Content beyond the syllabus

Logic plays a special role in computer science: it has been called “the calculus of computer science”

Logic plays a similar role in computer science to that played by calculus in the physical sciences and traditional engineering disciplines

Logic in computer science is an applied science , combining foundational research with applications .Essential to solve the software/hardware correctness problem.

One well-known application of Boolean logic/propositional logic is for the design of circuit Each digital gate is represented by a logical connective.

It is possible to write a program which decides if a temporal formula is valid or not and at the origin of neural networks are finite automata

Some applications of logic are:
architecture (logic gates)
software engineering (specification and verification)
programming languages (semantics, logic programming)
databases (relational algebra)
artificial intelligence (automatic theorem proving)
theory of computation (general notion of compiexity

combinatorics are used in:

1) Counting- the number of ways in which we can perform a finite sequence of operations and how objects can be arranged or selected.

2) Drawing bijections- The classic Stars and bars problem provides us key ideas to count the number of integral solutions to equations of the form
$x1+x2+\ldots xn=k$x1+x2+…xn=k.

Combinatorics is used in almost everywhere for analyzing algorithms in Computer Science and to come up with efficient algorithms

In group theory, the pigeonhole principle is used to show that every element of a finite group has an order. One could argue that the proof that every finite integral domain is a field stems from similar logic.

The entire modern world relies on combinatorial algorithms. If we want to make a program faster,we need combinatorics. If we want to understand modern programming,we need combinatorics.

The recursion equation is the functional equation of any system helping in *enumeration*. Generating functions is a brilliant tool to solve recurrences. It is a mathematical device to find a closed form equation to the recursive relations.

Graphs are used in data base designing , software Engineering ,computer hardware ,Network design and system, Data Structure ,Image Processing ,Data mining, operating system and website desiging

Applications of graph theory are abundant within computer science and in every day life:

- Finding shortest routes in car navigation systems
- Search engines use ranking algorithms based on graph theory
- Optimizing time tables for schools or universities
- Analysis of social networks
- Optimizing utilization of railway systems
- Compilers use coloring algorithms to assign registers to variables
- Path planning in robotics

Modelling networks are done using graphs. For example if we need to study broadcasting or multicasting in certain types of network topologies we would use graphs to model the networks. For example:

- hypergraphs
- complete graphs
- star graphs
- meshes

When you model networks using graphs we can use all the power of graph theory to analyse the network.

Graph Theory has a variety of applications.

- Large Scale Networks
- Social Computing
- Bio-informatics

Lattices and fixed points are at the foundations of program analysis and verification. Though advanced results from lattice theory are rarely used because we are concerned with algorithmic issues such as computing and approximating fixed points, while research in lattice theory has a different focus (connections to topology, duality theory, etc).

Semirings are used for modelling annotations in databases (especially those needed for provenance), and often also for the valuation structures in valued constraint satisfaction. In both of these applications, individual values must be combined together in ways which lead naturally to a semiring structure, with associativity and the one semiring operation distributing over the other..

Rings, modules, and algebraic varieties are used in error correction and, more generally, coding theory.

semigroups and monoids are used quite intensely in automata theory

Automata are "monoid modules" (also called monoid actions or "acts"), which are at the right level of generality for Computer Science.

Lattice theory was a major force in the development of denotational semantics

Universal algebra is used for defining algebraic specifications of data types.Category theory is the foundation for type theory. As Computer Scientists keep inventing new structures to deal with various computational phenomena, category theory is a very comforting framework in which to place all these ideas. We also use structures that are enabled by category theory, which don't have existence in "traditional" mathematics, such as functor categories. Also, algebra comes back into the picture from a categorical point of view in the use of monoids and algebraic theories of effects.

Lattices and Boolean algebras have found applications in logic, circuit theory, and probability.

The application of Boolean algebra to circuits provided an actual physical representation for the corresponding symbolic operations
uses network diagrams to illustrate the distributive law
by means of Boolean Algebra it is possible to find many circuits equivalent in operating characteristics to a given circuit. The hindrance of the given circuit is written down and manipulated according to the rules. Each di
erent resulting expression represents a new circuit equivalent to the given one. In particular, expressions may be manipulated to eliminate
elements which are unnecessary, resulting in simple circuits

Boolean algebra is used in simplifying complicated circuits.It is used in modulation and simplifying switching relay circuits often used in circuit design