Concepts in Programming Languages: Revision Guide (revised 2017)

§ Topic I. Introduction and motivation

Keywords:

- Programming-language concepts, design, methods, paradigms, influences; Application domains; Execution models; Foundations; Standardisation.

Tripos question:

- 2006 Paper 6 Question 7 (a)
- 2012 Paper 3 Question 6 (a)
- 2015 Paper 3 Question 5 (a, b)

§ Topic II. FORTRAN: A simple procedural language

Keywords:

- FORTRAN 77; Execution model; Compilation; Data types; Control structures; Syntax; Types; Storage; Aliasing; Parameters.

Tripos questions:

- 2006 Paper 6 Question 7 (b)
- 2007 Paper 5 Question 7 (a)
- 2007 Paper 6 Question 7 (c)
- 2009 Paper 3 Question 2 (a)
- 2010 Paper 3 Question 5 (a)

§ Topic III. LISP: Functions, recursion, and lists

Keywords:

- LISP; Programming-Language phrases; S-expressions; `quote`; Static and Dynamic scope; Abstract machine; Recursion; Garbage collection; Programs as data; Reflection; Parameter passing.

Tripos questions:

- 2006 Paper 6 Question 7 (c)
- 2007 Paper 5 Question 7 (b)
- 2007 Paper 6 Question 7 (a)
- 2008 Paper 6 Question 7 (a)
- 2009 Paper 3 Question 2 (a)
- 2011 Paper 3 Question 6 ($a\,(ii)$)
- 2014 Paper 3 Question 6 (a)

§ Topic IV. Block-structured procedural languages – Algol and Pascal

Keywords:

- Parameters; Parameter-passing; Block structure; Algol 60; Recursion; Stack; Type system; Algol 68; BNF syntax; Heap; Garbage collection; Pascal; Quasi-strong typing; Variant records.

Tripos questions:

- 2006 Paper 6 Question 7 (b)
- 2007 Paper 6 Question 7 (b)
- 2008 Paper 5 Question 7 (a)
- 2010 Paper 3 Question 5 (a)
- 2012 Paper 3 Question 6 (c)
- 2013 Paper 3 Question 6 (b)
- 2007 Paper 5 Question 7 (c)
- 2008 Paper 6 Question 7 (b)
- 2009 Paper 3 Question 2 (c)
- 2011 Paper 3 Question 6 ($a\,(i)$)
- 2013 Paper 3 Question 6 ($a\,(i)$)
- 2015 Paper 3 Question 5 (c)

§ Topic V. Object-oriented languages – SIMULA and Smalltalk

Keywords:

- Objects in SML; Dynamic lookup; Abstraction; Subtyping; Inheritance; Subtyping vs. inheritance; SIMULA; Classes, objects and activation records; Subclasses and inheritance; Type checking and subtyping; Smalltalk; Dynabook; Syntax; Abstraction; Messages; Methods; Instance variables; Interfaces as types; Subtyping.

Tripos questions:

- 2006 Paper 6 Question 7 (d)
- 2008 Paper 5 Question 7 (c)
- 2011 Paper 3 Question 6 (a)
- 2013 Paper 3 Question 6 ($a\,(ii)$)
- 2007 Paper 6 Question 7 (d)
- 2010 Paper 3 Question 5 (b)
- 2012 Paper 3 Question 6 (f)

§ Topic VI. Types in programming languages

Keywords:

- Types; Type systems; Type safety; Type checking; Static vs. dynamic type checking; Type checking in SML; Type equality; Type declarations; Type inference; Type inference in SML; Polymorphism; `let`-polymorphism; Polymorphic exceptions.

Tripos questions:

- 2008 Paper 5 Question 7 (b)
- 2010 Paper 3 Question 5 (c)
- 2012 Paper 3 Question 6 (b)
- 2013 Paper 3 Question 6 (c)
- 2015 Paper 3 Question 5 (d, e, f)
- 2009 Paper 3 Question 2 (b)
- 2011 Paper 3 Question 6 (b)
- 2012 Paper 3 Question 6 (e)
- 2014 Paper 3 Question 6 (c)
- 2016 Paper 3 Question 5 (d, e)

§ Topic VII. Scripting Languages – JavaScript

Keywords:

- Scripting vs. dynamic typing; JavaScript; Prototypal inheritance; Browser integration.

Tripos questions: None yet. Students might consider the following questions:

- *"Scripting languages and dynamically typed languages are identical; discuss"*
- *"Discuss the notion of 'class' in relation to JavaScript"*

§ Topic VIII. Data abstraction and modularity – SML Modules

Keywords:

- Modules language; Signatures; Structures; Concrete and opaque signatures; Signature inclusion; Signature matching; Subtyping; Information hiding; Functors.

Tripos questions:

- 2007 Paper 5 Question 7 (d)
- 2009 Paper 3 Question 2 (d)
- 2010 Paper 3 Question 5 (d)
- 2011 Paper 3 Question 6 (c)
- 2013 Paper 3 Question 6 (d)
- 2014 Paper 3 Question 6 (d)

§ Topic IX. Languages for concurrency and parallelism.

Keywords:

- Theoretical models; Threads, shared memory, message passing; Distributed memory, multi-core, cloud computing; Programming-language support for parallelism and distribution. Internal and external iteration.

Tripos questions:

- 2014 Paper 3 Question 6 (b)

§ Topic X. Functional-style programming meets object-orientation.

Keywords:

- Scala and Java 8; Procedural programming; Declarative programming; Mutable state; Blocks; Functions; Parameter passing; Classes and objects; `abstract class`es; `trait`s; `case class`es; Pattern matching; Generic types and methods; Variance annotations; Functions as objects;
  [*The following topics are no longer explicitly lectured:*]
  Type parameter bounds; View bounds; Implicit parameters; Implicit conversions; Mixin-class composition.

Tripos questions:

- 2008 Paper 6 Question 7 (c)
- 2009 Paper 3 Question 2 (e)
- 2010 Paper 3 Question 5 (e)
- 2011 Paper 3 Question 6 (d)
- 2012 Paper 3 Question 6 (d)
- 2013 Paper 3 Question 6 (e)

§ Topic XI. Miscellaneous concepts

Keywords:

- Monads, GADTs, Reified continuations, Dependent typing.

Tripos questions:

- 2016 Paper 3 Question 5 (a, b, c)