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().

```java
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]