Solutions to the exam questions spring 1992, course 4338

Problem 1.

```
scheme
  LIBRARY =
    class
      type
        Book,
        Person,
        Library1 ::
          books : Book-set
          borrowers : Person-set
          borrowed : Book ~m~> Person,
        Library = {| b : Library1 • is_wf(b) |}

      value
        is_wf : Library1 → Bool
        is_wf(b) ≡
          dom borrowed(b) ⊆ books(b) ∧
          rng borrowed(b) ⊆ borrowers(b)

      variable lib : Library

      value
        owns : Book → read lib Bool
        owns(b) ≡ b ∈ books(lib),

        is_borrowed : Book ~→ read lib Bool
        is_borrowed(b) ≡ b ∈ dom borrowed(lib) pre owns(b),

        borrower : Person → read lib Bool
        borrower(p) ≡ p ∈ borrowers(lib),

        borrow_book : Book × Person ~→ write lib Unit
        borrow_book(b, p) ≡
          lib :=
            mk_Library1
              (books(lib), borrowers(lib), borrowed(lib) ∪ [ b ↦ p ])
          pre owns(b) ∧ ~ is_borrowed(b) ∧ borrower(p),
```

return_book : Book $\xrightarrow{\sim}$ **write** lib **Unit**
return_book(b)
post
books(lib) = books(lib`) $\wedge$
borrowers(lib) = borrowers(lib`) $\wedge$
borrowed(lib) = borrowed(lib`) $\setminus$ {b}
pre owns(b) $\wedge$ is_borrowed(b)
end