Syllabus- Up to 2019-2020

FIRST SEMESTER

MATHEMATICS – I

(4 lecture hours per week + 3 hours of practical's/week per batch of not more than 10 students)

(56 HOURS)

THEORY

1. ALGEBRA - I

Matrices

Elementary row and column transformations(operations), equivalent matrices, theorems on it. Row-reduced echelon form, Normal form of a matrix, Rank of a matrix, Problems. Homogeneous and Non – Homogeneous systems of m linear equations in n unknowns consistency criterion – criterion for uniqueness of solutions. Solution of the same by elimination method. Eigenvalues and Eigenvectors of a square matrix of order 2 and 3, standard properties, Cayley-Hamilton theorem (with proof). Finding A^{-1}, A^{-2} and A^2, A^3, A^4 (14 lecture hours)

2. CALCULUS - I

a) Differential Calculus

Successive Differentiation – nth derivatives of the functions: e^{ax} , $(ax + b)^n$, log(ax+ b), sin(ax + b) , cos(ax + b), e^{ax} sin(bx+ c), e^{ax} cos(bx + c) – Problems Leibnitz theorem (with proof) and its applications. Partial differentiation –Function of two and three variables - First and higher derivatives - Homogeneous functions – derivatives- Euler's theorem and its extension (with proof) - Total derivative and differential - Differentiation of implicit functions and composite functions – Problems - Jacobians – Properties of Jacobians problems.

b) Integral Calculus

Reduction formulae for $\int Sin^n$x dx , $\int Cos^n$x dx , $\int Tan^n$x dx, $\int Cot^n$x dx$\int Sec^n$x dx, $\int Cosec^n$x dx, $\int Sin^n$x $Cos^n x$dx with definite limit. Differentiation under integral sign by Leibnitz rule. (28 lecture hours)

3.GEOMETRY

Analytical Geometry of Three Dimensions

Recapitulation of elements of three-dimensional geometry - Different forms of equations of straight line and plane. Angle between two planes - Line of intersection of two planes - Plane coaxal with given planes - Planes bisecting the angle between two planes - Angle between a line and a plane - Coplanarity of two lines - Shortest distance between two lines. Equation of the sphere in general and standard forms - equation of a sphere with given ends of a diameter. Tangent plane to a sphere, orthogonality of spheres. Standard equations of right circular cone and right circular cylinder. (14 lecture hours)

Note: All the derivations (book works) must be through vector methods with reduction to corresponding Cartesian equivalents.

Suggested distribution of lecture hours

1.Matrices: 1-hour per week

2.Differential Calculus and Integral Calculus: 2 hours per week

3. Analytic Geometry of three dimensions: 1-hour per week.

Text Books/open source materials

1. Shanti Narayan and P K Mittal, Text book of Matrices, 5th edition, New Delhi, S Chand and Co. Pvt. Ltd.,2013.

2. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: SChand and Co. Pvt. Ltd., 2014.

3. Shanthi Narayan and P K Mittal, Integral Calculus, Reprint. New Delhi: S.Chand and Co. Pvt. Ltd., 2013.

4. Shanthi Narayan and P K Mittal, Analytical Solid Geometry. New Delhi: S. Chand and Co. Pvt. Ltd., 2014.

5. www.scilab.org.

6. wxmaxima.sourceforge.net

7. www.geogebra.org

Reference Books

1. B S Vatssa, Theory of Matrices, New Delhi: New Age International Publishers, 2005.

2. A R Vashista, Matrices, Krishna Prakashana Mandir, 2003.

3. G B Thomasand R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

4. J Edwards, An elementary treatise on the differential calculus: with applications and numerous examples, Reprint. Charleston, USA: BiblioBazaar, 2010.

5. N P Bali, Differential Calculus, India: Laxmi Publications (P) Ltd.., 2010.

6. S Narayanan & T. K. Manicavachogam Pillay, Calculus.: S. Viswanathan Pvt. Ltd., vol. I & II1996.

7. Frank Ayres and Elliott Mendelson, Schaum's Outline of Calculus, 5th ed. USA: Mc. Graw Hill., 2008.

8. S.P.Mahajan & Ajay Aggarwal, Comprehensive Solid Geometry , 1st ed.: Anmol Publications , 2000.

Useful web links:

1. http://www.cs.columbia.edu/~zeph/3203s04/lectures.html

2. http://home.scarlet.be/math/matr.htm

3. http://www.themathpage.com/

4. http://www.abstractmath.org/

5. http://ocw.mit.edu/courses/mathematics/

6. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

7. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall- 2005/CourseHome/index.htm

8. http://mathworld.wolfram.com/Calculus.html

9. http://ocw.mit.edu/courses/mathematics/

10. http://www.univie.ac.at/future.media/moe/galerie.html

11. http://mathworld.wolfram.com/AnalyticGeometry.html

PRACTICALS – I

Mathematics practicals with Free and OpenSource Software (FOSS) tools for computer programs

(3 hours/ weekper batch of not more than 10 students)

LIST OF PROBLEMS

1. Introduction to Scilab and commands connected with matrices.

2. Computations with matrices.

3. Row reduced echelon form and normal form.

4. Establishing consistency or otherwise and solving system of linear equations.

5. Introduction to Maxima and commands for derivatives and nth derivatives.

6. Scilab and Maxima commands for plotting functions.

7. nth derivative without Leibnitz rule.

8. nth derivative with Leibnitz rule.

9. Obtaining partial derivative of some standard functions

10.Verification of Euler's theorem, its extension and Jacobian.

11.Maxima commands for reduction formula with or without limits.

12.Implementing vector form of line.

13.Implementing vector form of plane.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).

