

# MATHEMATICS

## Syllabus for Screening Test and Sample Questions

The screening test is mainly based on mathematics covered in a reasonable B.Sc. course. The interview need not be confined to this.

### Algebra

Definitions and examples of groups (finite and infinite, commutative and non-commutative), cyclic groups, subgroups, homomorphisms, quotients. Definitions and examples of rings and fields. Basic facts about finite dimensional vector spaces, matrices, determinants, and ranks of linear transformations. Integers and their basic properties. Polynomials with real or complex coefficients in 1 variable.

### 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).

### 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 metric spaces, examples of subsets of Euclidean spaces (of any dimension), connectedness, compactness. Convergence in metric spaces, continuity of functions between metric spaces.

### General

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

## Sample Questions

The test-paper will contain 30 questions of true/false type, 8 each from Algebra, Analysis, Geometry/Topology and 6 of General type. The duration of the test will be 90 minutes. The following are some sample questions.

State whether the following statements are **TRUE** or **FALSE**.

### Algebra

1. Any finite group has an even number of elements.
2. There exists a field containing exactly 4 elements.
3. The dimension of a finite dimensional vector space is divisible by the dimension of any subspace.


### Analysis

1. If  $f$  and  $g$  are two real valued functions on the real line, such that  $f(n) = g(n)$  for all integers  $n$ , then  $f(x) = g(x)$  for all  $x$ .
2.  $\int_1^\infty \log x dx$  is finite.
3. If  $f$  is a real valued, continuous function on an open interval, and  $|f|$  is differentiable, then  $f$  is differentiable.

### Topology/Geometry

1. The upper half plane  $\{(x, y) \in \mathbb{R}^2 \mid y > 0\}$  is connected.
2. Any continuous real valued function on an ellipse has a maximum.
3. In an infinite metric space, any open ball of radius 2 is an infinite set.

### General

1. For any natural number  $x$ , the numbers  $x$ ,  $x + 4$  and  $x + 8$  are either all even, or they are all odd.
2. The following figure can be drawn without lifting the pen from the paper, and without tracing any segment twice: 
3. A man buys  $r$  cups of ice cream from a shop selling  $n$  flavours. The number of different purchases he can make is equal to the binomial coefficient  $\binom{n}{r}$ .