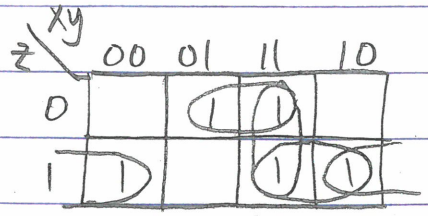
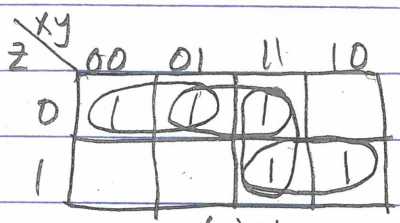
EECS 140/141 HW 6 Sol'ns S'20

1. a).



$f = y\cdot\bar{z} + \bar{y}\cdot z +$ (either xy or xz)

EPIs cost = 13



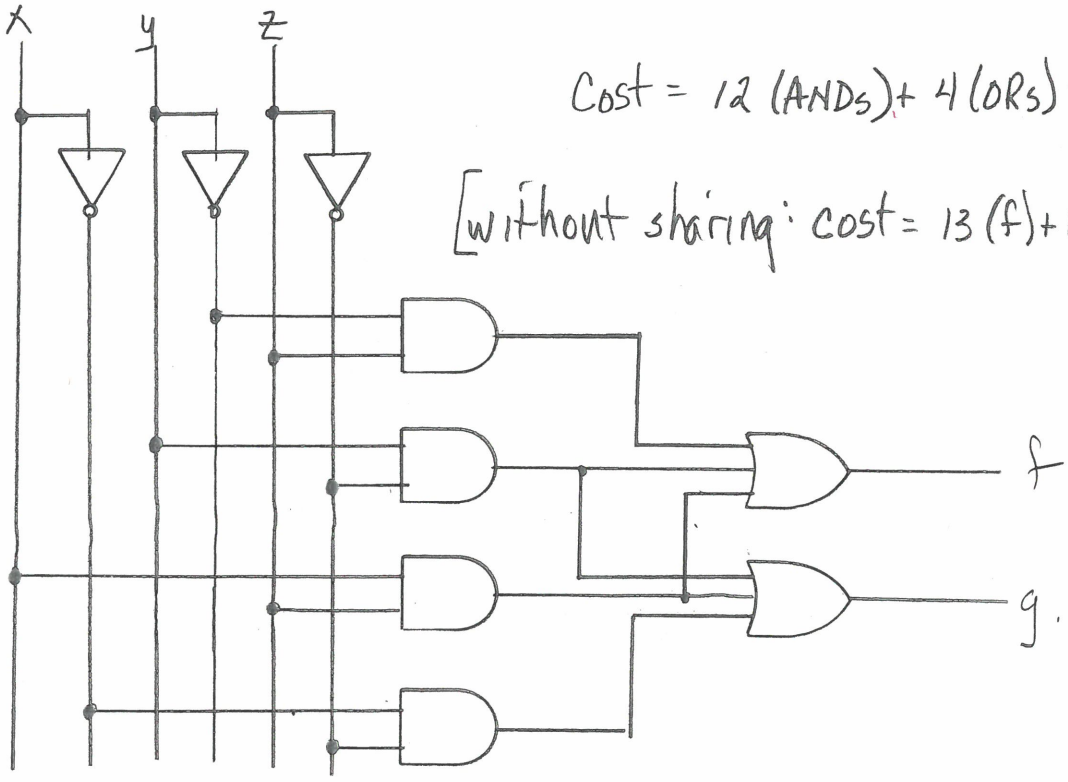
$g = \bar{x}\cdot\bar{z} + xz +$ (either $y\cdot\bar{z}$ or xy).

EPIs cost = 13.

b. For f, choose xz since it can be shared with g.
For g, choose $y\cdot\bar{z}$ " " " " " " f.

