to acquaint students with various applications of these topics relating to extreme value problems, problems of finding areas and distance travelled, moreover to describe connection between integral and differential calculus through Fundamental Theorem of Calculus.

#### UNIT I (15 hrs )

**Continuity and Differentiability :** Introduction. Limits. Continuity. Differentiability. Exponential and Logarithmic Differentiation. Derivative of a function in parameter Second order derivative . Mean Value Theorem [Scope as in Chapter 13 of a text book of Mathematics of XI & Chapter 5 of a text book- Mathematics for class XII Part- I NCERT].

#### UNIT II (15 hrs )

**Application of derivative :** increasing and decreasing functions. Maxima and Minima. Rolle's Theorem (without proof). Mean Value Theorem. Tangents and Normals. [Scope as in Chapters 6 of a Text book –'Mathematics' for Class XII, NCERT.] Indeterminate forms, L'Hopital's Rule. Taylor and Maclaurin series(without proofs). [Scope as in Section 6.6 of Chapter 6 and Section 8.9 & 8.10 of Chapter 8 of a book 'Calculus' by Thomas & Finney, 9<sup>th</sup> Edition.]

#### UNIT III (15 hrs )

**Integral Calculus:** Integral as antiderivative. Integration by substitution, by partial fractions and by parts. Definite integral and its properties. Areas of bounded regions. The definition of integral of a real valued function of real variable as limit of sum

motivated by the determination of area. Fundamental theorem of integral calculus.[Scope as in Chapters 7 &8 of a Text book- 'Mathematics' for Class XII, NCERT.Part II]

#### **UNIT IV (15 hrs )**

**Differential Equations** : Introduction & basic concepts. General and particular solutions of a differential Equation. Formation of differential equation.Methods of solving First order, First degree Differential equations [Scope as in Ch 9 of a text book- Mathematics for class XII Part II ]

#### **Suggested Readings**

4. Mathematics, A Text book for Class XI and XII (Parts I & II), NCERT 2003, New Delhi.
5. 'Calculus' by Thomas & Finney, 9<sup>th</sup> Edition, Pearson Education, 2004.
6. Thomas Calculus, 12<sup>th</sup> Edition, Pearson, 2014.



## MAT –GE4-PS: Linear Algebra

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

### *Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures: 60**

**Credits: 6**

**Objective:** This Course is a requirement for majors in other sciences because Linear Algebra provides a basis for advanced studies not only in Mathematics but also in other branches like engineering, physics and computers etc.

### **UNIT I (15 hrs )**

Vector spaces over  $\mathbb{R}$  and  $\mathbb{C}$ , subspaces, linear span of vectors, linear independence and dependence, basis and dimension. Row rank, Column rank and determinantal rank of a matrix. Elementary row and column operations. Elementary matrices. Row echelon form of a matrix. Equivalence of matrices. Reduction to normal form under equivalence(method only). The equality of three ranks(statement only).

### **UNIT II (15 hrs )**

Methods of solving a system of equations with special reference to Gauss method, Matrix Inversion. Linear transformations. Rank and Nullity of a linear transformation, Inverse of a Linear Transformation. Rank and Nullity Theorem and its consequences. Matrix of a linear transformation with respect to a given basis.

[Scope as in Chapters 3(Sections 3.1-3.6), 4(Sections 4.1-4.5), 5(Sections 5.1, 5.2, 5.7-5.9) of the book 'Introduction to Linear Algebra' by V. Krishnamurthy, V.P.Mainra and J. L. Arora, East-West Press Pvt. Ltd.]

### **UNIT III (15 hrs )**

Cayley-Hamilton Theorem. Characteristic roots and characteristic vectors of a square matrix. Nature of roots of different types of matrices, Minimal polynomial of a matrix.

### **UNIT IV (15 hrs )**

Similarity of matrices, similarity reduction to a diagonal form, diagonalizable matrix, orthogonal reduction of real symmetric matrices. Unitary reduction of a Hermitian matrix (for these three reductions only the methods are expected to be taught. No proofs are expected to be taught).

[Scope as in 11(Sections 11.1-11.5, 11.11-11.13), 12(Sections 12.1-12.3), 13(Sections 13.1-13.4) of the book 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, 10<sup>th</sup> edition, S. Chand & Co.]