SECOND SEMESTER

MATHEMATICS – II

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than 10 students)

(56 HOURS)

THEORY

1. ALGEBRA - II

Group Theory

Binary operation, algebraic structure-problems on finding identity and inverse. Definitions of semigroup and group, abelian group – problems on finite and infinite groups. Properties of group with proof – standard problems on groups – A finite semigroup with both the cancellation laws is a group – Any group of order less than five is abelian – permutation groups. Subgroups- theorems on subgroups (with proof)- problems. (14 lecture hours)

2. CALCULUS - II

a) Differential Calculus

Polar coordinates - Angle between the radius vector and the tangent - Angle of intersection of curves (polar form) polar sub-tangent and polar subnormal perpendicular from pole on the tangent - Pedal equations. Derivative of an arc in Cartesian, parametric and polar forms. Curvature of plane curves - formula for radius of curvature in Cartesian, parametric, polar and pedal forms - centre of curvature - evolutes. Singular points– Asymptotes – Envelopes. General rules for tracing of curves.

b) Integral Calculus

Applications of Integral Calculus: computation of length of arc, plane area and surface area and volume of solids of revolutions for standard curves in Cartesian and Polar forms. (28 lecture hours)

4.DIFFERENTIAL EQUATIONS – I

Solutions of ordinary differential equations of first order and first degree:

(i) Linear equations, Bernoulli equation and those reducible to these.

(ii)Exact equations (excluding reducible to Exact)

Equations of first order and higher degree – non-linear first order, higher degree –(Mention) solvable for p - solvable for y - solvable for x - Clairaut's equation -singular solution - Geometric meaning. Orthogonal trajectories in Cartesian and polar forms. (14 lecture hours)

Suggested distribution of lecture hours

1. Algebra-II (Group theory): 1 hour / week

2. Calculus-II (Differential calculus & Integral Calculus): 2 hours / week.

3.Differential Equations-I: 1 hour / week.

Text Books/open source materials

1. Herstein I N, Topics in Algebra, 4th ed. New Delhi, India: Vikas Publishing House Pvt. Ltd, 1991.

2. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: S Chand and Co. Pvt. Ltd., 2014.

3. Shanthi Narayan and P K Mittal, Integral Calculus, Reprint. New Delhi: S.Chand and Co. Pvt. Ltd., 2013.

4. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.

5. www.scilab.org.

6. wxmaxima.sourceforge.net

7. www.geogebra.org

Reference Books

1. Michael Artin, Algebra, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2011.

2. Vashista, A First Course in Modern Algebra, 11th ed.: Krishna Prakasan Mandir,1980.

3. John B Fraleigh, A First course in Abstract Algebra, 3rd ed.: Narosa Publishing House., 1990.

4. R Balakrishan and N.Ramabadran, A Textbook of Modern Algebra, 1st ed. New Delhi, India: Vikas publishing house pvt. Ltd., 1991.

5. G B Thomasand R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

6. J Edwards, An elementary treatise on the differential calculus: with applications and numerous example, Reprint. Charleston, USA: BiblioBazaar, 2010.

7. N P Bali, Differential Calculus, New ed. New Delhi, India: Laxmi Publications (P) Ltd.., 2010.

8. S Narayanan & T. K. Manicavachogam Pillay, Calculus.: S. Viswanathan Pvt. Ltd., vol. I & II, 1996.

9. Frank Ayres and Elliott Mendelson, Schaum's Outline of Calculus, 5th ed. USA: Mc. Graw Hill., 2008.

10.E Spiegel, Schaum's Outline of AdvancedCalculus, 5th ed. USA: Mc. Graw Hill., 2009.

11.M D Raisinghania, Advanced Differential Equations, S Chand and Co.Pvt. Ltd., 2013.

12.F Ayres, Schaum's outline of theory and problems of Differential Equations, 1st ed. USA: McGraw-Hill, 2010.

13.S Narayanan and T K Manicavachogam Pillay, Differential Equations.: S VPublishers Private Ltd., 1981.

14.G F Simmons, Differential equation with Applications and historical notes, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.

Useful web links:

1. http://www.themathpage.com/

2. http://www.abstractmath.org/

3. http://ocw.mit.edu/courses/mathematics/

4. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

5. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall- 2005/CourseHome/index.htm

6. http://mathworld.wolfram.com/Calculus.html

7. http://ocw.mit.edu/courses/mathematics/

8. http://www.univie.ac.at/future.media/moe/galerie.html

9. http://tutorial.math.lamar.edu/classes/de/de.aspx

10. http://www.sosmath.com/diffeq/diffeq.html

11. http://www.analyzemath.com/calculus/Differential_Equations/applications. html

PRACTICALS –II

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Creating a Scilab program (simple examples).

2. Creating a Maxima program (simple examples).

3. i. Verifying whether given operator is binary or not.

ii. To find identity element of a group.

iii.To find inverse element of a group.

4. Finding all possible subgroups of a finite group.

5. Plotting of standard Cartesian curves using Scilab/Maxima.

6. Plotting of standard Cartesian curves using Scilab/Maxima.

7. Plotting of standard Polar curves using Scilab/Maxima.

8. Plotting of standard parametric curves using Scilab/Maxima.

9. Scilab/Maxima programs for area and volume.

10. Solution of Differential equation using Scilab/Maxima and plotting the solution-I.

11. Solution of Differential equation using Scilab/Maxima and plotting the solutionII.

12.Solution of Differential equation using Scilab/Maxima and plotting the solutionIII.

13.Solution of Differential equation using Scilab/Maxima and plotting the solutionIV.

