ELECTIVES IN MATHS

1. Aug – Nov term

(1) Commutative algebra: localization, primary decomposition, integral extensions, dimension theory. If time permits: Ext, Tor, Koszul complexes, depth, completion.
   Textbooks:
   (a) Atiyah-MacDonald
   (b) Eisenbud
   (c) Matsumura

(2) Algebraic Geometry I: affine, projective varieties, non-singular varieties, (roughly the material in the first chapter of Hartshorne). If time permits: Riemann-Roch for curves.
   Textbooks:
   (a) Mumford, *Red book*
   (b) Hartshorne, Chap. 1
   (c) Fulton, *Alg. curves*

(3) Homological algebra: Modules, complexes, Koszul complexes, Injective, flat and projective resolutions, Tor, Ext, sheaves (over topological spaces, not schemes), push-forward, pull-back.
   Textbooks:
   (a) Weibel
   (b) Gelfand and Manin
   (c) Bredon
   (d) Iversen

(4) Representation Theory of Finite Groups: introductory course on the representation theory of finite groups
   Textbooks:
   (a) Serre, *Linear representations of finite groups*
   (b) Fulton and Harris *Representation theory*

(5) Partial Differential Equations: a functional analysis approach (distributions, Fourier transform, linear PDE, à la Rudin) or a direct approach (à la Fritz John).

(6) Riemann surfaces : Uniformisation theorem, Mittag-Leffler, Weirstrass theorms, existence of enough functions open Riemann surfaces.
   Textbooks:
   (a) Forster
   (b) Gunning, *Lectures on Riemann surfaces*
   (c) Springer, *Introduction to Riemann surfaces*
   (d) Farkas and Kra
   (e) Raghavan Narasimhan.
   (f) TIFR notes

   Pre-requisites: complex analysis; familiarity with fundamental groups and covering spaces.

2. Jan – Apr term

(1) Introduction to Algebraic Number Theory:
Number fields, rings of integers, prime splitting and ramification theory, ideal class group, field theory,
Textbooks:
(a) Neukirsch
(b) Marcus, *Number fields*
Pre-requisite: Algebra IV or equivalent.

(2) Algebraic Geometry II: Schemes and cohomology. Divisors. Projective morphisms, Serre duality.
Textbooks:
(a) Hartshorne, Chaps. 2 and 3.
(b) Ueno
(c) Mumford-Oda.
Pre-requisite: Algebraic Geometry I or equivalent.

(3) Sheaves and cohomology. Derived categories and derived functors, $f^!$, $Rf_!$.
Textbooks:
(a) Godemont
(b) Iversen
Pre-requisite: Homological Algebra or equivalent.

(4) Semisimple Lie Algebras: introductory course
Textbooks:
(a) Serre, *Complex semisimple Lie algebras*
(b) Humphreys, *Representation theory of Lie algebras*

(5) Linear Groups This is an introductory course that discusses various matrix groups. Linear Groups, spheres, the special unitary group, the rotation group, one parameter groups, normal subgroups of the special linear group, group representations, definitions and examples, irreducible representations, unitary representations, characters, the regular representations, Schur's lemma, orthogonality relations, representations of the special unitary group.
Prerequisites: Algebra I and Algebra II.
Textbooks:
(a) M. Artin, *Algebra*

(6) Algebraic groups: introductory course
Textbooks:
(a) Humphreys
(b) Borel
(c) Springer

(7) Riemannian Geometry:
Textbooks:
(a) Do Carmo
(b) Milnor, *Morse theory*
(c) Gallot, Hulin and Lafontaine, *Riemannian geometry*
(d) Hicks, *Notes on differential geometry*
Prerequisites: introductory course on manifolds.

(8) Symplectic Geometry

Textbooks:
(a) ??
Prerequisites: introductory course on manifolds.

3. Other courses

(1) A course on Spectral theory
Textbooks:
(a) W. Arveson, *A Short Course on Spectral theory.*
(2) Introduction to Operator Algebras Gelfand-Naimark theory, Commutative C^*-algebras, Representation theory of C^*-algebras, The Hahn-Hellinger theorem, The Spectral theorem,Polar Decomposition, Compact and Trace class opertaors, The Double Commutant theorem, Kaplansky Density theorem,The GNS construction and Unbounded operators
Prerequisites: Functional Analysis, Measure Theory, Complex Analysis and Linear Algebra.
Textbooks:
(a) V. S. Sundar, *Operators on Hilbert spaces.*
(b) V. S. Sundar, *Functional Analysis.*
(c) W. Arveson, *Invitation to C*-algebras.*
(3) Hilbert spaces and linear operators
Textbooks:
(a) V. S. Sundar, *Operators on Hilbert spaces.*
(4) Abstract Harmonic analysis :
Textbook
(a) G. B. Folland, *Abstract Harmonic analysis*
(5) Groebner bases and applications: A course that is more application oriented, and does not assume much of the topics covered in the commutative algebra course.
Textbooks:
(a) Adams and Loustaunau
(b) Cox, Little and O'Shea, *Using algebraic geometry*
Prerequisites: Algebra III
(6) Reflection Groups
Text books
(a) Humphreys, *Reflection and Coxeter Groups*
(b) A. Borovik, *Mirrors and Reflections*
(c) K. Brown, *Buildings*, (1st two chapters)
(7) Enumerative Combinatorics. A course covering one or more of the following topics: Posets, lattices, Mobius inversion, Sieving methods etc; Theory of rational and exponential generating functions; Graph theory.
Textbooks:
(a) R. Stanley, *Enumerative Combinatorics vol. 1*
(b) H. Wilf, *generatingfunctionology.*
(c) West, *Introduction to Graph Theory*
(8) Introduction to Knot Theory.
Textbooks:

(a) Adams, *The Knot Book*.
(b) Cromwell, *Knot and Links*