### **References**

1. V. Krishnamurty, V.P. Mainra and J. L. Arora, Introduction to Linear Algebra, East-West Press Pvt. Ltd. 1976.
3. Shanti Narayan and P. K. Mittal, A textbook of Matrices, S. Chand & Co., 2010.
3. Schaum's Outlines, Linear Algebra, Tata McGraw-Hill Publishers, 3<sup>rd</sup> edition.

## SEMESTER-III

### MAT-C5: Theory of Real Functions

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

**Note :**

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures : 60**

**Credits: 6**

**Objective:** Introduction to the limit, continuity and derivatives of real functions.

#### Unit I

Limit of a function (epsilon-delta approach), limit theorems, sequential criterion for limits, One-sided limits, Infinite limits, limits at infinity, Continuous functions, sequential criterion for continuity & discontinuity, Algebra of continuous functions, Composition of continuous functions.

Scope as in [1] Sections 4.1 to 4.3, 5.1, 5.2.

#### Unit II

Intermediate Value Theorem and its Applications, Extreme Value Theorem, Uniform Continuity, Continuity and Uniform Continuity.

Differentiability, Carathéodory's theorem, Algebra of differentiable functions, Chain Rule, Lipschitz Functions and Uniform Continuity, Inverse of Strictly Monotone Functions.

Scope as in [1] Sections 5.3, 5.4.1 to 5.4.3, 6.1.

#### Unit III

Local Extrema, Interior Extremum Theorem, Rolle's theorem, Mean Value Theorem and its Applications to inequalities & approximation of polynomials, Taylor's theorem, Darboux's Theorem, L'Hospital's Rules.

Scope as in [1] Sections 6.2 and [2] 5.1 to 5.13.

#### Unit IV

Taylor's theorem with Lagrange's form of remainder, Taylor's theorem with Cauchy's form of remainder, application of Taylor's theorem to Convex functions, Taylor's series & Maclaurin's series expansions of exponential & trigonometric functions.

Continuity of a Monotone function, functions of Bounded Variation, Total Variation of a function, the Total Variation Function, Rectifiable Curves.

Scope as in [1] Sections 6.1 to 6.4.6 and [3] Chapter 6.

### **Books Recommended**

1. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
2. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
3. T. M. Apostol, *Mathematical Analysis*, 2<sup>nd</sup> Edition, Narosa Publishing House, Reprint 2002.
4. S.K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
5. S. Abbott, *Understanding Analysis*, Springer Verlag, New York, 2008.
6. S. R. Ghorpade and B.V. Limaye, *A Course in Calculus and Real Analysis*, Springer, 2006.
7. S. C. Malik and Savita Arora, *Mathematical Analysis*, 3<sup>rd</sup> Edition, New Age International Publishers, 2008.
8. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis*, 2<sup>nd</sup> Edition, Springer Verlag, Indian Reprint, 2004.
9. C. C. Pugh, *Real Mathematical Analysis*, Springer Verlag, New York, 2001.
10. A. Mattuck, *Introduction to Analysis*, Prentice Hall, 1999.

## MAT-C6: Group Theory - I

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

### Note :

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

Total Lectures : 60

Credits: 6

**Objective:** The course is an introduction to Group Theory which is one of the most important subjects of algebra.

### UNIT-I

Symmetries of a square, Dihedral groups, binary operations, semigroups, groups, groups of integers modulo  $n$ , matrix groups, groups of quaternions, symmetric groups, cycle notation for permutations, even and odd permutations, property of permutations. Elementary properties of groups.

### UNIT-II

Subgroups, examples of subgroups, order of group elements, centralizer, normalizer, center of a group, product of two subgroups, cyclic groups, classification of subgroups of cyclic groups, subgroups generated by a subset, generators and relations, generators of  $S_n$  and  $A_n$ .

### UNIT-III

Cosets, Lagrange's theorem and consequences including Fermat's Little theorem. Conjugacy, Class Equation and its applications, Normal subgroups, Quotient groups, Homomorphisms, Isomorphism Theorems, Cayley's Theorem.

### UNIT-IV

External and internal direct products and their properties, the group of units modulo  $n$  as an external direct product. Cauchy's theorem for finite abelian groups, Fundamental Theorem for finite Abelian groups and its applications. Elementary divisors and invariant factors of finite Abelian groups. Conjugacy in  $S_n$ , Simplicity of  $A_n$ .