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THIRD SEMESTER

MATHEMATICS-III

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than10 students)

(56 HOURS)

THEORY

1. ALGEBRA - III

Groups

Order of an element of a group – properties related to order of an element- subgroup generated by an element of a group –coset decomposition of a group, Cyclic groupsproperties- modulo relation- index of a group –Lagrange's theorem- consequences. (14 lecture hours)

2. ANALYSIS – I

a) Sequences of Real Numbers

Definition of a sequences-Bounded sequences- limit of a sequences convergent, divergent and oscillatory sequences- Monotonic sequences and their properties- Cauchy's criterion.

b) Series of Real Numbers

Definition of convergence, divergence and oscillation of series -properties of Convergence series - properties of series of positive terms – Geometric series Tests for convergence of series -p- series -

comparison of series Cauchy's root Test -D Alembert's test. Raabe's test, - Absolute and conditional convergence-D'Alembert test for absolute convergence - Alternating series - Leibnitz test. Summation of binomial, exponential and logarithmic series. (28 lecture hours)

3. CALCULUS - III

Differential Calculus

Recapitulation of Equivalence Class and partition of a set. Definition of the limit of a function in ε-δ form – continuity- types of discontinuities. Properties of continuous function on a closed interval (boundedness, attainment of bounds and taking every value between bounds). Differentiability -Differentiability implies Continuity – Converse not true. Rolle's Theorem- Lagrange's and Cauchy's First Mean Value Theorem (Lagrange's form) - Maclaurin's expansion. Evaluation of limits by L'Hospital's rule (14 lecture hours)

Suggested distribution of lecture hours

1. Algebra – III (Groups): 1 hour / week.

2. Analysis-I (sequences of real numbers and series of real numbers):2 hours /week

3. Calculus - III (differential calculus): 1 hour / week.

Text Books/open source materials

1. Herstein I N, Topics in Algebra, 4th ed. New Delhi, India: Vikas Publishing House Pvt. Ltd, 1991.

2. Boumslag and Chandler, Schaum's outline series on groups, 2010.

3. S.C.Malik and Savita Arora, Mathematical Analysis, 2nd ed. New Delhi, India: New Age international (P) Ltd., 1992

4. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: SChand and Co. Pvt. Ltd., 2014.

5. www.scilab.org.

6. wxmaxima.sourceforge.net

7. www.geogebra.org

Reference Books

1. Michael Artin, Algebra, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2011.

2. Vashista, A First Course in Modern Algebra, 11th ed.: Krishna Prakasan Mandir, 1980.

3. John B Fraleigh, A First course in Abstract Algebra, 3rd ed.: Narosa Publishing House., 1990.

4. R Balakrishan and N.Ramabadran, A Textbook of Modern Algebra, 1st ed. New Delhi, India: Vikas publishing house pvt. Ltd., 1991.

5. Richard R Goldberg, Methods of Real Analysis, Indian ed. New Delhi, India: Oxford and IBH Publishing Co., 1970.

6. G B Thomasand R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

7. J Edwards, An elementary treatise on the differential calculus: with applications and numerous example, Reprint. Charleston, USA: BiblioBazaar, 2010.

8. N P Bali, Differential Calculus, New ed. New Delhi, India: Laxmi Publications (P) Ltd.., 2010.

9. S Narayanan & T. K. Manicavachogam Pillay, Calculus.: S. Viswanathan Pvt. Ltd., vol. I & II1996.

10.Frank Ayres and Elliott Mendelson, Schaum's Outline of Calculus, 5th ed. USA: Mc. Graw Hill., 2008.

11.E Spiegel, Schaum's Outline of AdvancedCalculus, 5th ed. USA: Mc. Graw Hill., 2009.

Usefulweb links:

1. http://www.themathpage.com/

2. http://www.abstractmath.org/

3. http://ocw.mit.edu/courses/mathematics/

4. http://www.math.unl.edu/~webnotes/contents/chapters.htm

5. http://www-groups.mcs.st-andrews.ac.uk/~john/analysis/index.html

6. http://web01.shu.edu/projects/reals/index.html

7. http://www.mathcs.org/analysis/reals/index.html

8. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

9. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall-2005/CourseHome/index.htm

10. http://mathworld.wolfram.com/Calculus.html

11. http://ocw.mit.edu/courses/mathematics/

PRACTICALS –III

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Examples to verify Lagrange's theorem.

2. Examples for finding left and right coset and finding the index of a group.

3. Illustration of convergent, divergent and oscillatory sequences using Scilab/Maxima.

4. Illustration of convergent, divergent and oscillatory series using Scilab/Maxima.

5. Scilab/Maxima programs to find the sum of the series and its radius of convergence.

6. Using Cauchy's criterion to determine convergence of a sequence (simple examples).

7. Using Cauchy's criterion on the sequence of partial sums of the series to determine convergence of a series.

8. Testing the convergence of binomial, exponential and logarithmic series and finding the sum.

9. Scilab/Maxima programs to illustrate continuity of a function.

10.Scilab/Maxima programs to illustrate differentiability of a function and unequal left hand and right hand limits for discontinuous functions.

11.Scilab/Maxima programs to verify Rolle's theorem and Lagrange's theorem.

12.Scilab/Maxima programs to verify Cauchy's mean value theorem and finding Taylor's theorem for a given function.

13.Evaluation of limits by L'Hospital's rule using Scilab/Maxima.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics). Geogebra/Octave may also be used in place of scilab/maxima.

