St Joseph's College (Autonomous)

Bengaluru-560027

Department of Mathematics

Syllabus for Undergraduate Program

Re-accredited with **'A++' Grade and 3.794 CGPA** by NAAC

Recognized by UGC as College of Excellence

For Batch 2018-2021

SUMMARY OF CREDITS

Department of Mathematics (UG)
(2018-2021)

Semester	Theory/ Practical	Course Code	Cousre Title	Number of hours/week	Number of credits	Max marks for end sem	Duration of end sem
1	Theory	MT118	Mathematics I	4	4	70	2.5 hours
	Practical	MT1P1	Practicals I	3	2	35	3 hours
2	Theory	MT218	Mathematics II	4	4	70	2.5 hours
	Practical	MT2P1	Practicals II	3	2	35	3 hours
3	Theory	MT318	Mathematics III	4	4	70	2.5 hours
	Practical	MT3P1	Practicals III	3	2	35	3 hours
4	Theory	MT218	Mathematics IV	2	2	35	2.5 hours
	Practical	MT4P1	Practicals IV	3	2	35	3 hours
5	Theory	MT5118	Mathematics V	3	3	70	2.5 hours
	Practical	MT5P1	Practicals V	3	2	35	3 hours
	Theory	MT5218	Mathematics VI	3	3	70	2.5 hours
	Practical	MT5P2	Practicals VI	3	2	35	3 hours
6	Theory	MT6118	Mathematics VII	3	3	70	2.5 hours
	Practical	MT6P1	Practicals VII	3	2	35	3 hours
	Theory	MT6218	Mathematics VIII	3	3	70	2.5 hours
	Practical	MT6P2	Practicals VIII	3	2	35	3 hours

Total Number of Credits = 42

FIRST SEMESTER

(4 lecture hours per week + 3 practical hours per week)

THEORY - MT118

(60 hours)

1. **MATRICES**

   Rank of a matrix. Invariance of rank under elementary transformations. Reduction to normal form, Solutions of linear homogeneous and non-homogeneous equations with number of equations and unknowns up to four. Matrices in diagonal form. Reduction to diagonal form up to matrices of order 3. Rank of matrix. Solutions of a system of linear equations using matrices. Illustrative examples of above concepts from Geometry, Physics, Chemistry, Combinatorics and Statistics. (13 hours)

   Self-study: Types of matrices. Computation of matrix inverses using elementary row operations. (2 hours)

2. **DIFFERENTIAL CALCULUS**

   Limit and Continuity (ϵ and δ definition). Types of discontinuities. Differentiability of functions. Successive differentiation. Leibnitz's theorem. Partial differentiation. Euler's theorem on homogeneous functions. (18 hours)

   Self-study: Recapitulation of differentiation of standard function and algebra of differentiation. (2 hours)

3. **INTEGRAL CALCULUS**

   Reduction formulae for integrals $\int \sin^n(x)$, $\int \cos^n(x)$, $\int \tan^n(x)$, $\int \cot^n(x)$, $\int \sec^n(x)$, $\int \csc^n(x)$ and $\int \sin^n(x) \cdot \cos^m(x)$ with definite limits. Differentiation under integral sign by Leibnitz rule. Jacobian. (8 hours)

   Self-study: Recapitulation of Integration by Partial fractions. Integration of rational and irrational functions. Properties of definite integrals. (2 hours)

4. **ANALYTICAL GEOMETRY**

   Angle between two planes. Line of intersection of two planes. Plane coaxial 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. orthogonallity of spheres. Standard equations of right circular cone and right circular cylinder. (13 hours)

   Self-study: Recapitulation of elements of three dimensional geometry. Different forms of equations of straight line and plane. (2 hours)

Suggested distribution of lecture hours:

1. Matrices: 1 hour per week.
2. Differential and Integral Calculus: 2 hours per week
3. Analytical Geometry: 1 hour per week.

Recommended Books

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

3. A.I. Kostrikin, Introduction to Algebra, Springer Verlag, 1984.
4. S. H. Friedberg, A. L. Insel and L. E. Spence, Linear Algebra, Prentice Hall of India Pvt. Ltd., 2004.
5. R. Bronson, Theory and Problems of Matrix Operations, Tata McGraw Hill, 1989.
6. S.P. Mahajan and A. Aggarwal, Comprehensive Solid Geometry, 1st ed.: Anmol Publications, 2000.