$f = (y\cdot\bar{z}) + \bar{y}\cdot z + (xz)$ $g = \bar{x}\cdot\bar{z} + (xz) + (y\cdot\bar{z})$

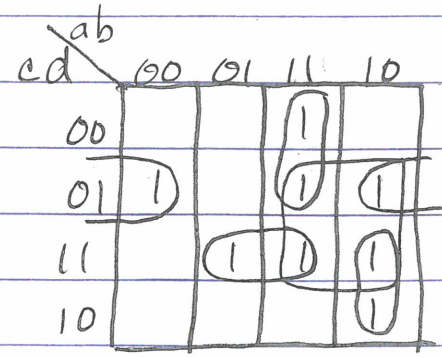
c.



Cost = 12 (ANDs) + 4 (ORs) = 20.

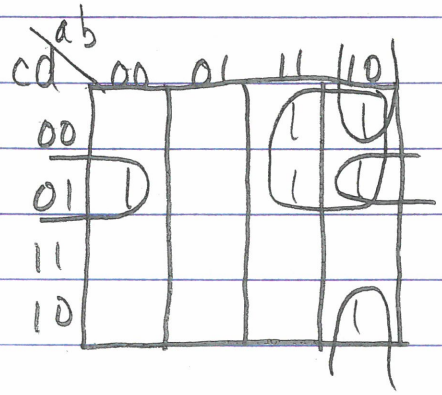
[without sharing: cost = 13 (f) + 13 (g) = 26]

2a.



PIs: ad, $ab\cdot\bar{c}$, $\bar{b}\cdot\bar{c}\cdot d$, $a\cdot\bar{b}\cdot c$, bcd,
EPIs: all except ad.
EPIs form cover.
$s = ab\cdot\bar{c} + \bar{b}\cdot\bar{c}\cdot d + a\cdot\bar{b}\cdot c + bcd$.
cost = 21.

b.