Scope as in Chapters 1-11 and 25 of [1]

### References

1. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4th Ed., Narosa Publishing House, New Delhi, 1999.
2. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
3. M. Artin, *Abstract Algebra*, 2<sup>nd</sup> Ed., Pearson, 2011.

4. Joseph J. Rotman, *An Introduction to the Theory of Groups*, 4th Ed., Springer Verlag, 1995.
5. I. S Luthar and I.B.S. Passi : *Algebra Volume 1: Groups*, Narosa Publishing House, 1999.
6. I.N. Herstein, *Topics in Algebra*, Wiley Eastern Limited, India, 1976.
7. Surjeet Singh Qazi Zameeruddin : *Modern Algebra*, 7<sup>th</sup> Ed., Vikas Publishing House, New Delhi, 1993.

# MAT-C7: PDE and System of ODE

## THEORY

4 hrs. per week  
[Max. Marks: 100]  
(Final-80+Internal Assessment-20)  
Time : 3hrs.

### Note :

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

Total Lectures: 40

Credits: 4

### Unit I

Ordinary differential equations in more than two variables-Surfaces and curves in three dimensions, Simultaneous differential equations of first order and the first degree in three variables, Methods of solutions of  $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ , Orthogonal trajectories of a system of curves on a surface, Pfaffian differential forms and equations, Solution of Pfaffian differential equations in three variables. (I N Sneddon, Chapter 1, section 1.1-1.6)

### Unit II

Partial differential equations of the first order-Partial differential equations, Origins of first order partial differential equations, Cauchy's problem for first order equations, linear equation of first order, Integral surface passing through a given curve, Surfaces orthogonal to a given system of surfaces, Non-linear partial differential equation of the first order, Cauchy method of characteristics, Compatible system of first order equations, Charpit's method, Special types of first order equations, Solutions satisfying given conditions, Jacobi's method, Applications of first order equations. (I N Sneddon, Chapter 2)

### Unit III

PDEs of second order-The origin of second order equations, Linear pdes with constant coefficients, separation of variables. Solution of Laplace equation, Heat equation and Wave equation with separation of variables in two dimensions. (I N Sneddon, Chapter 3).

### Unit IV

Systems of linear differential equations, types of linear systems, differential operators, an operator method for linear systems with constant coefficients, Basic Theory of linear systems in normal form, homogeneous linear systems with constant coefficients: Two Equations in two unknown functions. (S L Ross, Chapter 7, Section 7.1-7.4)

### Books Recommended

1. I N Sneddon, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists and Engineers*, 4th edition, Springer, Indian reprint, 2006.

3. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3<sup>rd</sup> Ed., Elsevier Academic Press, 2004.
5. W E Boyce and R C Diprima, *Elementary Differential Equations and boundary value problems*, John Wiley and Sons Inc., New York.



# MAT-C7: PDE and System of ODE

## PRACTICAL

(Using any software)

(3 practicals per week )  
In groups of 15 students  
[Max. Marks: 50](Final  
40+Internal Assessment-10)  
Time : 3hrs.

**Total Lectures : 20**

**Credits: 2**

### List of Practicals (using any software)

- (i) Solution of Cauchy problem for first order PDE.
- (ii) Finding and plotting the characteristics for the first order PDE.
- (iii) Plot the integral surfaces of a given first order PDE with initial data.
- (iv) Solution of one dimensional heat equation.
- (v) Solution of wave equation with associated conditions.
- (vi) Solving system of ODEs.

### Books Recommended

1. I N Sneddon, Elements of Partial differential equations, Dover Publications, Inc. Newyork, 2006.
2. Tyn Myint-U and Lokenath Debnath, *Linear Partial Differential Equations for Scientists andEngineers*, 4th edition, Springer, Indian reprint, 2006.
3. S.L. Ross, *Differential equations*, 3rd Ed., John Wiley and Sons, India, 2004.
4. Martha L Abell, James P Braselton, *Differential equations with MATHEMATICA*, 3<sup>rd</sup> Ed., Elsevier Academic Press, 2004.
5. W E Boyce and R C Dprima, Elementary Differential Equations and boundary value problems, John Wiley and Sons Inc., New York.