I Semester Blueprint

	Chapter 1	Chapter (2+3)	Chapter 4	Answering	Total
2 Marks	2	2+1	3	5/8	10
6 Marks	3/4	5/7 (5+2)	2/3	10/13	60
					70

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS I - MT1P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. Introduction to Python.
2. Computations with matrices.
3. Row reduced echelon form and normal form.
4. Establishing consistency or otherwise and solving system of linear equations.
5. Derivatives and nth derivatives.
6. n^{th} derivative without Leibnitz rule.
7. n^{th} derivative with Leibnitz rule.
8. Obtaining partial derivative of some standard functions.
9. Verification of Euler's theorem, its extension and Jacobian.
10. Plotting functions.
11. Plotting various 2D and 3D curves.

SECOND SEMESTER

(4 lecture hours per week + 3 practical hours per week)

THEORY - MT218

(30 hours)

1. **ALGEBRA**

   Definition and examples of groups. Examples of abelian and non-abelian groups. The group $\mathbb{Z}_n$ of integers under addition modulo n and the group $U(n)$ of units under multiplication modulo n. Complex roots of unity. Circle group. The general linear group $GL_n(R)$. Groups of symmetries of (i) an equilateral triangle and (ii) a square. The permutation group Sym(n). Subgroups. The concept of a subgroup generated by an element. (8 hours)

   Self-study: Example of group of symmetries of isosceles triangle and rectangle. Examples of subgroup including the centre of a group. (2 hours)

2. **LOGIC**

   Implications. Biconditional propositions. Converse. Contra positive and inverse propositions. Precedence of logical operators. Propositional equivalence: Logical equivalences. Predicates and quantifiers: Introduction, Quantifiers, Binding variables and Negations. (5 hours)

   Self-study: Propositions. Truth tables. Negation, conjunction and disjunction. (2 hours)

3. **DIFFERENTIAL CALCULUS**

   Tangents and Normals. Curvature. Asymptotes. Singular points. Envelopes. Convexity and Concavity. Parametric representation of curves and tracing of parametric curves. Polar coordinates and tracing of curves in polar coordinates. (16 hours)

   Self-study: Tracing of curves in Cartesian co-ordinates. (2 hours)

4. **INTEGRAL CALCULUS**

   Areas and lengths of curves in the plane. Volumes and surfaces of solids of revolution. Basics of Double and Triple integrals. (10 hours)

5. **DIFFERENTIAL EQUATIONS**

   First order exact differential equation. Integrating factors. Rules to find an integrating factor (Linear and Bernoulli's equation). First order higher degree equations solvable for x, y, p. Methods for solving higher-order differential equations. Solving a second order differential equation by reducing its order when dependent variable is missing and when independent variable is missing. Orthogonal trajectories in Cartesian and polar forms. (13 hours)

   Self-study: Forming DE and solving DE using variable separable. (2 hours)

Suggested distribution of lecture hours:

1. Algebra and Logic: 1 hour per week.
2. Differential and Integral Calculus: 2 hours per week
3. Differential Equations: 1 hour per week.

Recommended Books

1. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
2. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.

3. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley, 1975.
4. J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa Publishing, 2011.
5. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.
6. G F Simmons, Differential equation with Applications and historical notes, 2nd ed., McGraw-Hill Publishing Company, 1991.
7. J. B. Fraleigh, A first course in Abstract Algebra, 7th Edition Pearson Education India, 2002.
8. R.P. Grimaldi, Discrete Mathematics and Combinatorial Mathematics, Pearson Education, 1998.

II Semester Blueprint

	Chapter (1+2)	Chapter (3+4)	Chapter 5	Answering	Total
2 Marks	3+1	2+1	1	5/8	10
6 Marks	2/3	5/7 (3+2)	3/4	10/14	60
					70

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS II - MT2P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. Logic gates.
2. Tracing standard Cartesian curves.
3. Tracing standard Polar and Parametric curves.
4. Surface area of revolution - I.
5. Surface area of revolution - II.
6. Volume of revolution - I.
7. Volume of revolution - II.
8. Group Theory - I
9. Group Theory - II.
10. Solution of Differential equation and plotting the solution - I.
11. Solution of Differential equation and plotting the solution - II.

