Proposed Syllabus for B.Sc. Mathematics paper for 6 semesters under Revised Choice Based Credit Scheme (CBCS)

Effective from the academic year 2020 - 21

Department of Mathematics
Bangalore University

Structure of B.Sc. Mathematics papers

Subjects	Paper	Instruction hrs/week	Duration of Exam(hrs)	Marks			Credits
				IA	Exam	Total	
I Semester							
Mathematics paper with practicals of 3credits	Theory Practical	4 3	3 3	30 15	70 35	100 50	2 1
II Semester							
Mathematics paper with practicals of 3credits	Theory Practical	4 3	3 3	30 15	70 35	100 50	2 1
III Semester							
Mathematics paper with practicals of 3credits	Theory Practical	4 3	3 3	30 15	70 35	100 50	2 1
IV Semester							
Mathematics paper with practicals of 3credits	Theory Practical	4 3	3 3	30 15	70 35	100 50	2 1
V Semester							
Two Mathematics papers with practicals of 3 credits each	Theory Practical	3 3	3 3	30 15	70 35	100 50	2 1
	Theory Practical	3 3	3 3	30 15	70 35	100 50	2 1
VI Semester							
Two Mathematics papers with practicals of 3 credits each	Theory Practical	3 3	3 3	30 15	70 35	100 50	2 1
	Theory Practical	3 3	3 3	30 15	70 35	100 50	2 1

Note: The structure of the syllabus of mathematics paper of B. Sc. is included in the structure of M.Sc. (Mathematics) syllabus.

MISSION AND VISION OF THE NEW SYLLABUS IN MATHEMATICS

Mission

- Improve retention of mathematical concepts in the student.
- To develop a spirit of inquiry in the student.
- To improve the perspective of students on mathematics as per modern requirement.
- To initiate students to enjoy mathematics, pose and solve meaningful problems, to use abstraction to perceive relationships and structure and to understand the basic structure of mathematics.
- To enable the teacher to demonstrate, explain and reinforce abstract mathematical ideas by using concrete objects, models, charts, graphs, pictures, posters with the help of FOSS tools on a computer.
- To make the learning process student-friendly by having a shift in focus in mathematical teaching, especially in the mathematical learning environment.
- Exploit techno-savvy nature in the student to overcome math-phobia.
- Propagate FOSS (Free and open source software) tools amongst students and teachers as per vision document of National Mission for Education.
- To set up a mathematics laboratory in every college in order to help students in the exploration of mathematical concepts through activities and experimentation.
- To orient students towards relating Mathematics to applications.

Vision

- To remedy Math phobia through authentic learning based on hands-on experience with computers.
- To foster experimental, problem-oriented and discovery learning of mathematics.
- To show that ICT can be a panacea for quality and efficient education when properly integratedand accepted.
- To prove that the activity-centered mathematics laboratory places the student in a problem solving situation and then through self exploration and discovery habituates the student into providing a solution to the problem based on his or her experience, needs, and interests.
- To provide greater scope for individual participation in the process of learning and becoming autonomous learners.
- To provide scope for greater involvement of both the mind and the hand which facilitates cognition?
- To ultimately see that the learning of mathematics becomes more alive, vibrant, relevant and meaningful; a program that paves the way to seek and understand the world around them. A possible by-product of such an exercise is that math-phobia can be gradually reduced amongst students.
- To help the student build interest and confidence in learning the subject.

Support system for Students and Teachers in understanding and learning FOSS TOOLS:

As a national level initiative towards learning FOSS tools, IIT Bombay for MHRD, Government of India is giving free training to teachers interested in learning open source soft wares like scilab, maxima, python, octave, geogebraand others.

(website: http://spoken-tutorial.org ; email: contact@spoken-tutorial.org ; info@spokentutorial.org)

REVISED SYLLABUS
FIRST SEMESTER
MATHEMATICS – I

(4 lecture hours per week+3 hours of practical /week per batch of not more than 15 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.

