

## COMPUTER SCIENCE TRIPOS Part IB – 2020 – Paper 4

### 1 Programming in C (djc11)

Consider expressions represented using the following ML datatype:

```
datatype exp = Var of string | Neg of exp | Divide of exp * exp
```

- (a) Using at least one union, define a type or types in the C language for conveniently storing such expressions. [5 marks]
- (b) Give efficient C code that checks whether two structures represent identical expressions. (Do not consider whether they might evaluate to the same result.) Explain how much of the input expressions is explored when they differ. [4 marks]
- (c) Given that a lot of expressions are to be rapidly generated and discarded, what considerations apply to storage management? Define and discuss at least 3 different approaches to storage management. [5 marks]
- (d) The substitution operation for an expression replaces all occurrences of one variable with another variable. Given that sub-expression trees are commonly shared over numerous expressions, explain a problem that could arise in the substitution operation. Explain the details of a solution to the problem by giving code or otherwise. [6 marks]