## GENERIC ELECTIVE COURSE

(For students with background in Mathematics)

### **MAT-GE5-PS: Differential Equations and Fourier Series**

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures : 60**

**Credits: 6**

*Objective: The objective of the course is to enable the students to understand the basic concepts related to ordinary differential, partial differential equations and Fourier Series and their applications.*

#### **UNIT I**

Exact First Order Differential Equations, Linear second order equations. Homogeneous equation with constant coefficients, Characteristic equation and their roots. Non-homogeneous equations of second order, Particular integrals, method of variation of parameters.

#### **UNIT II**

Solution in series of second order linear differential equations with variable coefficients (in particular, solutions of Legendre's and Bessel's equations.)  
Bessel functions, Legendre functions, their recurrence and orthogonal relations, Gamma and Beta functions.

#### **UNIT III**

Fourier Series; Periodic functions. Fourier series and Fourier coefficients. Functions having arbitrary period. Sine and Cosine series. Half-range expansions. Exponential and complex form of Fourier series. Differentiation and integration of Fourier series. Fourier integrals.

#### **UNIT IV**

Formation of first and second order of partial differential equations and their classification, solution of first order equation, Lagrange's equation. Solution of Laplace, diffusion and wave equations by method of separation of variables. D'Alembert's solution of wave equation.  
[Scope as in Sections 1.5.4, 4.6, 5.3.1, 5.3.2, 5.3.4, 5.4.1, 5.5, 6.1-6.4, 7.2, 7.4, 7.4.1, 7.5.1, 8.1, 8.2, 8.3, 8.5.4, 8.6 of Ref.1.]

#### **Suggested Readings**

1. R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2<sup>nd</sup> edition, 2003.
2. Sokolnikoff and Redheffer : Mathematics for Physics and Engineering, McGraw-Hill, 2<sup>nd</sup> Edition, 1966..
3. Erwin Kreyszig : Advanced Engineering Mathematics (Wiley Eastern Limited), 8<sup>th</sup> edition, 2006.
4. R. V. Churchill & J. W. Brown : Complex Variables and Application, 4<sup>th</sup> Edition, McGraw Hill, NY, 1984.



**(For students without background in Mathematics)**

## **MAT-GE5-BM: Matrices**

**[6 hrs/per week (including Tutorials)]**

**[Max. Marks: 150]**

**(Final-120+Internal Assessment-30)**

**Time : 3hrs.**

*Note :*

- 1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
- 4. There will be two questions from each unit and the students will be required to answer one question from each unit.**
- 5. All questions carry equal marks.**

**Total Lectures : 60**

**Credits: 6**

**Objective :** This course familiarizes the students with the theory of matrices which are used in solving equations in mechanics and other streams used in Mathematics, Physics etc.

### **UNIT – I**

Symmetric and Skew symmetric, Hermitian and Skew Hermitian, Orthogonal and Unitary matrices (Definitions and examples only).

Rank of a matrix, elementary transformations, reduction to normal form (methods only), elementary matrices, equivalence of matrices.

[Scope as in Chapter 1, 2, 4 of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002].

### **UNIT - II**

Vector as n-tuples. Linear dependence and independence of vectors. Rank of a matrix.

Row rank, Column Rank and Determinantal Rank of a matrix.

System of linear equations, consistency and inconsistency. Homogeneous and non-homogeneous equations. Gauss method of solving a system of equations.

[Scope as in Chapter 5(Sections 5.1-5.8), Chapter 6(Sections 6.1-6.6) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

### **UNIT - III**

Characteristic equation of a square matrix. Characteristic roots and characteristic vectors. Nature of Characteristics roots of special matrices. Cayley-Hamilton Theorem (statement only). Orthogonal reduction of real symmetric matrices. (method only)

[Scope as in Chapters 11(Sections 11.1-11.4, 11.11) Chapter 12(Sections 12.1, 12.2) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

### **UNIT - IV**

Unitary reduction of Hermitian matrices(method only). Similarity of matrices. Reduction to Diagonal form, diagonalizable matrices.

[Scope as in Chapter 12(Sections 12.3-12.5), Chapter 13(Sections 13.1-13.4) of 'A Text Book of Matrices' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Reprint 2002.]

### **Suggested Readings**

1. Shanti Narayan & P. K. Mittal, A Text Book of Matrices, S. Chand & Co. Ltd., New Delhi, Reprint 2002.
2. R.K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics(Narosa Publishing House), 2nd edition, 2005.

