Solution to Homework Problem 16

Task. Design a Turing machine that, given a positive binary number n greater than or equal to 16, adds 16 from this number. Test it, step-by-step, on the example of $n = 3$.

Solution. Here are the rules for the Turing machine:
start, – → R, skip1st
skip1st, 0 → R, skip2nd
skip1st, 1 → R, skip2nd
skip1st, – → 0
skip2nd, 0 → R, skip3rd
skip2nd, 1 → R, skip3rd
skip2nd, – → 0
skip3rd, 0 → R, skip4th
skip3rd, 1 → R, skip4th
skip3rd, – → 0
skip4th, 0 → R, moving
skip4th, 1 → R, moving
skip4th, – → 0
moving, 1 → 0, R
moving, 0 → 1, L, back
moving, – → 1, L, back
back, 1 → L
back, 0 → L
back, – → halt

Tracing. We start with the number $3_{10} = 11_2$ which is represented as 01001.

$\underline{-}$	1	1	–	–	–	–	...	start
–	$\underline{1}$	1	–	–	–	–	...	skip1st
–	1	$\underline{1}$	–	–	–	–	...	skip2nd
–	1	1	$\underline{-}$	–	–	–	...	skip3rd
–	1	1	0	$\underline{-}$	–	–	...	skip4th
–	1	1	0	0	$\underline{-}$	–	...	moving
–	1	1	0	$\underline{0}$	1	–	...	back

–	1	1	$\underline{0}$	0	1	–	...	back
–	1	$\underline{1}$	0	0	1	–	...	back
–	$\underline{1}$	1	0	0	1	–	...	back
$\underline{-}$	1	1	0	0	1	–	...	back
$\underline{-}$	1	1	0	0	1	–	...	halt