FOURTH SEMESTER

MATHEMATICS - IV

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than 10 students)

(56 HOURS)

THEORY

1. ALGEBRA –IV

Groups

Normal subgroups-examples and problems –Quotient group-Homomorphism and Isomorphism of groups-Kernel and image of a homomorphism-Normality of the KernelFundamental theorem of homomorphism-properties related to isomorphism-Permutation group-Cayley's theorem. (14 lecture hours)

2. ANALYSIS -II

Fourier Series Trigonometric Fourier series of functions with period 2π and period $2L$ – Half range Cosine and sine series. (9 lecture hours)

3. CALCULUS - IV

Differential Calculus

Continuity and differentiability of a function of two and three variables –Taylor's Theorem and expansion of functions of two variables- Maxima and Minima of functions Of two variables. Method of Lagrange multipliers. (9 lecture hours)

4. MATHEMATICAL METHODS - I

Definition and basic properties Laplace transform of some common functions and Standard results –Laplace transform of periodic functions- Laplace transforms ,of derivatives And the integral of function- Laplace

transforms, Heaviside function convolution theorem (statement only) Inverse Laplace transforms. (10 lecture hours)

5. DIFFERENTIAL EQUATIONS –II

Second and higher order ordinary linear differential equations with constant Coefficients- complementary function- particular integrals (standard types) Cauchy-Euler differential equation. Simultaneous linear differential equations (two variables) with constant coefficients. Solutions of second order ordinary linear differential equations with variables coefficients by the following methods.

(i). When a part of complementary function is given

(ii). Changing the independent variable

(iii). Changing the dependent variable

(iv). Variation of parameters

(v). Conditions for exactness and the solution when the equation is exact. (14 lecture hours)

Suggested distribution of lecture hours

1. Algebra – IV (Rings, Fields and Integal domains): 1 hour / week

2. Analysis – II (Fourier series), Calculus-IV (Differential Calculus) and

Mathematical methods-I (Laplace transform): 2 hours / week.

3. Differential Equations II: 1 hour / week.

Text Books/open source materials

1. Herstein I N, Topics in Algebra, 4th ed. New Delhi, India: Vikas Publishing House Pvt. Ltd, 1991.

2. Boumslag and Chandler, Schaum's outline series on groups, 2010.

3. Erwin Kreyszig, Advanced Engineering Mathematics, 8th ed. New Delhi, India: Wiley India Pvt. Ltd., 2010.

4. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: S Chand and Co. Pvt. Ltd., 2014.

5. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.

6. www.scilab.org.

7. wxmaxima.sourceforge.net

8. www.geogebra.org

Reference Books

1. Michael Artin, Algebra, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2011.

2. Vashista, A First Course in Modern Algebra, 11th ed.: Krishna Prakasan Mandir, 1980.

3. John B Fraleigh, A First course in Abstract Algebra, 3rd ed.: Narosa Publishing House., 1990.

4. R Balakrishan and N.Ramabadran, A Textbook of Modern Algebra, 1st ed. New Delhi, India: Vikas publishing house pvt. Ltd., 1991.

5. G B Thomasand R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

6. J Edwards, An elementary treatise on the differential calculus: with applications and numerous example, Reprint. Charleston, USA: BiblioBazaar, 2010.

7. N P Bali, Differential Calculus, Laxmi Publications (P) Ltd.., 2010.

8. S Narayanan & T. K. Manicavachogam Pillay, Calculus.: S. Viswanathan Pvt. Ltd., vol. I & II1996.

9. Frank Ayres and Elliott Mendelson, Schaum's Outline of Calculus, 5th ed. USA: Mc. Graw Hill., 2008.

10.E Spiegel, Schaum's Outline of AdvancedCalculus, 5th ed. USA: Mc. Graw Hill., 2009.

11.Raisinghania M.D., Laplace and Fourier Transforms. New Delhi, India: S.Chand and Co. Ltd. , 1995.

12.M D Raisinghania, Advanced Differential Equations, S Chand and Co. Pvt. Ltd., 2013.

13.FAyres, Schaum's outline of theory and problems of Differential Equations, 1st ed. USA: McGraw-Hill, 2010.

14.S Narayanan and T K Manicavachogam Pillay, Differential Equations.: S V Publishers Private Ltd., 1981.

15.G F Simmons, Differential equation with Applications and historical notes, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.

Useful web links:

1. http://www.themathpage.com/

2. http://www.abstractmath.org/

3. http://www.fourier-series.com/

4. http://mathworld.wolfram.com/

5. http://www.princeton.edu/~rvdb

6. http://www.zweigmedia.com/RealWorld/Summary4.html

7. http://ocw.mit.edu/courses/mathematics/

8. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

9. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall-2005/CourseHome/index.htm

10. http://mathworld.wolfram.com/Calculus.html

11. http://ocw.mit.edu/courses/mathematics/

12. http://www.univie.ac.at/future.media/moe/galerie.html

13. http://tutorial.math.lamar.edu/classes/de/de.aspx

14. http://www.sosmath.com/diffeq/diffeq.html

15. http://www.analyzemath.com/calculus/Differential_Equations/applications.html

PRACTICALS –IV

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Illustrating homomorphism and isomorphism of groups.

2. Verification of Normality of a given subgroup.

3. Verifying Cayley's theorem and isomorphism theorems.

4. To plot periodic functions with period 2□ and 2L.

5. To find full range trigonometric Fourier series of some simple functions with period 2□ and 2L.

6. Plotting of functions in half-range and including their even and odd extensions.

7. To find the half-range sine and cosine series of simple functions.

8. Finding maxima/minima of functions of two variables.

9. Finding the Laplace transforms of some standard functions.

10.Finding the inverse Laplace transform of simple functions.

11.Implementing Laplace transform method of solving ordinary linear differential equations of first and second order with constant coefficient.

12.Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations.

13. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics). Geogebra/Octave may also be used in place of scilab/maxima.