## MAT-SEC-1 Logic and Sets

[2 hrs/per week]  
[Max. Marks: 50]  
(Final-40+Internal Assessment-10)  
Time : 3hrs.

**Total Lectures : 20**

**Credits: 2**

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.

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.

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, n- ary relations.

### Books Recommended

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

## **MAT-SEC-2 LaTeX and HTML**

**(3 practicals per week) In groups of 15 students**  
**[Max. Marks: 50] (Final 40+Internal Assessment-10)**  
**Time : 3hrs.**

**(2 hrs/week)**  
**Credits - 2**  
**Total Lectures 20**

**Objective :** The objective of this syllabus is to teach computer fundamentals and introduction to 'C' Language. This will help students to learn about functioning of computers and familiarity with computer Language 'C' and also learn about create a web pages through HTML.

LaTeX: This Will help Student to Typesetting of journal articles, technical reports, thesis, books, and slide presentations. Control over large documents containing sectioning, cross-references, tables and figures. Typesetting of complex mathematical formulae.

### **PART 1**

Introduction to 'C' language: Data types, constants and literals. Operators: arithmetic, relational and logical. Statements for: decision control, loop control and case control.

### **PART 2**

Elements of LaTeX; Hands-on-training of LaTeX; graphics in LaTeX; PSTricks; Beamer presentation;

HTML, creating simple web pages, images and links, design of web pages.

[1] Chapter 1-5,

[3] Chapter 9-11, 15

**Practical Six practical should be done by each student. The teacher can assign practical from the exercises from [1] and [3].**

#### **References:**

[1] Let Us C by Yashwant Kanetkar, BPB publications, 10th Edition, 2010.

[2] C Programming Language by Brian W. Kernighan and Dennis M. Ritchie, Prentice hall, 2nd Edition, 1988..

[3] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011. [2] L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

## SEMESTER-IV

### MAT-C8: Numerical Methods

4 hrs.per week  
[Max. Marks: 100]  
(Final-80+Internal Assessment-20)  
Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.
4. Use of Scientific Calculator is allowed.

Total Lectures : 40

Credits: 4

#### Unit-I

Algorithms, Convergence, Errors: Relative, Absolute, Round off, Truncation.

Transcendental and Polynomial equations: Bisection method, Newton's method, Secant method. Rate of convergence of these methods.

#### Unit-II

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

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

#### Unit-III

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

#### Unit-IV

Ordinary Differential Equations: Numerical differentiation, Taylor's series method, Euler's method, Modified Euler's method, Runge-Kutta methods of orders two and four.

#### **Books Recommended**

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 Engineering Computation*, 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 Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.

# MAT-C8: Numerical Methods

## PRACTICAL

(Using any software)

(3 practicals per week )  
In groups of 15 students  
[Max. Marks: 50](Final  
40+Internal Assessment-10)  
Time : 3hrs.

Total Lectures : 20

Credits: 2

### List of Practicals (using any software)

- (i) Calculate the sum  $1/1 + 1/2 + 1/3 + 1/4 + \dots + 1/N$ .
- (ii) To find the absolute value of an integer.
- (iii) Enter 100 integers into an array and sort them in an ascending order.
- (iv) Bisection Method.
- (v) Newton Raphson Method.
- (vi) Secant Method.
- (vii) Regulai Falsi Method.
- (viii) LU decomposition Method.
- (ix) Gauss-Jacobi Method.
- (x) SOR Method or Gauss-Siedel Method.
- (xi) Lagrange Interpolation or Newton Interpolation.
- (xii) Simpson's rule.

**Note:** For any of the CAS (Computer aided software) Data types-simple data types, floating data types, character data types, arithmetic operators and operator precedence, variables and constant declarations, expressions, input/output, relational operators, logical operators and logical expressions, control statements and loop statements, Arrays should be introduced to the students.

### Books Recommended

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 Engineering Computation*, 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 Learning Private Limited, 2013.
5. John H. Mathews and Kurtis D. Fink, *Numerical Methods using Matlab*, 4th Ed., PHI Learning Private Limited, 2012.