Eigenvalues and Eigenvectors of a square matrix of order 2 and 3, standard properties, Matrix polynomial, Cayley-Hamilton theorem (with proof). Finding A^{-1}, A^{-2} and A^2, A^3, A^4. Application Problems. **(14 lecture hours)**

2. CALCULUS – I

a) Differential Calculus

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

Partial differentiation –Function of two and three variables - First and higher order 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. Application Problems

b) Integral Calculus

Reduction formulae for $\int \sin^n x\,dx$, $\int \cos^n x\,dx$, $\int \tan^n x\,dx$, $\int \cot^n x\,dx$, $\int \sec^n x\,dx$, $\int \operatorname{cosec}^n x\,dx$, $\int \sin^m x \cos^n x\,dx$, with definite limit - problems. Differentiation under integral sign by Leibnitz rule- problems. **(28 lecture hours)**

3. GEOMETRY

Analytical Geometry of Three Dimensions

Recapitulation of elements of three dimensional geometry- 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 and problems.

(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

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:

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
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 practical with Free *and* **O***pen* **S***ource* **S***oftware* **(FOSS) tool for computer programs (3 hours/ week per batch of not more than 15 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 n^{th} derivatives.
6. Python program to find n^{th} 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).

SECOND SEMESTER
MATHEMATICS – II

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than 15 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 semi group 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 (with derivations).

Curvature of plane curves - formula for radius of curvature in Cartesian, parametric, polar and pedal forms - centre of curvature - evolutes. Singular points – Asymptotes – Envelopes. Application Problems

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. Application Problems.

(28 lecture hours)

3. DIFFERENTIAL EQUATIONS – I

Recapitulation of Solutions of ordinary differential equations of first order and first degree.

Solutions of:

(i) Linear equations, Bernoulli's equation.

(ii) Exact equations(excluding reducible to Exact)

Equations of first order and higher degree – nonlinear first order, higher degree – solvable for p - solvable for y - solvable for x - Clairaut's equation - singular solution - Geometric meaning. Orthogonal trajectories in Cartesian and polar forms. Application Problems.

(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

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: 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. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.
5. Eric Ayars, *Computational Physics with Python*, California State University, Chico.
6. Hans Petter Langtangen and Anders Logg, *Solving PDEs in Python*, Springer, 2017.

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 Advanced Calculus*, 5th ed. USA: Mc. Graw Hill., 2009.
11. M D Raisinghania, *Advanced Differential Equations*, S Chand and Co. Pvt. Ltd., 2013.
12. FAyres, *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 V Publishers Pvt. Ltd., 1981.
14. G F Simmons, *Differential equation with Applications and historical notes*, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.
15. Hans Petter Langtangen, *A primer on Scientific programming with Python*, Springer, 2016.

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
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 –II

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tool for computer programs (3 hours/ week per batch of not more than 15 students)

LIST OF PROGRAMMES

1. i). Verifying whether given operator is binary or not
   ii). To find identity and inverse element of a group
2. Plotting of standard Cartesian curves(Part-1)
3. Plotting of standard Cartesian curves (Part-2)
4. Plotting of standard polar curves
5. Plotting of standard parametric curves
6. Surface area and Volume of curves
7. Solution of differential equation and plotting(Part-1)
8. Solution of differential equation and plotting(Part-2)
9. Solution of differential equation and plotting(Part-3)
10. Solution of differential equation and plotting the solution(Part-4)

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

THIRD SEMESTER
MATHEMATICS-III

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than 15 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 – Equivalence Class and partition of a set, coset decomposition of a group, Cyclic groups- properties- 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. Application Problems.

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'stest ,- Absolute and conditional convergence-D' Alembert test for absolute convergence - Alternating series - Leibnitz test.

Summation of binomial, exponential and logarithmic series. Application Problems.

(28 lecture hours)

3. 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. Application Problems. **(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. Mathematical Methods - I (1 hour / week.)

Text Books

1. Herstein I N, *Topics in Algebra*, 4th ed. New Delhi, India: Vikas Pub. 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. John Kerl, Concrete abstract algebra in Python, Notes.
5. Titus Adrian Beu, Introduction to Numerical programming, CRC Press, Taylor and Fransis.
6. Eric Ayars, *Computational Physics with Python*, California State University, Chico.

