

Contents

| | |
|--|---------------|
| <i>Preface</i> | vii |
| <i>Syllabus</i> | ix |
| Chapter 1: Matrix I | 1–28 |
| 1.1 Introduction | 1 |
| 1.2 Definition of matrix | 1 |
| 1.3 Definitions of various types of matrices | 2 |
| 1.4 Algebraic operations on matrices | 4 |
| 1.5 Laws of algebraic operations of matrices | 5 |
| 1.6 Special matrices | 6 |
| <i>Illustrative examples</i> | 7 |
| 1.7 Transpose of a matrix | 11 |
| <i>Illustrative examples</i> | 11 |
| 1.8 Symmetric and skew-symmetric matrices | 14 |
| <i>Illustrative examples</i> | 16 |
| <i>Miscellaneous examples</i> | 17 |
| <i>Multiple choice questions</i> | 22 |
| <i>Answers to multiple choice questions</i> | 25 |
| <i>Problems</i> | 25 |
| <i>Answers to problems</i> | 28 |
| Chapter 2: Matrix II | 29–107 |
| 2.1 Determinant | 29 |
| 2.2 Minor and cofactor of an element in a determinant | 31 |
| 2.3 Properties of determinants | 32 |
| <i>Illustrative examples</i> | 35 |
| 2.4 Minors and complementary minors of a determinant | 46 |
| 2.5 Laplace's method of expansion of a determinant | 47 |
| 2.6 Solution of a system of linear simultaneous equations: Cramer's rule | 48 |
| <i>Illustrative examples</i> | 50 |
| 2.7 Product of determinants | 51 |
| <i>Illustrative examples</i> | 52 |
| 2.8 Adjoint of a determinant | 57 |

| | | |
|---|---|----------------|
| 2.9 | Reciprocal of a determinant | 60 |
| 2.10 | Symmetric and skew-symmetric determinants | 60 |
| | <i>Illustrative examples</i> | 61 |
| 2.11 | Singular and non-singular matrices | 67 |
| 2.12 | Adjoint of a matrix | 68 |
| 2.13 | Inverse of a matrix | 69 |
| 2.14 | Orthogonal matrix | 71 |
| 2.15 | Trace of a matrix | 72 |
| | <i>Illustrative examples</i> | 73 |
| | <i>Miscellaneous examples</i> | 78 |
| | <i>Multiple choice questions</i> | 92 |
| | <i>Answers to multiple choice questions</i> | 96 |
| | <i>Problems</i> | 97 |
| | <i>Answers to problems</i> | 106 |
| Chapter 3: Matrix III | | 108–165 |
| 3.1 | Rank of a matrix | 108 |
| 3.2 | Elementary row operations on a matrix | 109 |
| 3.3 | Elementary column operations on a matrix | 109 |
| 3.4 | Row equivalent and column equivalent matrices | 110 |
| 3.5 | Zero-row and non-zero row of a matrix | 111 |
| 3.6 | Echelon matrix | 111 |
| | <i>Illustrative examples</i> | 112 |
| 3.7 | Solution of simultaneous linear equations by matrix inversion method | 116 |
| | <i>Illustrative examples</i> | 117 |
| 3.8 | Consistency and inconsistency of a system of homogeneous and inhomogeneous linear simultaneous equations | 123 |
| | <i>Illustrative examples</i> | 125 |
| 3.9 | Eigen values and eigen vectors | 134 |
| 3.10 | Characteristic polynomial and characteristic equation | 134 |
| 3.11 | Properties of eigen values | 138 |
| 3.12 | Properties of eigen vectors | 142 |
| 3.13 | Cayley-Hamilton theorem | 143 |
| | <i>Illustrative examples</i> | 145 |
| | <i>Multiple choice questions</i> | 155 |
| | <i>Answers to multiple choice questions</i> | 159 |
| | <i>Problems</i> | 159 |
| | <i>Answers to problems</i> | 163 |
| Chapter 4: Limit, Continuity and Differentiability | | 166–192 |
| 4.1 | Introduction | 166 |
| 4.2 | Limit | 166 |
| 4.3 | Neighbourhood of a point on the real line | 167 |
| 4.4 | Limit of a function | 167 |
| | <i>Illustrative examples</i> | 169 |
| 4.5 | Different types of limits | 170 |
| 4.6 | Some standard limits | 172 |