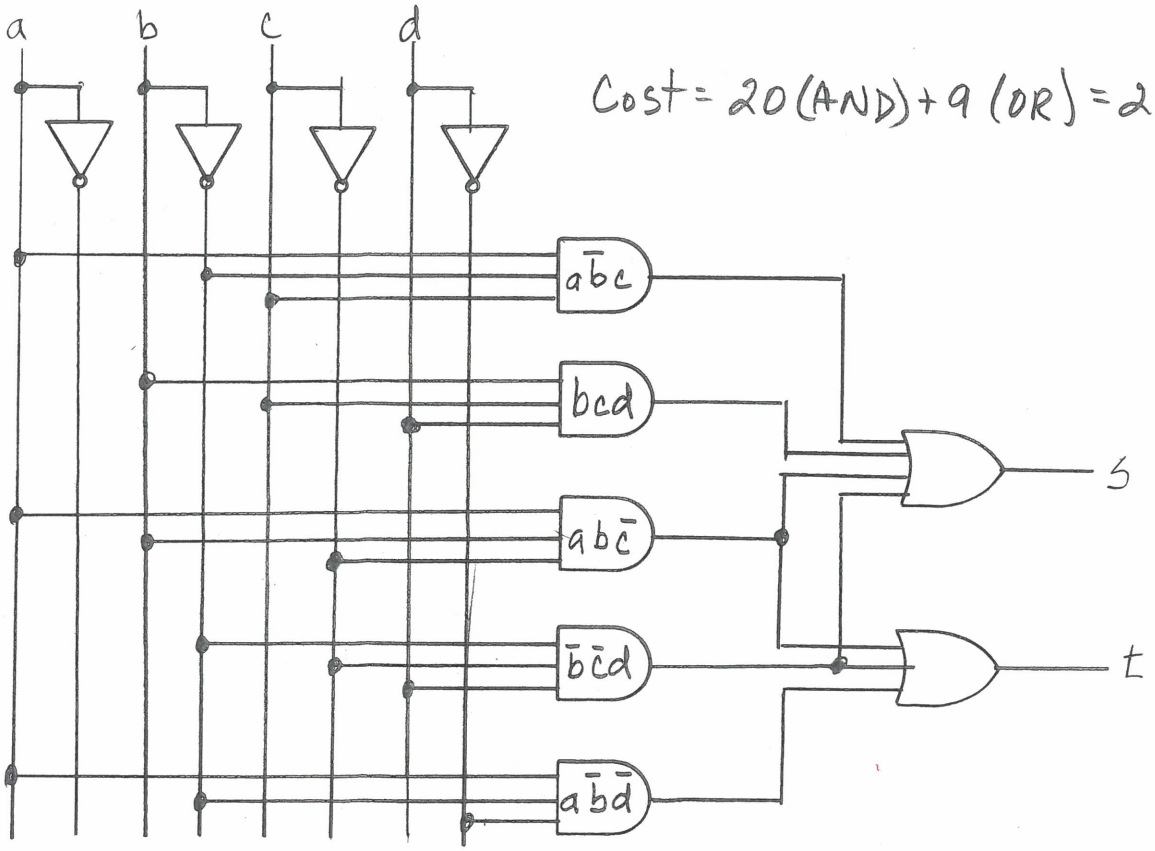


PIs: $a\cdot\bar{c}$, $a\cdot\bar{b}\cdot\bar{d}$, $\bar{b}\cdot\bar{c}\cdot d$
EPIs: all
EPIs form cover.
$t = a\cdot\bar{c} + a\cdot\bar{b}\cdot\bar{d} + \bar{b}\cdot\bar{c}\cdot d$
cost = 15.

c. Obvious sharing: $\bar{b}\cdot\bar{c}\cdot d$
Total cost: $21(s) + 3(a\cdot\bar{c}) + 4(a\cdot\bar{b}\cdot\bar{d}) + 4(t\ \text{OR}) = 32$.
But we could replace $a\cdot\bar{c}$ in t with $a\cdot b\cdot\bar{c}$ so that $a\cdot b\cdot\bar{c}$ can be shared.
$s = (ab\cdot\bar{c}) + (\bar{b}\cdot\bar{c}\cdot d) + a\cdot\bar{b}\cdot c + bcd$.
$t = (ab\cdot\bar{c}) + a\cdot\bar{b}\cdot\bar{d} + (\bar{b}\cdot\bar{c}\cdot d)$
Total cost: $21(s) + 4(a\cdot\bar{b}\cdot\bar{d}) + 4(t\ \text{OR}) = 29$.

Note that the t implementation here, if considered in isolation, would not be min-cost. We have chosen a sub-optimal implementation for t to maximize sharing with s, hence reducing the total cost of the combined 2-output circuit.

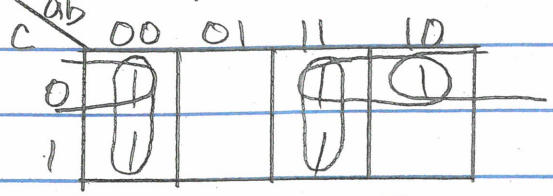
2d.



Cost = 20(AND) + 9(OR) = 29.

3. For EECS 140: $f(a,b,c) = \Sigma m(0,1,4,6,7)$

K-Map:



a). PI's: $\bar{a}\bar{b}$, ab, $a\bar{c}$, $\bar{b}\bar{c}$

EPIs: $\bar{a}\bar{b}$, ab

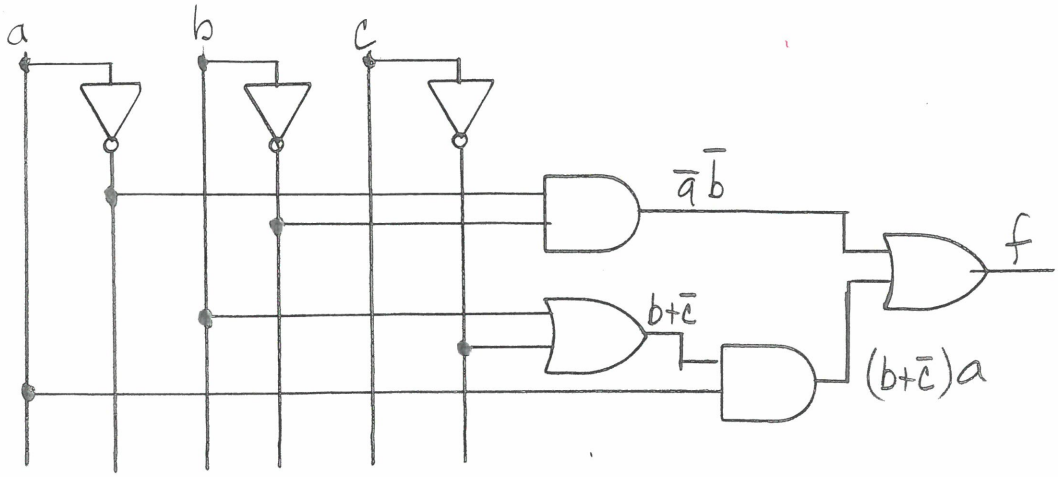
$f = \bar{a}\bar{b} + ab + a\bar{c}$ (or) $f = \bar{a}\bar{b} + ab + \bar{b}\bar{c}$