THIRD SEMESTER

(4 lecture hours per week + 3 practical hours per week)

THEORY - MT318

(60 hours)

1. **ALGEBRA**

   Part 1: 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 groups. Properties. Index of a group. Lagrange's theorem. Normal subgroups. Examples and problems. Quotient group. (13 hours)

   Self Study: Consequences of Lagrange's theorem. (2 hours)

   Part 2: 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. (8 hours)

2. **CALCULUS**

   Part 1: Open and closed intervals. Limit points and interior points. Properties of continuous of function on a closed interval (boundedness, attainment of bounds, taking every value between bounds). Differentiability implies Continuity, converse is not true. Rolle's Theorem. Lagrange's and Cauchy's First Mean Value Theorem (Lagrange's form). Maclaurin's expansion. (11 hours)

   Part 2: Continuity and differentiability of a function of two and three variables. Maxima and Minima of functions Of two variables. Method of Lagrange multipliers. (7 hours)

   Self Study: Evaluation of limits by L'Hospital's rule. Taylor's Theorem and expansion of functions of two variables. (4 hours)

3. **DIFFERENTIAL EQUATIONS –II**

   Second and higher order ordinary linear differential equations with constant Coefficients. Complementary function. Particular integrals (standard types). 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. (13 hours)

   Self Study: Cauchy-Euler differential equation. (2 hours)

Suggested distribution of lecture hours:

1. Algebra + Calculus (Part 2): 2 hours per week.
2. Calculus (Part 1): 1 hour per week.
3. Differential Equation II: 1 hour per week

Recommended Books

1. J. A. Gallian, Contemporary Abstract Algebra, 4th Edition, Narosa Publishing, 2011
2. J. B. Fraleigh, A first course in Abstract Algebra, 7th Edition Pearson Education India, 2002

3. I. N. Herstein, Topics in Algebra, 2nd Edition, Wiley, 1975
4. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Edition, Wiley and Sons, 2010.
5. S. C. Malik and S Arora, Mathematical Analysis, New Age international publishers.
6. H. Anton, I. Birens and S. Davis, Calculus, John Wiley and Sons, Inc., 2002.
7. G.B. Thomas and R.L. Finney, Calculus, Pearson Education, 2007.
8. V. Sundarapandian, Ordinary and Partial Differential Equations, Tata McGraw-Hill.
9. Shepley L. Ross, Differntial Equations, 3rd Edition, Wiley.
10. M. D. Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.
11. G. F. Simmons, Differential equation with Applications and historical notes, 2nd Edition, McGraw-Hill Publishing Company, 1991.

III Semester Blueprint

	Chapter 1	Chapter 2	Chapter 3	Answering	Total
2 Marks	2	(1+3)=4	2	5/8	10
6 Marks	2/3	5/7 (3+4)	3/4	10/14	60
					70

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS III - MT3P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. (a) Examples for finding left and right coset and finding the index of a group.
   (b) Verification of Normality of a given subgroup.
2. Illustrating homomorphism and isomorphism of groups.
3. (a) Continuity of a function.
   (b) Differentiability of a function and unequal left hand and right hand limits for discontinuous functions.
4. Verify Rolle's Theorem and Lagrange's mean value theorem.
5. Taylor's theorem for a given function.
6. Finding maxima/minima of functions of two variables.
7. Evaluation of limits by L'Hospital's rule.
8. Finding complementary function and particular integral of constant coefficient second and higher order ordinary differential equations.
9. Finding complementary function and particular integral of variable coefficient second and higher order ordinary differential equations - I
10. Finding complementary function and particular integral of variable coefficient second and higher order ordinary differential equations - II

Note. The 11th lab will be for conducting mock practical examination.

FOURTH SEMESTER

(2 lecture hours per week + 3 practical hours per week)

THEORY - MT418

(30 hours)

1. **ANALYSIS**

   a) **Sequences of Real Numbers:**

   Definition of sequence. Bounded sequence. Limit of a sequence. 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 Convergent Series. Properties of Positive terms of Series. Geometric series tests of series for convergence. p-test for series of convergence. Comparison test of series of convergence. 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 series. (28 hours)

   Self Study: Summation of exponential and logarithmic series. (2 hours)

Recommended Books

1. R. G. Bartle and D. R. Sherbert, Introduction to Real Analysis, 3rd Edition, Wiley and Sons, 2010.
2. S. C. Malik and S Arora, Mathematical Analysis, New Age international publishers.

