I2OS 22 Final Exam Solutions

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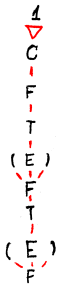
1. (a) The result $= \boxed{1}$



(b) The result $= 2 - 2 - 2 = 0 - 2 = \boxed{-2}$

(c) The result $= (3/3)/3 = 1/3 = \frac{1}{3} \simeq \boxed{0}$

(d) The result $= 4 - - - -4 = 4 - -4 = \boxed{8}$

2. The order of division and multiplication will be reversed resulting in a derivation tree as follows:

The result will be: $3/(3/3) = 3/1 = \boxed{3}$

3. (a) 3

   (b) 3

4. (a) Maximum registers needed $= \log(n) + 1$, minimum registers needed $= 4$

   (b) Array access takes 2 pebbles.

5.
```
moveg2s 0 7   // mode = 0
```

   This would set the mode to *system* enabling access to all adresses in the memory, since adress translation (required by user mode) wouldn't be required.

6. If we don't do anything special in the kernel (like overwriting $gpr(0)$) nothing will change, except the fact that users won't be able to access $gpr(0)$ and will have to account for that by possibly redeclaring another gpr as a zero — always keeping 0_{32} in that gpr.

7. (a) $4 \cdot (32 + 1) = 128 + 4 = 132$
   (b) $2 \cdot 4 \cdot (32 + 8) = 8 * 40 = 320$
   (c) $320 + 4 \cdot 3 = 332$

8. (a) For function calls.
   (b) To enable the use of local variables.

9. The given invariants allow us to save and restore user and kernel state.

10. (a) $2^{15} - 2$ forwards and $2^{15} - 1$ backwards
    (b)
    - For if-parts in the case of an if-then statement: $2^{15} - 2$. In the case of an if-else statement: $2^{15} - 3$.
    - For else-parts: $2^{15} - 2$
    - For while bodies: $2^{15} - 1 - |\texttt{code(n1)}|$, where $n1$ is the while condition.

11. (a)