cost of either: 13.

b). $f = \bar{a}\bar{b} + a(b+\bar{c})$ (or) $f = (\bar{a}+\bar{c})\bar{b} + ab$.

cost of either: 12.

c). For 1st option (2nd option also correct, but not shown).

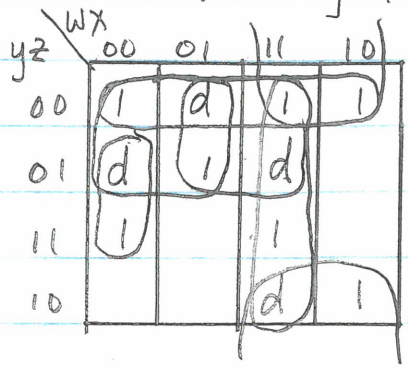


d.

	SoP	Multi-level
Cost	13	12
# Levels	2	3
Max fan-in	3	2

3. For EECS 141: $g(w,x,y,z) = \Sigma m(0,3,5,8,10,12,15) + D(1,4,13,14)$

a.



PIs: $\bar{y}\bar{z}, wx, \bar{w}\bar{y}, x\bar{y}, w\bar{z}, \bar{w}\bar{x}z$

EPIs: $wx, w\bar{z}, \bar{w}\bar{x}z$

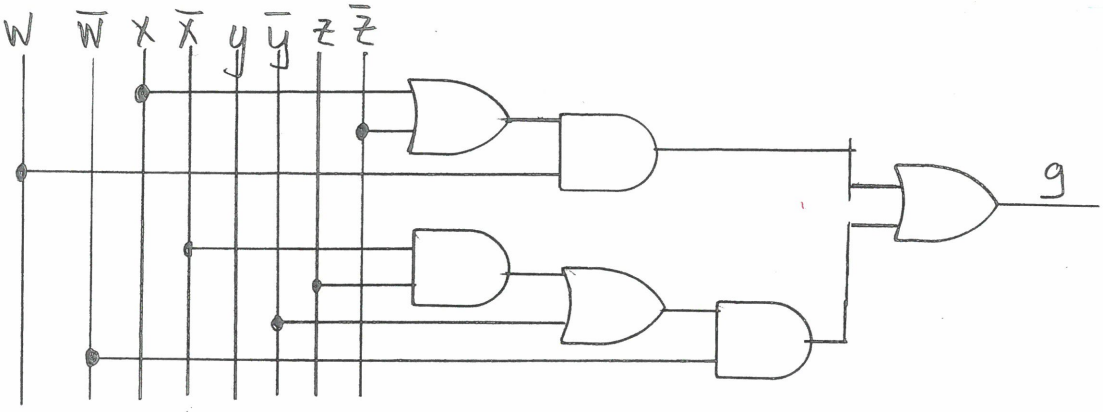
Min-cost:

$g = wx + w\bar{z} + \bar{w}\bar{x}z + \bar{w}\bar{y}$ (unique).

cost = 18

b. $g = w(x+\bar{z}) + \bar{w}(\bar{x}z + \bar{y})$ cost = 18 (same).

c.



d.

	SoP	factored
Cost	18	18
# levels	2	4
max fan-in	4	2.