## **MAT-C9: Riemann Integration and Series of Functions**

**[6 hrs/per week (including Tutorials)]**

**[Max. Marks: 150]**

**(Final-120+Internal Assessment-30)**

**Time : 3hrs.**

*Note :*

- 1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.**
- 2. There will be two questions from each unit and the students will be required to answer one question from each unit.**
- 3. All questions carry equal marks.**

**Total Lectures : 60**

**Credits: 6**

**Objective:** Introduction to Riemann Integration, Improper Integrals, Uniform Convergence and Power Series.

### **Unit I**

Riemann Integration, Upper and Lower Darboux Sums, Riemann Sums and definition of Riemann integral through Riemann sums, Cauchy Criteria for integrability, Equivalence of two definitions. The Class of Riemann integrable functions, Properties of the Riemann integral, Fundamental theorems of Calculus.

Scope as in [1] Chapter 6 (Art. 32.1 to 32.9, 33.1, 33.2, 33.3, 33.4 to 33.8, 33.9, 34.1, 34.3)

### **Unit II**

Improper Integrals, Tests for Convergence of Improper Integrals, Beta and Gamma functions.

Scope as in [4] Chapter 11 and [2] 8.17 to 8.20.

### **Unit III**

Pointwise and Uniform Convergence of Sequence of functions, Weierstrass M-Test, Uniform Convergence and Continuity, Uniform convergence and Integration, Uniform convergence and differentiation, A Continuous nowhere differentiable function, Weierstrass Approximation Theorem.

Scope as in [2] 7.1 to 7.12, 7.16, 7.17, 7.18.

### **Unit IV**

Power series, Radius of convergence, Cauchy-Hadamard Theorem, Differentiation and integration of power series, Taylor Series Theorem, Abel's Theorem, Multiplication of Two Series, Exponential, Logarithmic and Trigonometric functions.

Scope as in [2] 8.1 to 8.7.

### **Books Recommended**

1. K.A. Ross, *Elementary Analysis, The Theory of Calculus*, Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.
2. W. Rudin. *Principles of Mathematical Analysis*, 3rd edition. McGraw Hill, 1976.
3. R.G. Bartle and D. R. Sherbert, *Introduction to Real Analysis*, 3rd Ed., John Wiley and Sons (Asia) Pvt. Ltd., Singapore, 2002.
4. S. C. Malik and Savita Arora, *Mathematical Analysis*, 3<sup>rd</sup> Edition, New Age International Publishers, 2008.
5. Shanti Narayan, *A Course of Mathematical Analysis*, S. Chand and Company Ltd.1984.
6. Charles G. Denlinger, *Elements of Real Analysis*, Jones & Bartlett (Student Edition), 2011.
7. M. H. Protter and C. B. Morrey, *A First Course in Real Analysis*, 2<sup>nd</sup> Edition, Springer Verlag, Indian Reprint, 2004.
8. C. C. Pugh, *Real Mathematical Analysis*, Springer Verlag, New York, 2001.
9. S. K. Berberian, *A First Course in Real Analysis*, Springer Verlag, New York, 1994.
10. S. Abbott, *Understanding Analysis*, Springer Verlag, New York, 2008.

## MAT-C10: Ring Theory and Linear Algebra-I

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures : 60**

**Credits: 6**

**Objective:** The course is an introduction to Ring Theory and Linear Algebra which is one of the most important subjects of algebra.

### UNIT-I

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 on ideals, prime and maximal ideals.

### UNIT-II

Ring homomorphisms, properties of ring homomorphisms, Isomorphism theorems I, II and III, field of quotients and Embedding Theorems. Polynomial Rings over commutative rings, division algorithm and consequences.

*Scope as in Chapters 12-16 of [4]*

### UNIT-III

Inner Product Spaces, Gram-Schmidt orthogonalisation process, orthogonal complements, Linear Functionals and Adjoint of a linear operator, Normal and self-adjoint operators, Unitary and Orthogonal operators and their matrices

### UNIT-IV

Orthogonal Projections and the Spectral Theorem, The Singular Value Decomposition and the pseudo inverse, Bilinear and Quadratic Forms.