| | | |
|-------------------|--|----------------|
| 4.7 | Fundamental theorems | 173 |
| 4.8 | Continuity of a function | 173 |
| | <i>Illustrative examples</i> | 174 |
| 4.9 | Theorem of continuity | 176 |
| 4.10 | Derivability of a function | 176 |
| | <i>Illustrative examples</i> | 178 |
| 4.11 | Differential of a function | 184 |
| | <i>Multiple choice questions</i> | 185 |
| | <i>Answers to multiple choice questions</i> | 188 |
| | <i>Problems</i> | 189 |
| | <i>Answers to problems</i> | 192 |
| Chapter 5: | Successive Differentiation | 193–228 |
| 5.1 | Introduction | 193 |
| 5.2 | The n th order derivatives of some functions | 193 |
| | <i>Illustrative examples</i> | 198 |
| 5.3 | Use of partial fractions | 203 |
| | <i>Illustrative examples</i> | 204 |
| 5.4 | Use of De Moivre's theorem | 205 |
| | <i>Illustrative examples</i> | 206 |
| 5.5 | Leibnitz's theorem | 209 |
| | <i>Illustrative examples</i> | 210 |
| | <i>Multiple choice questions</i> | 223 |
| | <i>Answers to multiple choice questions</i> | 224 |
| | <i>Problems</i> | 224 |
| | <i>Answers to problems</i> | 227 |
| Chapter 6: | Mean Value Theorems and Expansions of Functions | 229–269 |
| 6.1 | Introduction | 229 |
| 6.2 | Rolle's theorem | 229 |
| | <i>Illustrative examples</i> | 230 |
| 6.3 | Lagrange's mean value theorem | 234 |
| | <i>Illustrative examples</i> | 236 |
| 6.4 | Cauchy's mean value theorem | 246 |
| | <i>Illustrative examples</i> | 247 |
| 6.5 | Generalized mean value theorem: Taylor's theorem | 249 |
| 6.6 | Maclaurin's theorem | 251 |
| 6.7 | Expansion of functions in infinite series | 251 |
| 6.8 | Some useful limits | 251 |
| | <i>Illustrative examples</i> | 252 |
| | <i>Multiple choice questions</i> | 262 |
| | <i>Answers to multiple choice questions</i> | 265 |
| | <i>Problems</i> | 265 |
| | <i>Answers to problems</i> | 268 |
| Chapter 7: | Integration by Reduction Formulae | 269–307 |
| 7.1 | Introduction | 270 |
| 7.2 | Integration as the inverse process of differentiation | 270 |

| | |
|---|----------------|
| 7.3 Reduction formula for $\int \sin^n x dx$ and $\int_0^{\pi/2} \sin^n x dx$ | 274 |
| <i>Illustrative examples</i> | 276 |
| 7.4 Reduction formula for $\int \cos^n x dx$ and $\int_0^{\pi/2} \cos^n x dx$ | 278 |
| <i>Illustrative examples</i> | 279 |
| 7.5 Reduction formula for $\int \sin^m x dx$ and $\int_0^{\pi/2} \sin^m x \cos^n x dx$ | 280 |
| <i>Illustrative examples</i> | 282 |
| 7.6 Reduction formula for $\int \cos^m x \sin nx dx$ and $\int_0^{\pi/2} \cos^m x \sin nx dx$ | 284 |
| <i>Illustrative examples</i> | 285 |
| 7.7 Reduction formula for $\int \frac{dx}{(x^2 + a^2)^n}$ | 287 |
| <i>Illustrative examples</i> | 287 |
| <i>Miscellaneous examples</i> | 288 |
| <i>Multiple choice questions</i> | 302 |
| <i>Answers to multiple choice questions</i> | 305 |
| <i>Problems</i> | 305 |
| <i>Answers to problems</i> | 306 |
| Chapter 8: Calculus of Functions of Several Variables | 308–387 |
| 8.1 Introduction | 308 |
| 8.2 Functions of two or more variables | 308 |
| 8.3 Limit and continuity of a function of two variables | 309 |
| <i>Illustrative examples</i> | 311 |
| 8.4 Partial derivatives | 316 |
| <i>Illustrative examples</i> | 317 |
| 8.5 Differentiability and total differential | 329 |
| <i>Illustrative examples</i> | 331 |
| 8.6 Homogeneous functions | 335 |
| <i>Illustrative examples</i> | 338 |
| 8.7 Change of variables: Chain rules | 345 |
| <i>Illustrative examples</i> | 346 |
| 8.8 Implicit functions | 358 |
| <i>Illustrative examples</i> | 360 |
| 8.9 Jacobians | 364 |
| <i>Illustrative examples</i> | 364 |
| <i>Multiple choice questions</i> | 377 |
| <i>Answers to multiple choice questions</i> | 380 |
| <i>Problems</i> | 381 |
| <i>Answers to problems</i> | 387 |
| Chapter 9: Extrema for Functions of Several Variables | 388–405 |
| 9.1 Introduction | 388 |
| 9.2 Maxima and minima for functions of two variables | 388 |
| <i>Illustrative examples</i> | 390 |