FIFTH SEMESTER

MATHEMATICS V

(3 lecture hours per week+ 3 hours of practicals /week per batch of not more than 10 students)

THEORY (42 hours)

1. ALGEBRA - IV

Rings, Integral Domains, Fields

Rings, Types of Rings properties of rings – Rings of integers modulo n –Subrings – Ideals ,Principal, Prime and $Maximal\ ideals\ in\ a\ commutative\ ring$ – $examples\ and\ standard\ properties\ following\ the\ definition$ –

Homomorphism, Isomorphism – Properties – Quotient rings – Integral Domain- Fields – properties following the definition – Fundamental Theorem of Homomorphism of Rings - Every field is an integral domain – Every finite integral domain is a field – Problems. (14 lecture hours)

2. CALCULUS - V

Differential Calculus of Scalar and Vector Fields Scalar field – gradient of a scalar field, geometrical meaning – directional derivative – Maximum directional derivative – Angle between two surfaces - vector field– divergence and curl of a vector field – solenoidal and irrotational fields – scalar and vector potentials – Laplacian of a scalar field – vector identities. Standard properties, Harmonic functions, Problems. (14 lecture hours)

3. NUMERICAL METHODS - I

Finite differences – Definition and properties of $\Delta, \nabla, \delta, \mu$ and E, the relation between them – The nth differences of a polynomial, Factorial notations, separation of symbols, divided differences and related theorems. Newton –Gregory forward and backward interpolation formulae – Lagrange's and Newton's interpolation formulae for unequal intervals - Inverse interpolation. Numerical Integration: Quadrature formula – Trapezoidal rule -Simpon's 1/3 and 3/8 rule (without proofs) and problems. (14 lecture hours)

Suggested distribution of lecture hours.

1. Algebra IV: 1 hour /week.

2. Calculus-V (Differential calculus of scalar and vector fields): 1 hours/week

3. Numerical Methods I: 1 hours/week

Text Books/open source materials

1. Herstein I N, Topics in Algebra, 4th ed. New Delhi, India: Vikas Publishing House Pvt. Ltd, 1991.

2. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: S Chand and Co. Pvt. Ltd., 2014.

3. M D Raisinghania, Vector calculus,S Chand Co. Pvt. Ltd., 2013.

4. M K Jain, S R K Iyengar, and R K Jain, Numerical Methods for Scientific and Engineering Computation, 4th ed. New Delhi, India: New Age International, 2012.

5. www.scilab.org.

6. wxmaxima.sourceforge.net

7. www.geogebra.org

Reference Books

1. Michael Artin, Algebra, 2nd ed. New Delhi, India: PHI Learning Pvt. Ltd., 2011.

2. Vashista, A First Course in Modern Algebra, 11th ed.: Krishna Prakasan Mandir, 1980.

3. John B Fraleigh, A First course in Abstract Algebra, 3rd ed.: Narosa Publishing House., 1990.

4. R Balakrishan and N.Ramabadran, A Textbook of Modern Algebra, 1st ed. New Delhi, India: Vikas publishing house pvt. Ltd., 1991.

5. G B Thomasand R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

6. B Spain,Vector Analysis , ELBS, 1994.

7. D E Bournesand, P C Kendall, Vector Analysis, ELBS, 1996.

8. S S Sastry, Introductory methods of Numerical Analysis, Prentice Hall of India,2012.

Useful web links:

1. http://www.themathpage.com/

2. http://www.abstractmath.org/

3. http://ocw.mit.edu/courses/mathematics/

4. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

5. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall-2005/CourseHome/index.htm

6. http://mathworld.wolfram.com/Calculus.html

7. http://www.univie.ac.at/future.media/moe/galerie.html

8. http://www.math.gatech.edu/~harrell/calc/

9. http://www.amtp.cam.ac.uk/lab/people/sd/lectures/nummeth98/index.htm

10. http://math.fullerton.edu/mathews/numerical.html

11. http://www.onesmartclick.com/engineering/numerical-methods.html

PRACTICALS –V

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Examples on different types of rings.

2. Examples on integral domains and fields.

3. Examples on subrings, ideals and subrings which are not ideals.

4. Homomorphism and isomorphism of rings- illustrative examples.

5. To demonstrate the physical interpretation of gradient, divergence and curl.

6. Writing gradient, divergence, curl and Laplacian in cylindrical coordinates.

7. Writing gradient, divergence, curl and Laplacian in spherical coordinates.

8. Using cyclic notations to derive different vector identities.

9. Using cyclic notations to derive some more vector identities.

10.Scilab/Maxima programs on Interpolations with equal intervals.

11.Scilab/Maxima programs on Interpolations with unequal intervals.

12.Scilab/Maxima programs to evaluate integrals using Simpson's $1/3^{rd}$ rule.

13.Scilab/Maxima programs to evaluate integrals using Simpson's $3/8^{th}$ rule.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics). Geogebra/Octave may also be used in place of scilab/maxima.

FIFTH SEMESTER

MATHEMATICS – VI

(3 lecture hours per week+ 3 hours of practicals/week per batch of not more than 10 students)

(42 HOURS)

THEORY

1. MATHEMATICAL METHODS - II

Calculus of Variation

Variation of a function f = f (x, y, y) – variation of the corresponding functional –extremal of a functional – variational problem – Euler's equation and its particular forms– Examples – standard problems like geodesics, minimal surface of revolution, hanging chain, Brachistochrone problem –Isoperimetric problems. (14 Lecture hours)

2. CALCULUS – VI

a). Line and Multiple Integrals

Definition of line integral and basic properties examples evaluation of line integrals. Definition of double integral – its conversion to iterated integrals. Evaluation of double integrals by change of order of integration and by change of variables – computation of plane and surface areas, volume underneath a surface and volume of revolution using double integrals. Definition of triple integral and evaluation – change of variables – volume as a triple integral. (18lecture hours)

b). Integral Theorems

Green's theorem (with proof) - Direct consequences of the theorem. The Divergence theorem (with proof) - Direct consequences of the theorem. The Stokes' theorem (with proof) - Direct consequences of the theorem.