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

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/
12. http://www.nptelvideos.in/2012/11/mathematics.html
13. https://www.my-mooc.com/en/categorie/mathematics
14. www.python.org
15. http://doc.sagemath.org/html/en/thematic_tutorials/group_theory.html
16. http://doc.sagemath.org/html/en/reference/groups/sage/groups/abelian_gps/abelian_group_morphism.html
17. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS –III

Mathematics practicals with Free *and* O*pen* S*ource* S*oftware* (FOSS) tool for computer programs(3 hours/ week per batch of not more than 15 students)

LIST OF PROBLEMS

1. Examples for finding right and left coset and the index of a group.
2. Examples to verify Lagrange's theorem.
3. Illustration of convergent, divergent and oscillatory sequence.
4. Illustration of convergent, divergent and oscillatory series.
5. Using Cauchy's criterion to determine the convergence of a sequence.
6. To find the sum of the series.
7. Finding the Laplace transform.
8. Finding the inverse Laplace transform.
9. Laplace transform method of solving first order ordinary differential equations with constant coefficients.
10. Laplace transform method of solving second order ordinary differential equations with constant coefficients

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FOURTH SEMESTER
MATHEMATICS – IV

(4 lecture hours per week+ 3 hours of practicals /week per batch of not more than 15 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 Kernel-Fundamental theorem of homomorphism- properties related to isomorphism-Permutation group-Cayley's theorem. **(10 lecture hours)**

2. ANALYSIS -II

Fourier Series

Trigonometric Fourier series of functions with period 2π and period 2L - Half range Cosine and sine series. Application problems. **(10 lecture hours)**

3. CALCULUS - III

Differential Calculus

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 - Theorem : 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

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**.** **(22 lecture hours)**

4. 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, Analysis – II, Calculus - III: 3 hours / week.
2. Differential Equations II: 1 hour / week.

Text Books

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: SChand and Co. Pvt. Ltd., 2014.
5. M D Raisinghania, *Ordinary and Partial Differential Equations*,S Chand and Co. Pvt. Ltd., 2014.
6. John Kerl, Concrete abstract algebra in Python, Notes.

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 Thomas and 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 & 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 Advanced Calculus*, 5th ed. USA: Mc. Graw Hill., 2009.
11. M D Raisinghania, *Advanced Differential Equations*,S Chand and Co. Pvt. Ltd., 2013.
12. FAyres, *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 V Publishers Private Ltd., 1981.
14. G F Simmons, *Differential equation with Applications and historical notes*, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.
15. Shepley L. Ross, Differential Equations, 3rd Ed., John Wiley and Sons,1984.

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
16. http://www.nptelvideos.in/2012/11/mathematics.html
17. https://www.my-mooc.com/en/categorie/mathematics
18. www.python.org
19. http://www.auraauro.com/uncategorized/demonstration-of-fourier-series-using-python-code/
20. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS –IV

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tool for computer programs(3 hours/ week per batch of not more than 15 students)

LIST OF PROBLEMS

1. Verification of normality of a given subgroup
2. Illustrating homomorphism and isomorphism of groups
3. To find full range trigonometric Fourier series of some simple functions with period 2π and 2L
4. Finding the half-range sine and cosine series of simple functions and plotting them.
5. Program to illustrate continuity of a function
6. Program to illustrate differentiability of a function
7. Program to verify Rolle's theorem
8. Program to verify and Lagrange's theorem
9. Evaluation of limits by L'Hospital's rule
10. Solution of second and higher order ordinary differential equations with constant coefficients
11. Solution of second order ordinary differential equations with variable coefficients
    i) Method of variation of parameters
    ii) When the equation is exact

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

FIFTH SEMESTER
MATHEMATICS - V

(3 lecture hours per week+ 3 hours of practicals /week per batch of not more than 15 students)

(42 HOURS)

THEORY

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. 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. Application 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, Weddle's rule - problems. Application Problems.

(14 lecture hours)

Suggested distribution of lecture hours.

1. Algebra IV: 1 hour /week.
2. Calculus of Variation: 1 hours/week
3. Numerical Methods I : 1 hours/week

Text Books

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: SChand 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. JaanKiusalaas, *Numerical methods in engineering with python 3*, Cambridge University press, 2013.
6. Philip N. Klein, *Coding the Matrix: Linear Algebra through Computer Science Applications*, Newtonian Press, 2013.

