1. Write a URM program for each of the following functions.
(a) $f(x) = x - 5$. (Be careful with where f is undefined.)

(b)

$$f(k) = \begin{cases} 1 & \text{if } x < 3 \\ 2 & \text{if } 3 \leq x < 5 \\ 3 & \text{otherwise} \end{cases}$$

(c) Let P be the following URM program.

1. J(1,2,3)
2. S(1)
3. S(1)

Let $f(x)$ be the function computed by P. Complete each of the following.
(a) $f(0) =$ $f(1) =$ $f(100) =$

(b) $f(x) = \begin{cases} & \text{if} \\ & \text{otherwise} \end{cases}$

2. Suppose P is a URM program such that $f_P^{(3)}(x, y, z) = xyz$.
Then, $f_P^{(1)}(x) =$? Explain why.

3. Use the recursion and composition theorems to prove $f(x) = x!$ is computable. You may assume that the functions $M(x, y) = xy$, $A(x, y) = x + y$, and $k(x) = 1 \dot{-} x$ are computable. (But you may not make any other assumptions.)

4. Use the recursion and composition theorems to prove the predicate "x is even" is decidable. You may assume that the functions $M(x, y) = xy$, $A(x, y) = x + y$, and $k(x) = 1 \dot{-} x$ are computable. (But you may not make any other assumptions.)

5. Let f be a partial function from $\mathbf{N}$ to $\mathbf{N}$, and let g be a total function from $\mathbf{N}$ to $\mathbf{N}$.
(a) Is it possible for $f \circ g$ to be a total function? If yes, give an example. If not, prove why not.

(b) Is $g \circ f$ partial or total? Support your claim.