(10 lecture hours)

Suggested distribution of lecture hours

1. Mathematical Methods II (Calculus of variation): 1 hour /week.

2. Calculus VI (Line and Multiple Integrals and Integral theorems): 2 hours/week

Text Books/open source materials

1. R Weinstock, Calculus of Variation, Dover, 1970.

2. M. D. Raisinghania, Vector Calculus, S Chand Co. Pvt. Ltd., 2013.

3. www.scilab.org

4. wxmaxima.sourceforge.net

5. www.geogebra.org

Reference Books

1. F B Hildebrand, Methods in Applied Mathematics,

2. B Spain,Vector Analysis , ELBS, 1994.

3. D E Bournesand, P C Kendall, Vector Analysis, ELBS, 1996.

Useful web links:

1. http://ocw.mit.edu/courses/mathematics/

2. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

3. http://mathworld.wolfram.com/Calculus.html

4. http://www.univie.ac.at/future.media/moe/galerie.html

5. http://www.math.gatech.edu/~harrell/calc/

PRACTICALS –VI

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Example on Euler's equation in full form.

2. Example on particular forms of Euler's equation.

3. Examples on minimum surface of revolution and Brachistochrome problem.

4. Examples on Isoperimetric problems.

5. Evaluation of the line integral with constant limits.

6. Evaluation of the double integral with constant limits.

7. Evaluation of the triple integral with constant limits.

8. Evaluation of the line integral with variable limits.

9. Evaluation of the double integral with variable limits.

10.Evaluation of the triple integral with variable limits.

11.Verifying Green's theorem.

12.Verifying Gauss divergence theorem.

13.Verifying Stokes' theorem

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SIXTH SEMESTER

MATHEMATICS - VII

(3 lecture hours per week+ 3 hours of practicals /week per batch of not more than 10 students)

(42 HOURS)

THEORY

1. ALGEBRA –V

Linear Algebra

Vector space – Examples – Properties – Subspaces – criterion for a subset to be a subspace –linear span of a set - linear combination – linear independent and dependent subsets – Basis and dimensions– Standard properties – Examples illustrating concepts and results. Linear transformations – properties – matrix of a linear transformation – change of basis – range and kernel – rank and nullity – Rank – Nullity theorem – Non-singular and singular linear transformations - Standard properties – Examples. (14 lecture hours)

2. DIFFERENTIAL EQUATIONS III

a). Orthogonal Curvilinear Coordinates

Definition of orthogonal curvilinear coordinates. Fundamental vectors or base vectors, Scale factors or material factors - quadratic differential form. Spherical curvilinear system: Cartesian, Cylindrical – conversion of Cylindrical to orthogonal Spherical polar coordinates. Theorem: The Spherical coordinate system is orthogonal curvilinear coordinate system. (without proof) No problems on conversions of one system to another.

b). Partial Differential Equations

Total differential equations-Necessary condition for the equation Pdx+Qdy+Rdz= 0 to be integrable-Simultaneous equations of the form $\frac{dx}{P} = \frac{dy}{Q} = \frac{dz}{R}$ Formation of partial differential equation .Equations of First Order Lagrange's linear equation – Charpit's method, Standard types of first order non-linear partial differential equation (By known substitution). Solution of second order linear partial differential equations in two variables with constant coefficients by finding complementary function and particular integral Solution of one – dimensional heat equations, Solution of one – dimensional wave equations using Fourier series. (28 lecture hours)

Suggested distribution of lecture hours:

1. Algebra-V (Linear Algebra): 1 hours / week.

2. Differential Equations III: 2 hours / week

Text Books/open source materials

1. Krishnamoorty V K and Mainra V P and Arora J L, An Introduction to Linear Algebra, Reprint. New Delhi, India: Affiliated East West Press Pvt. Ltd., 2003.

2. M. D. Raisinghania, Vector Calculus, S Chand Co. Pvt. Ltd., 2013.

3. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.

4. www.scilab.org

5. wxmaxima.sourceforge.net

6. www.geogebra.org

Reference Books

1. G Strang, MIT open courseware (http://ocw.mit.edu/courses).

2. B Spain, Vector Analysis, ELBS, 1994.

3. D E Bournes and, P C Kendall, Vector Analysis, ELBS, 1996.

4. Frank Ayres, Schaum's outline of theory and problems of Differential Equations, 1st ed. USA: McGraw-Hill, 1972.

5. GF Simmons, Differential equation with Applications and historical notes, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.

6. S Narayanan & T K Manicavachogam Pillay, Differential Equations.: S V Publishers Private Ltd., 1981.

7. I N Sneddon, Elements of Partial Differential Equations, 3rd ed.: Mc. Graw Hill., 1980.

Useful web links:

1. http://ocw.mit.edu/courses/mathematics/

2. http://mathworld.wolfram.com/Calculus.html

3. http://www.math.gatech.edu/~harrell/calc/

4. http://tutorial.math.lamar.edu/classes/de/de.aspx

5. http://www.sosmath.com/diffeq/diffeq.html

6. http://www.analyzemath.com/calculus/Differential_Equations/applications.html

PRACTICALS –VII

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. i. Vector space, subspace – illustrative examples.

ii. Expressing a vector as a linear combination of given set of vectors.

iii. Examples on linear dependence and independence of vectors.

2. i. Basis and Dimension – illustrative examples.

ii. Verifying whether a given transformation is linear.

3. i. Finding matrix of a linear transformation.

ii. Problems on rank and nullity.

4. Plotting of cylinder and cone using orthogonal curvilinear coordinates.

5. Plotting of sphere using orthogonal curvilinear coordinates.

6. Solutions to the problems on total and simultaneous differential equations.

7. Solutions to the problems on different types of Partial differential equations.

8. Solving second order linear partial differential equations in two variables with constant coefficient.

9. Solving some more second order linear partial differential equations in two variables with constant coefficient.

10.Solution of one-dimensional heat equation using Fourier series with Dirichlet condition.