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 Thomas and R L Finney, *Calculus and analytical geometry, Addison Wesley, 1995.*

6. B Spain, *Vector Analysis*, ELBS, 1994.
7. D E Bournes and, P C Kendall, *Vector Analysis*, ELBS, 1996.
8. S S Sastry, *Introductory methods of Numerical Analysis*, Prentice Hall of India, 2012.
9. Brian Heinold, *A Practical Introduction to Python Programming*, Department of Mathematics and Computer Science, Mount St. Mary's University, 2019.
10. Titus Adrian Beu, Introdution to numerical programming, CRC press, Taylor and Fransis.
11. J. C. Bautista, *Mathematics and Python programmings*, lulu.com, 2014.

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
12. http://www.nptelvideos.in/2012/11/mathematics.html
13. https://www.my-mooc.com/en/categorie/mathematics
14. www.python.org
15. https://docs.sympy.org/latest/modules/series/fourier.html
16. https://docs.sympy.org/latest/modules/series/fourier.html

PRACTICALS –V

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs (3 hours/ week per batch of not more than 15 students)

LIST OF PROBLEMS

2. Examples on different types of rings.
3. Examples on integral domains and fields.
4. Examples on subrings, ideals and subrings which are not ideals.
5. Homomorphism and isomorphism of rings- illustrative examples.
6. Example on Euler's equation in full form.
7. Example on particular forms of Euler's equation.
8. Examples on minimum surface of revolution and Brachistochrone problem.
9. Examples on Isoperimetric problems.
10. Programs on Interpolations with equal intervals.
11. Programs on Interpolations with unequal intervals.

12. Programs to evaluate integrals using Simpson's $\frac{1}{3}^{rd}$ and $\frac{3}{8}^{th}$ rule.

13. Programs to evaluate integrals using Weddle's rule.

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

FIFTH SEMESTER

ELECTIVE - I
MATHEMATICS – VI(A)

(3 lecture hours per week+ 3 hours of practicals/week per batch of not more than 15 students)

(42 HOURS)

THEORY

1. CALCULUS - IV

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. Orthogonal curvilinear co-ordinates (only conversions)

(14 lecture hours)

2. CALCULUS – V

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 .

(18 lecture 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. Differential Calculus Of Scalar And Vector Fields: 1 hour /week.
2. Calculus VI (Line and Multiple Integrals and Integral theorems): 2 hours/week

Text Books

1. R Weinstock, *Calculus of Variation*, Dover Pub. Ltd., 1970.
2. M. D. Raisinghania, *Vector Calculus*, S Chand Co. Pvt. Ltd., 2013.
3. Philip N. Klein, *Coding the Matrix: Linear Algebra through Computer Science Applications*, Newtonian Press, 2013.
4. Hans Petter Langtangen, *A primer on Scientific programming with Python*, Springer, 2009.

Reference Books:

1. F B Hildebrand, *Methods in Applied Mathematics*,
2. B Spain,*Vector Analysis*, ELBS, 1994.
3. D E Bournesand and 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/
6. http://www.nptelvideos.in/2012/11/mathematics.html
7. https://www.my-mooc.com/en/categorie/mathematics
8. www.python.org
9. http://kitchingroup.cheme.cmu.edu/blog/2013/02/02/Integrating-functions-in-python/
10. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS – VI(A)

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs (3 hours/ week per batch of not more than 15 students)

LIST OF PROBLEMS

1. To demonstrate the physical interpretation of gradient, divergence curl and laplacian.
2. Using cyclic notations to derive some more vector identities
3. Evaluation of the line integral with constant limits.
4. Evaluation of the double integral with constant limits.
5. Evaluation of the triple integral with constant limits.
6. Evaluation of the line integral with variable limits.
7. Evaluation of the double integral with variable limits.
8. Evaluation of the triple integral with variable limits.
9. Green's theorem.
10. Gauss divergence theorem.
11. Stokes' theorem

FIFTH SEMESTER

ELECTIVE - II

MATHEMATICS – VI(B)

(3 lecture hours per week+ 3 hours of practicals/week per batch of not more than 15 students)

(42 HOURS)

THEORY

1. Number Theory

Introduction to number theory - Divisibility– Prime and composite numbers - Euclidean algorithm – fundamental theorem of Arithmetic – The greatest common divisor and least common multiple – congruences – Linear congruences –Simultaneous congruences – Wilson's, Euler's and Fermat's Theorems and their applications.