IV Semester Blueprint

	Chapter (1a+1b)	Total
5 Marks	7/9(3+6)	35

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS IV - MT4P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. (a) Illustration of convergent, divergent and oscillatory sequences.
   (b) Illustration of convergent, divergent and oscillatory series.
2. (a) Python programs to find the sum of the series and its radius of convergence.
   (b) Testing the convergence of binomial, exponential and logarithmic series and finding the sum.
3. (a) Interpolations with equal intervals.
   (b) Interpolations with unequal intervals.
4. (a) Evaluate integrals using Simpson's 1/3rd rule.
   (b) Evaluate integrals using Simpson's 3/8th rule
5. Solving algebraic equation (Bisection method and Regula-Falsi method).
6. Solving algebraic equation (Newton-Raphson method and Secant method).
7. Solving system of equations (Jacobi and Gauss-Seidel methods).

8. Solving for largest eigenvalue by Power method.
9. Solving ordinary differential equation by modified Euler's method.
10. Solving ordinary differential equation by Runge-Kutta method of 4^{th} order.

Note. The 11th lab will be for conducting a mock practical examination.

OPEN ELECTIVE
QUANTITATIVE METHODS FOR COMPETITIVE EXAMINATIONS

Objective:

In this open course we teach the tactics of solving mathematics for quantitative examinations. Here the student will develop skills to solve various types of analytical problems which appear in various competitive examinations. The student will revise his school mathematics with a better understanding of the concepts and with a different approach to the problems posed. Here we will be training students to confidently face the quantitative exams.

In this course we have four major Topics of Mathematics - Arithmetic, Algebra, Geometry and Data Analysis

SYLLABUS:

1. **Play with numbers (ARITHMETIC):** (7 hours)
   Decimals. Exponents and Roots. Fractions. Integers. Percent. Ratio. Real Numbers.
2. **Earth Measures (GEOMETRY):** (8 hours)
   Circles. Lines and Angles. Polygons. Quadrilaterals. Three-Dimensional Figures. Triangles.
3. **I connect arithmetic and geometry (ALGEBRA):** (8 hours)
   I am the unknown between the known. Applications. Coordinate Geometry. Functions. Graphs of Functions. Operations with Algebraic Expressions. Rules of Exponents. Solving Linear Equations. Solving Linear Inequalities. Solving Quadratic Equations
4. **DATA ANALYSIS : I have huge information can you interpret it ?** (7 hours)
   Counting Methods. Data Interpretation Examples. Distributions of Data. Random Variables and Probability Distributions. Graphical Methods for Describing Data. Numerical Methods for Describing Data. Probability.

CBCS Blueprint

	Arithmetic	Geometry	Algebra	Data Analysis
Questions	3	3	2	2

Recommended Books:

1. BARRON'S NEW GRE, 19TH EDITION.
2. HIGHER ALGEBRA BY H S HALL AND S R KNIGHT
3. GEOMETRY BY S L LONEY

FIFTH SEMESTER

MATHEMATICS V

(3 lecture hours per week + 3 practical hours per week)

THEORY - MT5118

(45 hours)

1. **ALGEBRA**
   a) **Introduction**

   Motivation and definition of Rings. Examples of Rings. Properties of Rings. Subrings.

   b) **Integral Domains**

   Definition and examples. Fields. Characteristic of a Ring. (12 hours)

   Self Study: Characteristic of an Integral Domain. Subfields. (3 hours)

   c) **Ideals and Factor Rings**

   Ideals. Factor Rings (also called quotient rings). Prime Ideals and Maximal ideals.

   d) **Ring Homomorphisms**

   Definition and examples. Properties of Ring Homomorphisms. The field of quotients. (14 hours)

   Self Study: Ideals are kernels. (1 hour)

2. **ANALYSIS**
   a) **Fourier Series**

   Trigonometric Fourier series of functions with period 2π and period $2L$. Half range Cosine and sine series. (6 hours)

   Self Study: Additional Problems from half range Fourier Series. (1 hour)

   b) **Beta and Gamma functions**

   Definition of Beta and Gamma functions (without proof of convergence of integral). Properties of beta and gamma functions. Relation between beta and gamma functions. (7 hours)

