

5 Concepts in Programming Languages (AM)

- (a) “Fortran, Algol and Lisp invented most programming language concepts 50 years ago; adding the concept of object-orientation suffices to explain all programming languages to date”. To what extent is this statement true or false? Provide evidence for both, keeping in mind developments in hardware, large-scale system design, type systems and the like. [5 marks]
- (b) “JavaScript is just Java with dynamic typing”. Discuss. [3 marks]
- (c) In Java and the JVM every value is either a primitive type or a heap-allocated object. However, Java 8 added ML-style functions-as-values. How is this achieved both at the value level and the type level, and does this addition increase the expressiveness of Java or merely provide more compact syntax? [4 marks]
- (d) What is the difference between internal and external iteration? Explain the key differences between the `Collection` and `Stream` interfaces in Java 8, commenting on any association with internal and external iteration. [4 marks]
- (e) The `Stream` interface to Java provides the `parallel()` method to cause the elements of a `Stream` to be processed in parallel. Comment, fixing any problems you find, on the following program fragment (forming part of a top-level class) which has recently been adjusted by a new employee “to work faster” by the insertion of the call to `parallel()`.

```
int nin, nout;
Stream<String> shortstrings(Stream<String> s) {
    return s.parallel().filter(w ->
        { nin++;
          if (w.length() < 4) { nout++; return true;}
          return false;
        });
}
```

[4 marks]