(14 lecture hours)

2. Graph Theory

Konigsberg bridge problem, graph, subgraph, adjacency, incidency, degree of a vertex, finite and infinite graphs, order and size of a graph, multiple edges, loops, simple graph,multigraph,general graph,underlying graph, r - regular graph, complete graph,walk,trail, path, closed walk,circuit cycle, directed graph, connected and disconnected graphs, component of a graph,trees, pendant vertices in a tree, distance and centers in a tree, rooted and binary trees, spanning Trees - with fundamental theorems and examples. **(14 lecture hours)**

3. Fourier Transforms

The Fourier integral, Different forms of Fourier integral, Problems complex Fourier Transform, Self reciprocals, slit functions Basic properties of Fourier transforms, Linear, Change of scale, Shifting, Modulation. Derivation of a Function Extension.

Fourier sine and cosine Transform and Inverses properties, self reciprocal. The derivatives – theorems and problems.

(14 lecture hours)

Suggested distribution of lecture hours:

1. Number Theory: 1 hour / week.
2. Graph Theory: 1 hour / week
3. Fourier Transforms: 1 hour / week

Text Books

1. David M. Burton, *Elementary Number Theory*, 6th ed., Tata McGraw-Hill Edition, Indian reprint, 2007.
2. Frank Harary, *Graph Theory*, Addison-Wesley Publishing Company, 1969.
3. Douglas B. West, *Introduction to Graph Theory*, 2nd edition, Pearson, 2015.
4. F. B. Hildebrand, *Method of Applied Mathematics*, Dover Publications.
5. Mohammed Zuhair Al-Taie and Seifedine Kadry, *Python for Graph and Network Analysis*, Springer, 2017.

Reference Books

1. Neville Robinns, *Beginning Number Theory*, 2nd ed., Narosa Publishing House Pvt. Ltd., Delhi, 2007.
2. Narsingh Deo, *Graph Theory*, Prentice-Hall of India Pvt. Ltd., 2000
3. B Spain, *Vector Analysis*, ELBS, 1994.
4. Lokenath Debnath and D Bhatta, Integral *Transforms and their Applications*, Taylor and Fransis, 2002.

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/
6. http://www.nptelvideos.in/2012/11/mathematics.html
7. https://www.my-mooc.com/en/categorie/mathematics
8. www.python.org
9. http://kitchingroup.cheme.cmu.edu/blog/2013/02/02/Integrating-functions-in-python/
10. https://www.geeksforgeeks.org/
11. https://www.python-course.eu/graphs_python.php
12. https://medium.com/apprentice-journal/the-graph-theory-an-introduction-in-python-5906d5be0e4b
13. https://pypi.org/project/graph-theory/

PRACTICALS –VI (B)

Mathematics practical with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs(3 hours/ week per batch of not more than 15 students)

LIST OF PROBLEMS

1. Check whether given number is prime or not.
2. Program to find the GCD and LCM
3. Program to compute elements of the sequences
4. Create a graph using adjacency matrix and then show all the edges that exist in the graph.
5. Find the adjacency matrix from the given digraph.
6. Find the degree of all vertices in a graph.
7. Program to find the connected components of a undirected graph.
8. Check whether given degrees of vertices represent a graph or tree.
9. To return a list of all paths (without cycles).
10. Find if there is a path between two vertices in a graph.
11. Detect cycle in a directed graph.
12. To find the Fourier integrals for the given function
13. To find the Fourier sine and cosine Transform

SIXTH SEMESTER

MATHEMATICS – VII

(3 lecture hours per week + 3 hours of practicals/week per batch of not more than 15 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 –Eigen values and eigen vectors of linear transformation - Application Problems

(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, Cartesian, cylindrical co-ordinate systems-Theorem: The Spherical and cylindrical coordinate systems are orthogonal curvilinear coordinate system (excluding problems on conversion 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- Application Problems.

(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

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. Hans Petter Langtangen, *A primer on Scientific programming with Python*, Springer, 2009.