*Scope as in Chapter 6 of [3]*

### Books Recommended

1. John B. Fraleigh, *A First Course in Abstract Algebra*, 7th Ed., Pearson, 2002.
2. M. Artin, *Abstract Algebra*, 2nd Ed., Pearson, 2011.
3. Stephen H. Friedberg, Arnold J. Insel, Lawrence E. Spence, *Linear Algebra*, 4th Ed., Prentice-Hall of India Pvt. Ltd., New Delhi, 2004.
4. Joseph A. Gallian, *Contemporary Abstract Algebra*, 4<sup>th</sup> Ed., Narosa Publishing House, New Delhi, 1999.
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, RayAlden Kunze, *LinearAlgebra*, 2<sup>nd</sup> Ed., Prentice-Hall of India Pvt. Ltd., 1971.
9. D.A.R. Wallace, *Groups, Rings and Fields*, Springer Verlag London Ltd., 1998.
10. I. S. Luthar and I. B. S. Passi, *Algebra Volume II, Rings*, Narosa Publishing House 1999.

## MAT-SEC-3 Graph Theory

[2 hrs/per week]  
[Max. Marks: 50]  
(Final-40+Internal Assessment-10)  
Time : 3hrs.

**Total Lectures : 20**

**Credits: 2**

Definition, examples and basic properties of graphs, pseudo graphs, complete graphs, bi-partite graphs, isomorphism of graphs, paths and circuits, Eulerian circuits, Hamiltonian cycles, the adjacency matrix, weighted graph, travelling salesman's problem, shortest path, Dijkstra's algorithm, Floyd-Warshall algorithm.

### **Books Recommended**

1. B.A. Davey and H.A. Priestley, *Introduction to Lattices and Order*, Cambridge University Press, Cambridge, 1990.
2. Edgar G. Goodaire and Michael M. Parmenter, *Discrete Mathematics with Graph Theory*, 2nd Edition, Pearson Education (Singapore) P. Ltd., Indian Reprint 2003.
3. Rudolf Lidl and Gunter Pilz, *Applied Abstract Algebra*, 2nd Ed., Undergraduate Texts in Mathematics, Springer (SIE), Indian reprint, 2004.

## **MAT-SEC-4 Computer Algebra Systems and Related Softwares**

**(3 practicals per week) In groups of 15 students**  
**[Max. Marks: 50] (Final 40+Internal Assessment-10)**  
**Time : 3hrs.**

**(2 hrs/week)**  
**Credits-2**

**Total Lectures – 20**

**Objective :** The objective of this course is to teach pointers, structures in 'C'. This paper also introduces mathematical packages from programming point of view to help Mathematics students to solve their problems.

### **PART 1**

Functions and storage classes in C. Arrays: declaring an array, initializing an array. one dimensional arrays: array manipulation, two dimensional arrays, addition/multiplication of two matrices. Pointers: concept of pointers, address operators, pointer type declaration, pointer assignment, pointer initialization pointer arithmetic.

Structures and Unions: basic of structures, structures variables, initialization, structure assignment.

### **PART 2**

Use of Mathematica, Maple, and Maxima as calculator, in computing functions, in making graphs; MATLAB/Octave for exploring linear algebra and to plot curve and surfaces; the statistical software R: R as a calculator, explore data and relations, testing hypotheses, generate table values and simulate data, plotting.

[1] Chapter 5,8,10

[3] Chapter 12-14

**Practical Six practical should be done by each student. The teacher can assign practical from the exercises from [1] and [3]**

#### **References:**

[1] Let Us C by Yashwant Kanetkar, BPB publications, 10th Edition, 2010.

[2] C Programming Language by Brian W. Kernighan and Dennis M. Ritchie, Prentice hall, 2nd Edition, 1988.

[3] Martin J. Erickson and Donald Bindner, A Student's Guide to the Study, Practice, and Tools of Modern Mathematics, CRC Press, Boca Raton, FL, 2011. \

[4] L. Lamport. LATEX: A Document Preparation System, User's Guide and ReferenceManual. Addison-Wesley, New York, second edition, 1994.

## GENERIC ELECTIVE COURSES

### **MAT-GE6-PS: Integral Transforms and Complex Analysis**

(For students with background in Mathematics)

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures : 60**

**Credits: 6**

**Objective :** To acquaint the students with the application of Laplace transforms to solve ordinary differential equations. Moreover, basics of Complex Analysis are also included in this course.

#### **UNIT I**

Laplace Transforms : definition, elementary transforms. Transforms of derivatives and integrals. Transforms of periodic functions. Convolution theorem. Inverse Laplace transforms. Application to ordinary differential equations.

