Syllabus for Part II

The syllabus for the written examination will be as per the following outline:

Algebra: Definitions and examples of groups (finite and infinite, commutative and non-commutative), cyclic groups, subgroups, homomorphisms, quotients. Group actions, semidirect products, Sylow's Theorems. Definitions, examples and basic properties of rings, fields, ideals, modules. Normal and separable extensions of fields, the characteristic of a field. Quotients of rings and modules, Chinese Remainder Theorem. Prime and irreducible elements, Unique Factorization Domains, Principal Ideal Domains, Euclidean Domains, Gauss's Lemma, Eisenstein's Criterion.
Basic facts about vector spaces, matrices, determinants, ranks of linear transformations, characteristic and minimal polynomials, symmetric matrices. Jordan and rational canonical forms, diagonalizable linear transformations. Inner products, positive definiteness. Modules over a PID.

References.
K. Hoffman and R. Kunze, Linear Algebra, Prentice Hall India
D. Dummit and R. Foote, Abstract Algebra, Wiley India
Michael Artin, Algebra, Prentice Hall India
I. N. Herstein, Topics in Algebra, Wiley India.

Analysis: Basic facts about real and complex numbers, convergence of sequences and series of real and complex numbers, continuity, differentiability and Riemann integration of real valued functions defined on an interval (finite or infinite), elementary functions (polynomial functions, rational functions, exponential and log, trigonometric functions), sequences and series of functions and their different types of convergence. Fourier Series. Ordinary differential equations.

Differentiable functions on $\mathbb{R}^n$, partial derivatives, $\mathscr{C}^k$-functions, $\mathscr{C}^\infty$-functions. Implicit Function Theorem, Inverse Function Theorem, Mean Value Theorem, Maxima and Minima, Taylor's Theorem.

References.
T. Apostol, Mathematical Analysis, Narosa
S. Lang, Undergraduate Analysis, Springer
G. F. Simmons, Differential Equations with Applications and Historical Notes, McGraw Hill Education, India
Walter Rudin, Principles of Mathematical Analysis, McGraw Hill Education, India.

Geometry/Topology: Elementary geometric properties of common shapes and figures in 2 and 3 dimensional Euclidean spaces (e.g. triangles, circles, discs, spheres, etc.). Plane analytic geometry (= coordinate geometry) and trigonometry. Definition and basic properties of topological spaces including but not limited to metric spaces, examples of subsets of Euclidean spaces (of any dimension), Hausdorffness, connectedness and path connectedness, compactness, closure, completion of metric spaces. Convergence in metric spaces, continuity of functions between topological spaces, properties of continuous functions. Bolzano-Weierstrass theorem, Heine-Borel theorem. Products of topological spaces, quotient spaces.

References.
J. R. Munkres, Topology, Prentice Hall India
G. F. Simmons, Introduction to Topology and Modern Analysis, McGraw Hill Education, India.

General: Pigeon-hole principle (box principle), induction, elementary properties of divisibility, elementary combinatorics (permutations and combinations, binomial coefficients), elementary reasoning with graphs.