Reference Books

1. G Strang, Linear Algebra and its Applications, Thomson, 2007
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
7. http://www.nptelvideos.in/2012/11/mathematics.html
8. https://www.my-mooc.com/en/categorie/mathematics
9. www.python.org
10. https://docs.sympy.org/0.7.6/modules/mpmath/calculus/differentiation.html
11. https://apmonitor.com/pdc/index.php/Main/SolveDifferentialEquations
12. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS –VII

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs(3 hours/ week per batch of not more than 15 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. Solutions to the problems on total and simultaneous differential equations.
5. Solutions to the problems on different types of Partial differential equations.
6. Solving second order linear partial differential equations in two variables with constant coefficient.
7. Solving some more second order linear partial differential equations in two variables with constant coefficient.
8. Solution of one dimensional heat equation using Fourier series with Dirichlet condition.
9. Solution of one dimensional heat equation using Fourier series with Neumann condition.
10. Solution of one dimensional wave equation using Fourier series with Dirichlet condition.
11. Solution of one dimensional wave equation using Fourier series with Neumann condition.

SIXTH SEMESTER
ELECTIVE - I

MATHEMATICS – VIII(A)

(3 lecture hours per week+ 3 hours of practicals /week per batch of not more than 15 students)

(42 HOURS)

THEORY

1. ANALYSIS - III

Complex Analysis

Complex numbers-Cartesian and polar form-geometrical representation-complex-Plane-Euler's formula- $e^{i\theta} = \cos\theta + i\sin\theta$. 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 generalized 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 4^{th} 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

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. B. Bradie, *A Friendly Introduction to Numerical Analysis*, Pearson Education, India, 2007.
4. Brian Heinold, *A Practical Introduction to Python Programming*, Department of Mathematics and Computer Science, Mount St. Mary's University, 2019.
5. Titus Adrian Beu, *Introduction to Numerical programming*, CRC press, Taylor and Francis.

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
5. http://www.nptelvideos.in/2012/11/mathematics.html
6. https://www.my-mooc.com/en/categorie/mathematics

7. www.python.org
8. https://docs.sympy.org/latest/modules/series/fourier.html
9. https://kitchingroup.cheme.cmu.edu/pycse/pycse.html

PRACTICALS –VIII (A)

Mathematics practicals with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs(3 hours/ week per batch of not more than 15 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-Falsi and 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 4^{th} order.

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

MATHEMATICS – VIII (B)
ELECTIVE - II

(3 lecture hours per week+ 3 hours of practical /week per batch of not more than 15 students)

(42 HOURS)

THEORY

1. Linear Programming

Linear inequalities and their graphs. Statement of the linear programming problem in standard form-classification of solutions-solution of linear programming problems by graphical method.

Illustrative examples on the solution of linear programming problems in two and three variables by the simplex method. (Maximization and minimization)

Transportation problem:- North West rule, Vogel's method, Row minima method, Column minima method. **(14 lecture hours)**

2. Particle Dynamics

Newton's laws of motion – Conservative forces and potential energy - Definitions of work, kinetic energy and power.

Motion of a particle in a uniform force field – simple harmonic motion – Two dimensional motion of projectiles, Inclined plane.

(14 lecture hours)

3. Improper Integrals

Gamma and Beta functions-results following definitions-Relations connecting the two functions-duplication formula-Applications to evaluation of integrals.

(14 lecture hours)

Text book:

1. Robert J. Vanderbei, *Linear Programming*, Springer, 1996.
2. A. R. Vasishtha and D. C. Agarwal, *Dynamics of a Particle*, Krishna Prakashana Media Pvt. Ltd., 2003.
3. Murrey R. Spiegel, *Theory and Problems of Advanced Calculas*, Schaum's Outline series.
4. Hans Petter Langtangen, *A primer on scientific programming with Python*, Springer, 2016.
5. Surg Kruk, *Practical Python A1 projects: Mathematical models of optimization problems*, A press, 2018.
6. J. C. Bautista, *Mathematics and Python programming*, lulu.com, 2014.