| | | |
|--------------------|--|----------------|
| 9.3 | Extrema of constrained functions: Lagrange's multiplier method | 395 |
| | <i>Illustrative examples</i> | 396 |
| | <i>Multiple choice questions</i> | 402 |
| | <i>Answers to multiple choice questions</i> | 403 |
| | <i>Problems</i> | 404 |
| | <i>Answers to problems</i> | 405 |
| Chapter 10: | Line Integrals, Double Integrals and Triple Integrals | 406–455 |
| 10.1 | Introduction | 406 |
| 10.2 | Basic concepts | 406 |
| 10.3 | Line integrals | 407 |
| | <i>Illustrative examples</i> | 408 |
| 10.4 | Double integrals | 415 |
| | <i>Illustrative examples</i> | 418 |
| 10.5 | Change of variables in a double integral | 431 |
| | <i>Illustrative examples</i> | 431 |
| 10.6 | Triple integrals | 439 |
| | <i>Illustrative examples</i> | 440 |
| 10.7 | Change of variables in a triple integral | 446 |
| | <i>Illustrative examples</i> | 447 |
| | <i>Multiple choice questions</i> | 451 |
| | <i>Answers to multiple choice questions</i> | 453 |
| | <i>Problems</i> | 443 |
| | <i>Answers to problems</i> | 455 |
| Chapter 11: | Infinite Series | 456–517 |
| 11.1 | Sequence | 456 |
| 11.2 | Real sequence | 456 |
| 11.3 | Bounded sequence | 456 |
| 11.4 | Monotonic sequence | 457 |
| 11.5 | Limit of a sequence | 457 |
| 11.6 | Convergence, divergence and oscillation of a sequence | 458 |
| 11.7 | Some standard limits | 459 |
| | <i>Illustrative examples</i> | 459 |
| 11.8 | Infinite series | 461 |
| 11.9 | Some properties of an infinite series | 462 |
| 11.10 | Two important infinite series | 463 |
| 11.11 | Necessary condition for convergence | 467 |
| 11.12 | Comparison test | 469 |
| | <i>Illustrative examples</i> | 470 |
| 11.13 | D'Alembert's ratio test | 477 |
| | <i>Illustrative examples</i> | 477 |
| 11.14 | Raabe's test | 490 |
| | <i>Illustrative examples</i> | 490 |
| 11.15 | Cauchy's root test | 496 |
| | <i>Illustrative examples</i> | 496 |

| | | |
|--|---|----------------|
| 11.16 | Alternating series | 500 |
| | <i>Illustrative examples</i> | 500 |
| 11.17 | Absolute convergence and conditional convergence..... | 504 |
| | <i>Illustrative examples</i> | 505 |
| | <i>Multiple choice questions</i> | 509 |
| | <i>Answers to multiple choice questions</i> | 513 |
| | <i>Problems</i> | 513 |
| | <i>Answers to problems</i> | 516 |
| Chapter 12: Vector Algebra | | 518–576 |
| 12.1 | Vectors | 518 |
| 12.2 | Algebra of vectors | 518 |
| 12.3 | Product of two vectors | 523 |
| | <i>Illustrative examples</i> | 530 |
| 12.4 | Product of three vectors | 546 |
| 12.5 | Vector equations of straight line, plane and sphere | 550 |
| | <i>Illustrative examples</i> | 556 |
| | <i>Multiple choice questions</i> | 571 |
| | <i>Answers to multiple choice questions</i> | 574 |
| | <i>Problems</i> | 575 |
| | <i>Answers to problems</i> | 576 |
| Chapter 13: Vector Calculus | | 577–665 |
| 13.1 | Derivative of a vector function | 577 |
| 13.2 | Formulae of differentiation | 579 |
| 13.3 | Two important theorems | 579 |
| | <i>Illustrative examples</i> | 581 |
| 13.4 | Scalar and vector fields | 587 |
| 13.5 | Gradient of a scalar point function | 588 |
| | <i>Illustrative examples</i> | 590 |
| 13.6 | Divergence of a vector point function | 605 |
| 13.7 | Curl or rot of a vector point function | 606 |
| 13.8 | Important identities | 607 |
| | <i>Illustrative examples</i> | 613 |
| 13.9 | Green's theorem in the plane | 626 |
| | <i>Illustrative examples</i> | 626 |
| 13.10 | Gauss' divergence theorem | 633 |
| | <i>Illustrative examples</i> | 634 |
| 13.11 | Stokes' theorem | 647 |
| | <i>Illustrative examples</i> | 648 |
| | <i>Multiple choice questions</i> | 657 |
| | <i>Answers to multiple choice questions</i> | 661 |
| | <i>Problems</i> | 661 |
| | <i>Answers to problems</i> | 664 |
| Appendix-I | | 666–705 |
| Appendix-II | | 706–714 |
| Papers | | 715–728 |