   Self Study: Legender's Duplication formula. (1 hour)

Suggested distribution of lecture hours:

1. Algebra: 2 hour per week.
2. Analysis: 1 hour per week.

Text Books

1. Joseph Gallian, Contemporary Abstract Algebra, 8th ed. Cengage
2. Erwin Kreyszig, Advanced Engineering Mathematics, 8th ed. New Delhi, India: Wiley India Pvt. Ltd., 2010
3. S K Mapa, Introduction to Real Analysis, 8th ed. Levant Books India

Reference Books

1. S K Mapa, Higher Algebra: Abstract and Linear, 14th ed. Levant Books, India.
2. Vashista, A First Course in Modern Algebra, 11th ed.: Krishna PrakasanMandir, 1980.
3. John B Fraleigh, A First course in Abstract Algebra, 3rd ed.: Narosa Publishing House., 1990.
4. Dr KSC, Engineering Mathematics III, SP Publications
5. Mainak Mukherjee, A Course in Real Analysis, Narosa Publishing House
6. R Weinstock,Calculus of Variation, Dover, 1970.

Paper 5 Blueprint:

	Algebra	Analysis	Answering	Total
2 Marks	4(1+1+1+1)	4(2+2)	5/8	10
6 Marks	7/9(4+5)	3/5(2+3)	10/14	60

Paper Pattern: Part I (2 marks). Part II (Algebra 6 marks). Part III (Analysis 6 marks)

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS V - MT5P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. To find full range trigonometric Fourier series of some simple functions with period 2π and $2L$.
2. To find the half-range sine and cosine series of simple functions.
3. Example on Euler's equation in full form.
4. Example on particular forms of Euler's equation.
5. Examples on minimum surface of revolution.
6. Examples of Brachistochrome problem.
7. Examples on Isoperimetric problems. [1]
8. a) To check if a given ring is a Commutative ring with unity
   b) To check if a given ring is an Integral domain or field.
9. Subrings and Ideals
10. Homomorphism and isomorphism of rings.

[1] With full theory for Labs 3, 4, 5, 6 and 7

MATHEMATICS VI

(3 lecture hours per week + 3 practical hours per week)

THEORY - MT5218

(45 hours)

1. **COMPLEX ANALYSIS**

   a) **Complex Numbers and Complex functions and Mappings**

   Complex Numbers and their properties. Complex Plane. Polar form of Complex numbers. Powers and roots. Sets in the complex plane. Complex functions. Complex functions as Mappings. Linear Mappings. Special Power Functions: z^n, $z^{1/n}$. Reciprocal Function. Complex Conjugate. Limits and continuity. (9 hours)

   b) **Analytic Functions, Elementary Functions and Conformal Mappings**

   Differentiability and Analyticity. Cauchy-Riemann Equations. Harmonic Functions.

   Exponential and Logarithmic Functions. Complex Powers. Trigonometric ($\sin z$) and Hyperbolic Functions ($\sinh z$). Conformal Mapping. Linear Fractional Transformations (Bi-linear Transforms). Circle-Preserving property. Mapping Lines to Circles. Bi-linear Transforms as Matrices. Cross - Ratio. (8 hours)

   Self Study: $\cos z$, $\cosh z$, $z + \frac{1}{z}$, Bilienar Transformation. (4 hours)

   c) **Integration in the Complex Plane**

   Complex Integrals (Contour Integration) and their properties. Cauchy's Integral Formula and Cauchy's Integral Formula for Derivatives with proof. Consequences of Cauchy's Formulae: Derivative of Analytic Function is Analytic, Cauchy's Ineqaulity, Liouville's Theorem, Fundamental Theorem of Algebra. (9 hours)

2. **VECTOR DIFFERENTIAL CALCULUS**

   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. Scalar and vector potentials. Laplacian of a scalar field. Vector identities. Standard properties. (13 hours)

   Self Study: Solenoidal, Irrotaional and Harmonic functions. (2 hours)

Suggested distribution of lecture hours:

1. Complex Analysis: 2 hours per week.
2. Vector Differential Calculus: 1 hour per week.

Text Books

1. Dennis Zill and Patrick Shanahan, A first course in Complex Analysis, with applications, Jones and Bartlett Publishers.
2. John Mathews and Russell Howell, Complex Analysis for Mathematics and Engineering, 6th ed., Jones and Bartlett Learning.
3. James Stewart, Calculus: Early Transcendetals, 6th ed. Thompson Higer Education
4. G B Thomas and R L Finney, Calculus and analytical geometry, Addison Wesley,1995.