#### **UNIT II**

Complex numbers, absolute value, argument. Functions  $e^z$ ,  $\sin z$ ,  $\cos z$ ,  $\log z$  and hyperbolic functions. Analytic functions, Cauchy-Riemann equations. Harmonic functions and their conjugates.

#### **UNIT III**

Integration of complex functions, Cauchy's theorem (statement only), Cauchy's theorem for multiply connected domains (statement only). Cauchy's integral formula (statement only) and simple consequences.

#### **UNIT IV**

Expansion into Laurent series, singularities, Residues, Cauchy residue theorem (*statement only*). *Evaluation of definite integrals using contour integration.*  
[Scope as in relevant sections of Chapter 1-6 of Ref. 4.]

#### **Suggested Readings**

- 1 R. K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics (Narosa Publishing House), 2<sup>nd</sup> edition, 2004.
- 2 Sokolnikoff and Redheffer : Mathematics for Physics and Engineering 2<sup>nd</sup> Edition, 1996.
- 3 Erwin Kreyszig: Advanced Engineering Mathematic (Wiley Eastern Limited), 10<sup>th</sup> Edition, 2011.
- 4 R. V. Churchill & J. W. Brown : Complex Variables and Application, 4th Edition, 1995.

(For students without background in Mathematics)

**MAT-GE6-BM: Vector Analysis, Differential Equations and Transforms**

[6 hrs/per week (including Tutorials)]

[Max. Marks: 150]

(Final-120+Internal Assessment-30)

Time : 3hrs.

*Note :*

1. The question paper will have nine questions. Question No.1 spread over the whole syllabus will be compulsory. Candidates will attempt five questions.
2. There will be two questions from each unit and the students will be required to answer one question from each unit.
3. All questions carry equal marks.

**Total Lectures : 60**

**Credits: 6**

*Objective: The aim of this course is to make the students acquire facility and confidence in the use of vectors and vector calculus so that they may employ the same in an effective manner to various applications and to exhibit the techniques of solving ordinary and partial differential equations.*

**UNIT - I**

Vector valued functions. Limit and continuity of vector functions. Differentiation of vector functions., Arc length., Line, Surface and Volume integrals. The gradient, divergence and curl. The del operator. Green's, Gauss' and Stokes' theorems (statements only). Applications to physical problems.

[Scope as in Chapters 9-11 of 'A Text Book of Vector Analysis' by Shanti Narayan and P. K. Mittal, S. Chand & Co. Ltd., New Delhi, Revised Edition 2003.]

**UNIT - II**

Differential Equations and their solutions, Equations with variables separable, Homogeneous equations, First order linear equations.

Homogeneous and nonhomogeneous ordinary differential equations of second order with constant co-efficients. Wronskian and Linear independence and dependence of solution, particular integral, D-operator method, method of variation of parameters.

[Scope as in Sections 4.5-4.7, 5.1, 5.2, 5.3.1, 5.3.2, 5.4.1, 5.5 of Ref.4.]

**UNIT - III**

The Laplace transforms, Shifting theorem. The Convolution theorem. Inverse transform, Applications to ordinary differential equations. Legendre polynomials. Their recurrence and orthogonal relations.

[Scope as in Sections 8.1-8.4, 8.5.4, 7.2 of Ref.4.]

**UNIT - IV**

Formation of first and second order partial differential equations, solutions of first order equation, classification of linear second order equations, separation of variables, solution of one dimensional wave and heat equations, solution of Laplace equation.

[Scope as in Sections 16.2, 16.3.1, 9.5.1, 9.5.2, 9.5.3, 9.5.4, 9.5.5 of Ref.4.]

**Suggested Readings**

1. H. F. Davis & A. D. Snider, Introduction to Vector Analysis, Allyn and Bacon, Inc., Boston, USA, 1995.
2. Shanti Narayan & P. K. Mittal, A Text Book of Vector Analysis, S. Chand & Co.Ltd.,



- New Delh, 2003.
3. Erwin Kreyszig, Advanced Engineering Mathematics, Wiley Eastern Ltd., N. Delhi, Revised Edition 2003.[
  4. R.K. Jain & S.R.K. Iyengar: Advanced Engineering Mathematics(Narosa Publishing House), 2nd edition, 2005.