Reference Book:

1. Mokhtar S. Bazaraa, John J. Jarvis and Hanif D. Sherali, *Linear programming and Network flows*, 2nd Ed., John Wiley and Sons, India, 2004.
2. Hamdy A. Taha, *Operations Research*: *An introduction*, 8th Ed., Tata McGraw Hill, Singapore, 2004.
3. A. P. Roberts, *Statics and Dynamics with Background in Mathematics*, Cambridge University press, 2003.
4. Lokenath Debnath and D. Bhatta, *Integral Transforms and their Applications*, Taylor and Fransis Group, 2002.
5. Dimitris Bertsimas and J. N. Tsitsiklis, *Introduction to linear Optimization*, Athena Scientific, 1997.

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
5. http://www.nptelvideos.in/2012/11/mathematics.html
6. https://www.my-mooc.com/en/categorie/mathematics.

7. www.python.org
8. http://coderview.stackexchange.com//
9. http://scibook.readthedocs.io/en/latest/intro.html
10. http://gist.github.com/mick001/f4864f36551e89ab7bc4.
11. http://www.analyticsvidhya.com/blog/2017/02/lintroductory-guide-on-linear-programming-explained-in-simple-english/
12. http://kitchingroup.cheme.cmu.edu/blog/2013/02/02/Integrating-functions-in-python/

PRACTICALS –VIII (B)

Mathematics practical with F*ree and* O*pen* S*ource* S*oftware* (FOSS) tools for computer programs(3 hours/ week per batch of not more than 10 students)

LIST OF PROBLEMS

1. Graphs with linear inequalities.
2. Solution of linear programming problem by graphical method.
3. Implementation of the simplex method.
4. Implementation of solution procedure for the transportation problem.
5. Application of Newton's law of motion-problems on conservative forces and potential energy.
6. Problems on work done, kinetic energy and power.
7. Problems on simple harmonic motion.
8. Problems on two-dimensional motion of projectiles.
9. Problems on gamma and beta functions.
10. Problems on duplication formula.
11. Problems on evaluation of improper integrals in applications.

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

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Structure of B.Sc. Mathematics papers

Semester	Title of the paper		Teaching hrs/week	Duration of Exam (hrs)	IA MARKS	EXAM MARKS	TOTAL MARKS	Semester Total
1	B.Sc. I	Theory	4 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
2	B.Sc. II	Theory	4hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
3	B.Sc. III	Theory	4 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
4	B.Sc. IV	Theory	4 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
5	B.Sc. V	Theory	3 hrs	3 hrs	30	70	100	150
		Practical	3hrs	3 hrs	15	35	50	
	B.Sc. VI(A) or VI(B)	Theory	3 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
6	B.Sc. VII	Theory	3 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	
	B.Sc. VIII(A) or VIII(B)	Theory	3 hrs	3 hrs	30	70	100	150
		Practical	3 hrs	3 hrs	15	35	50	

Note: In the Practical component out of 35 marks: 25 for practical exam + 5 for vivo +5 for lab record.

PATTERN OF THE QUESTION PAPER

FROM 1st TO 4th SEMESTER

Time: 3 Hours **Max.Marks:70**

I	Answer any FIVE of the following (8 questions are given)	$5 \times 2 = 10$ Marks
II	Answer any THREE of the following (05 questions are given)	$3 \times 5 = 15$ Marks
III	Answer any THREE of the following (05 questions are given)	$3 \times 5 = 15$ Marks
IV	Answer any TWO of the following (03 questions are given)	2x 5 = 10 Marks
V	Answer any TWO of the following (03 questions are given)	2x 5 = 10 Marks
VI	Answer any TWO of the following (03 questions are given) Questions to be taken only from Application part	2x 5 = 10 Marks

PATTERN OF THE QUESTION PAPER

FOR 5th and 6th SEMESTER

I	Answer any FIVE of the following (8 questions are given)	$5 \times 2 = 10$ Marks
II	Answer any THREE of the following (05 questions are given)	$3 \times 5 = 15$ Marks
III	Answer any THREE of the following (05 questions are given)	$3 \times 5 = 15$ Marks
IV	Answer any THREE of the following (05 questions are given)	3x 5 = 15 Marks
V	Answer any THREE of the following (05 questions are given) Questions to be taken only from Application part	3x 5 = 15 Marks