11.Solution of one-dimensional heat equation using Fourier series with Neumann condition.

12.Solution of one-dimensional wave equation using Fourier series with Dirichlet condition.

13.Solution of one-dimensional wave equation using Fourier series with Neumann condition.

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SIXTH SEMESTER

MATHEMATICS - VIII

(3 lecture hours per week+ 3 hours of practicals /week per batch of not more than 10 students)

(42 HOURS)

THEORY

1. ANALYSIS - III

Complex Analysis

Complex numbers-Cartesian and polar form-geometrical representation-complex Plane-Euler's formula- $e^{i\theta}$ = cosθ + i sinθ. Functions of a complex variable-limit, continuity and differentiability of a complex function. Analytic function Cauchy Riemann equations in Cartesian and Polar Forms-Sufficiency conditions for analyticity (Cartesian form only)-Harmonic function-standard properties of analytic functions-construction of analytic function when real or imaginary part is given-Milne Thomson method. Complex integration-the complex integration –properties-problems. Cauchy's Integral theorem-proof using Green's theorem- direct

consequences. Cauchy's Integral formula with proof-Cauchy's generalised formula for the derivatives with proof and applications for evaluation of simple line integrals - Cauchy's inequality with proof – Liouville's theorem with proof. Fundamental theorem of algebra with proof. Transformations – conformal transformation – some elementary transformations namely Translation, rotation, magnification and inversion - examples.

The bilinear transformation (B.T.)-cross ratio-invariant points of a B.T.-properties-

(i) B.T. sets up a one to one correspondence between the extended z-plane and

the extended w-plane.

(ii) Preservation of cross ratio under a B.T.

(iii) A B.T. transforms circles onto circles or straight lines.

Problems on finding a B.T., and finding images under a B.T.and invariant points of a B.T. Discussion of transformations w = z^2, w = sin z, w = cosh z and w = e^z.(28 lecture hours)

2. NUMERICAL METHODS – II

Numerical solutions of algebraic and Transcendental equations – method of successive bisection - method of false position – Newton-Raphson method. Numerical solutions of non-Homogeneous system of linear algebraic equations in three variables by Jacobi's method and Gauss-Seidel method. Computation of largest Eigen value of a square matrix by power method. Solutions of initial value problems for ordinary linear first order differential equations by Taylor's series, Euler's and Euler's modified method and Runge-Kutta 4th ordered method. (14 lecture hours)

Suggested distribution of lecture hours:

1. Analysis-III (Complex Analysis): 2 hours / week.

2. Numerical Methods-II: 1 hour / week

Text Books/open source materials

1. S Shanthinarayan, Complex Analysis, S Chand Co. Pvt. Ltd., 2012.

2. M K Jain, S R K Iyengar, and R K Jain, Numerical Methods for Scientific and Engineering Computation, 4th ed. New Delhi, India: New Age International, 2012.

3. www.scilab.org

4. wxmaxima.sourceforge.net

5. www.geogebra.org

Reference Books

1. R V Churchil & J W Brown, Complex Variables and Applications, 5th ed.: McGraw Hill Companies., 1989.

2. L V Ahlfors, Complex Analysis, 3rd ed.: Mc Graw Hill. , 1979.

3. A R Vashista, Complex Analysis, Krishna Prakashana Mandir, 2012.

4. S S Sastry, Introductory methods of Numerical Analysis, Prentice Hall of India, 2012.

Useful web links:

1. http://www.mathcs.org/analysis/reals/index.html

2. http://www.amtp.cam.ac.uk/lab/people/sd/lectures/nummeth98/index.htm

3. http://math.fullerton.edu/mathews/numerical.html

4. http://www.onesmartclick.com/engineering/numerical-methods.html

PRACTICALS –VIII

Mathematics practicals with FOSS tools for computer programs (3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Some problems on Cauchy-Riemann equations (polar form).

2. Implementation of Milne-Thomson method of constructing analytic functions (simple examples).

3. Illustrating orthogonality of the surfaces obtained from the real and imaginary parts of an analytic function.

4. Verifying real and imaginary parts of an analytic function being harmonic (in polar coordinates).

5. Illustrating the angle preserving property in a transformation.

6. Illustrating that circles are transformed to circles by a bilinear transformation.

7. Examples connected with Cauchy's integral theorem.

8. Solving algebraic equation (Bisection method).

9. Solving algebraic equation (Regula-Falsiand Newton-Raphson methods).

10.Solving system of equations (Jacobi and Gauss-Seidel methods).

11.Solving for largest eigenvalue by Power method.

12.Solving ordinary differential equation by modified Euler's method.

13.Solving ordinary differential equation by Runge-Kutta method of 4th order.

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Revised Syllabus 2020-21

FIRSTSEMESTER

MATHEMATICS – I

(4 lecture hours per week+3 hours of practicals/week per batch of not more than 10 students)

(56 HOURS)

THEORY

1. ALGEBRA - I

Matrices

Elementary row and column transformations(operations), equivalent matrices, theorems on it. Row-reduced echelon form, Normal form of a matrix, Rank of a matrix, Problems. Homogeneous and Non – Homogeneous systems of m linear equations in n unknowns consistency criterion – criterion for uniqueness of solutions. Solution of the same by elimination method. Eigenvalues and Eigenvectors of a square matrix of order 2 and 3, standard properties, Cayley-Hamilton theorem (with proof). Finding A^{-1}, A^{-2} and A^2, A^3, A^4 (14 lecture hours)

2. CALCULUS - I

a) Differential Calculus

Successive Differentiation – nth derivatives of the functions: e^{ax} , $(ax + b)^n$, log(ax+ b), sin(ax + b) , cos(ax + b), e^{ax} sin(bx+ c), e^{ax} cos(bx + c) – Problems Leibnitz theorem (with proof) and its applications.