Reference Books

1. R V Churchil and J W Brown, Complex Variables and Applications, 5th ed., McGraw Hill Companies., 1989.
2. L V Ahlfors, Complex Analysis, 3rd ed., McGraw Hill. , 1979.
3. A R Vashista, Complex Analysis, Krishna PrakashanaMandir, 2012.
4. M. D. Raisinghania, Vector Calculus, S Chand Co. Pvt. Ltd., 2013
5. B Spain,Vector Analysis , ELBS, 1994
6. D E Bournesand, P C Kendall, Vector Analysis, ELBS, 1996.

Paper 6 Blueprint:

	Complex Analysis	Vector Calculus	Answering	Total
2 Marks	4	4	5/8	10
6 Marks	7/9(3+3+3)	3/5	10/14	60

Paper Pattern: Part I (2 marks). Part II (Complex Analysis 6 marks). Part III (Vector Differential Calculus 6 marks)

Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS VI - MT5P2

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. To demonstrate the physical interpretation of Gradient, Divergence, Curl and Laplacian.
2. Writing Gradient, Divergence, Curl and Laplacian in cylindrical coordinates (with introduction to Orthogonal Curvilinear Co-cordinates).
3. Writing Gradient, Divergence, Curl and Laplacian in spherical coordinates (with continuation of Orthogonal Curvilinear Co-cordinates).
4. a) Problems on Cauchy-Riemann equations in cartesian and polar form.
   b) Implementation of Milne-Thomson method of constructing analytic functions
5. Illustrating orthogonality of the surfaces obtained from the real and imaginary parts of an analytic function.
6. Verifying real and imaginary parts of an analytic function being harmonic in cartesian and polar coordinates.
7. Illustrating the angle preserving property in a transformation.
8. Illustrating that circles are transformed to circles by a bilinear transformation.
9. Examples connected with Cauchy's integral theorem.
10. Residue Theorem and related problems.

SIXTH SEMESTER

MATHEMATICS - VII

(3 lecture hours per week + 3 practical hours per week)

THEORY - MT6118

(45 hours)

1. **LINEAR ALGEBRA**

   a) **Vector Spaces**

   Introduction. Vector Spaces. Subspaces. Examples. Linear Combinations of Vectors. Linear Dependence and Independence. Bases and Dimension. Maximal Linearly. Independent Subsets. (13 hours)

   Self Study: Applications of Vector Spaces. (2 hours)

   b) **Linear Transformations and Matrices**

   Linear Transformatons, Null Spaces and Ranges. Matrix Representation of a Linear Transformation. Composition of Linear Transformations and Matrix Multiplication. Invertibility and and Isomorphisms. The Change of Co-ordinate Matrix. Dual Spaces.

   (13 hours)

2. **PARTIAL DIFFERENTIAL EQUATIONS**

   Total Differential Equations. Necessary condition for the equation $Pdx + Qdy + Rdz = 0$ to be integrable. Simultaneous Equations. Formation of Partial Differential Equations. Equations of First Order. Lagrange's Linear Equation. First order Non-linear Partial Differential Equation and their solution by Charpit's Method. Mentioning Different Types (I, II, III, Clairut's) of First order Non-linear Partial Differential Equations. Solution of second order Homogeneous Linear Partial Differential Equations in two variables with constant coefficients by finding complementary function and particular integral. (13 hours)

   Self Study: Type I, II, III, IV Problems. Non- Homogeneous Second order non-linear Partial Differential Equations. (4 hours)

Suggested distribution of lecture hours:

1. Linear Algebra: 2 hours per week.
2. PDE: 1 hour per week.

Text Books

1. Stephen Friedberg, Arnold Insel and Lawrence Spence, Linear Algebra, 4th ed., Pearson Publications
2. V. Sundarapandian, Ordinary and Partial Differential Equations, Tata McGraw-Hill.
3. M D Raisinghania, Ordinary and Partial Differential Equations, S Chand and Co. Pvt. Ltd., 2014.