Partial differentiation –Function of two and three variables - First and higher derivatives - Homogeneous functions – derivatives- Euler's theorem and its extension (with proof) - Total derivative and differential - Differentiation of implicit functions and composite functions – Problems - Jacobians – Properties of Jacobians problems.

b) Integral Calculus

Reduction formulae for $\int Sin^n$x dx , $\int Cos^n$x dx , $\int Tan^n$x dx, $\int Cot^n$x dx$\int Sec^n$x dx, $\int Cosec^n$x dx, $\int Sin^n$x $Cos^n x$dx with definite limit. Differentiation under integral sign by Leibnitz rule. (28 lecture hours)

3.GEOMETRY

Analytical Geometry of Three Dimensions

Recapitulation of elements of three-dimensional geometry - Different forms of equations of straight line and plane. Angle between two planes - Line of intersection of two planes - Plane coaxal with given planes - Planes bisecting the angle between two planes - Angle between a line and a plane - Coplanarity of two lines - Shortest distance between two lines. Equation of the sphere in general and standard forms - equation of a sphere with given ends of a diameter. Tangent plane to a sphere, orthogonality of spheres. Standard equations of right circular cone and right circular cylinder. (14 lecture hours)

Note: All the derivations (book works) must be through vector methods with reduction to corresponding Cartesian equivalents.

Suggested distribution of lecture hours

1.Matrices: 1-hour perweek

2.Differential Calculus and Integral Calculus: 2 hours perweek

3. Analytic Geometry of three dimensions: 1-hour perweek.

Text Books/open source materials

1 Shanti Narayan and P K Mittal, Text book of Matrices, 5th ed., New Delhi, S. Chand and Co. Pvt. Ltd., 2013.

2. Shanthi Narayan and P K Mittal, Differential Calculus, Reprint. New Delhi: S. Chand and Co. Pvt. Ltd., 2014.

3. Shanthi Narayan and P K Mittal, Integral Calculus, Reprint. New Delhi: S. Chand and Co. Pvt. Ltd., 2013.

4. Shanthi Narayan and P K Mittal, Analytical Solid Geometry. New Delhi: S. Chand and Co. Pvt. Ltd., 2014.

5. Philip N. Klein, Coding the Matrix: Linear Algebra through Computer Science Applications, Newtonian Press, 2013.

6. Brian Heinold, A Practical Introduction to Python Programming, Department of Mathematics and Computer Science, Mount St. Mary's University, 2019.

Reference Books

1. B S Vatssa, Theory of Matrices, New Delhi: New Age International Publishers, 2005.

2. A R Vashista, Matrices, Krishna Prakashana Mandir, 2003.

3. G B Thomasand and R L Finney, Calculus and analytical geometry, Addison Wesley, 1995.

4. J Edwards, An elementary treatise on the differential calculus: withapplications and numerous example, Reprint. Charleston, USA: BiblioBazaar, 2010.

5. N P Bali, Differential Calculus, India: Laxmi Publications (P) Ltd.., 2010.

6. S Narayanan & T. K. Manicavachogam Pillay, Calculus.: S. Viswanathan Pvt. Ltd., Vol. I & II, 1996.

7. Frank Ayres and Elliott Mendelson, Schaum's Outline of Calculus, 5th ed. USA: Mc. Graw Hill., 2008.

8. SPMahajan & Ajay Aggarwal, Comprehensive Solid Geometry, 1st ed.: Anmol Publications, 2000.

9. H. Anton, I Birens and S. Davis, Calculus, John Wiley and Sons, Inc, 2002.

Useful web links:

http://www.cs.columbia.edu/~zeph/3203s04/lectures.html

2. http://home.scarlet.be/math/matr.htm

3. http://www.themathpage.com/

4. http://www.abstractmath.org/

5. http://ocw.mit.edu/courses/mathematics/

6. http://planetmath.org/encyclopedia/TopicsOnCalculus.html

7. http://ocw.mit.edu/OcwWeb/Mathematics/18-01Fall-2005/CourseHome/index.htm

8. http://mathworld.wolfram.com/Calculus.html

9. http://ocw.mit.edu/courses/mathematics/

10. http://www.univie.ac.at/future.media/moe/galerie.html

11. http://mathworld.wolfram.com/AnalyticGeometry.html

12. http://www.nptelvideos.in/2012/11/mathematics.html

13. https://www.my-mooc.com/en/categorie/mathematics

14. www.python.org

15. www.rosettacode.org

16. http://faculty.msmary.edu/heinold/python.html

17. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS – I

Mathematics practicals with Free and OpenSource Software (FOSS) tools for computer programs (3 hours/ weekper batch of not more than 10 students)

LIST OF PROBLEMS

1. Introduction to Python: Basic syntax, variable types, basic operators, numbers, strings, lists, tuples, functions and input/output statements.

2. Some simple programs to understand the relational, conditional and logical operators.

i) Compare two numbers (less than, greater than) using if statement ii) Sum of natural numbers using while loop iii) Finding the factors of a number using for loop. iv) To check the given number is prime or not (use if... else statement). v) Find the factorial of a number (use if...if...else). vi) Simple programs to illustrate logical operators (and, or, not) Note: Give the structure of a while...do loop to the students and illustrate with an example.

3. Python commands to reduce given matrix to echelon form and normal form with examples.

4. Python program/command to establish the consistency or otherwise and solving system of linear equations.

5. Python command to find the nth derivatives.

6. Python program to find nth derivative with and without Leibnitz rule.

7. Obtaining partial derivative of some standard functions

8. Verification of Euler's theorem, its extension and Jacobean.

9. Python program for reduction formula with or without limits.

10. Python program to findequation and plot sphere, cone, cylinder.

Note: The above list may be changed annually with the approval of the BOS in UG (Mathematics).