Reference Books

1. G Strang, MIT open courseware (http://ocw.mit.edu/courses).
2. Otto Bretscher, Linear Algebra with applications, 5th ed., Pearson Publications.
3. Shepley L. Ross, Differntial Equations, 3rd Edition, Wiley.
4. G F Simmons, Differential equation with Applications and historical notes, 2nd ed.: McGraw-Hill Publishing Company, Oct 1991.

5. S Narayanan and T K ManicavachogamPillay, Differential Equations.: S V Publishers Private Ltd., 1981.
6. I N Sneddon, Elements of Partial Differential Equations, 3rd ed.: Mc. Graw Hill., 1980.

Paper 7 Blueprint:

	Linear Algebra	PDE	Answering	Total
2 Marks	4(2+2)	4	5/8	10
6 Marks	7/9(4+5)	3/5	10/14	60

Paper Pattern: Part I (2 marks). Part II (Linear Algebra 6 marks). Part III (PDE 6 marks)

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PRACTICALS VII - MT6P1

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. a) Vector space, subspace – illustrative examples.
   b) Expressing a vector as a linear combination of given set of vectors.
2. a) Examples on linear dependence and independence of vectors.
   b) Basis and Dimension – illustrative examples.
3. Verifying whether a given transformation is linear.
4. a) Finding matrix of a linear transformation.
   b) Finding Linear Transform from a Matrix
5. Problems on rank and nullity.
6. Solutions to the problems on total and simultaneous differential equations.
7. Solutions to the problems on different types (I, II, III, Clairut's) of Partial differential equations.
8. Solving second order linear partial differential equations in two variables with constant coefficient.
9. Solution of one dimensional heat equation using Fourier series with Dirichlet condition (with theory).
10. Solution of one dimensional wave equation using Fourier series with Dirichlet condition (with theory).

MATHEMATICS VIII

(3 lecture hours per week + 3 practical hours per week)

THEORY - MT6218

(45 hours)

1. **CALCULUS**

   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. (20 hours)

b) **Integral Theorems**

Green's theorem, Gauss Divergence theorem and Stokes' theorem (with proof) and related problems. (8 hours)

Self Study: Direct consequences and verification of all three theorems. (2 hours)

2. **LAPLACE TRANSFORMS**

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. Convolution Theorem. Inverse Laplace Transform. Solving Ordinary Differential Equations using Laplace Transform. (13 hours)

Self Study: Heaviside and step function. (2 hours)

Suggested distribution of lecture hours:

1. Calculuc: 2 hours per week.
2. Laplace Transforms: 1 hour per week.

Text Books

1. James Stewart, Calculus: Early Transcendetals, 6th ed. Thompson Higer Education
2. G B Thomas and R L Finney, Calculus and analytical geometry, Addison Wesley,1995.
3. Raisinghania M.D., Laplace and Fourier Transforms. New Delhi, India: S. Chand and Co. Ltd., 1995.

Reference Books

1. James Stewart, Calculus: Early Transcendetals, 6th ed. Thompson Higer Education
2. G B Thomas and R L Finney, Calculus and analytical geometry, Addison Wesley,1995.

Paper 8 Blueprint:

	Integrals	Laplace Transforms	Answering	Total
2 Marks	4(3+1)	4	5/8	10
6 Marks	7/9(6+3)	3/5	10/14	60

Paper Pattern: Part I (2 marks). Part II (Integrals 6 marks). Part III (Laplace Transforms 6 marks)
Caution: The blue print is only suggestive of the probable marks distribution and it is not binding on the examiner.

PRACTICALS VIII - MT6P2

Mathematics Practicals using Python

(3 hours per week per batch)

LIST OF PROBLEMS

1. a) Evaluation of the line integral with constant limits.
   b) Evaluation of the double integral with constant limits.
   c) Evaluation of the triple integral with constant limits.
2. a) Evaluation of the line integral with variable limits.
   b) Evaluation of the double integral with variable limits.
   c) Evaluation of the triple integral with variable limits.
3. Verifying Green's theorem.

4. Verifying Gauss divergence theorem.
5. Verifying Stokes' theorem
6. Laplace Transforms
7. Inverse Laplace Transform
8. Solving Differential Equations with Laplace Transforms
9. Fourier Transform
10. Inverse Fourier Transform