Friday, October 6, 2017

ESE 555 | HOMEWORK 1

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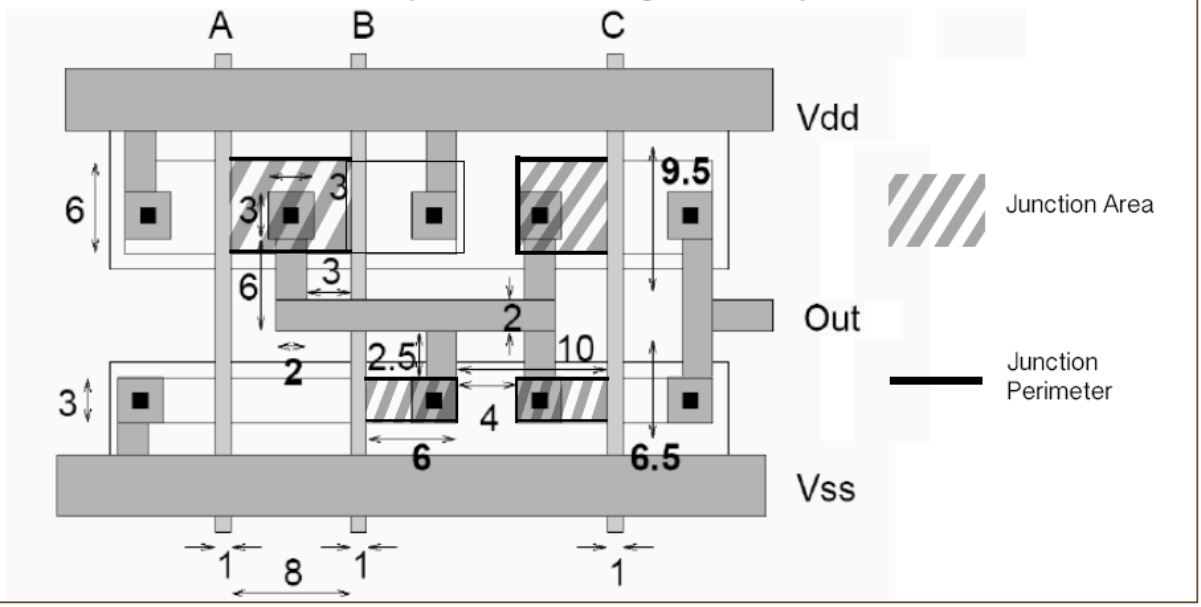
QUESTION:

Estimate the total capacitance at the output of the NAND gate in the following layout. All dimensions are in microns and drawn to scale. Assume that Cja = 0.5 fF/um2 and Cjp = 0.45fF/um for both n and p transistors. Consider only the parallel plate capacitance component of the interconnect capacitance and use the interconnect capacitance values given in the previous slide.



SOLUTION:

$$Junction\ Capacitance\ (C) = C_{ja}\,YW + C_{jb}\,(2Y + W), where\ C_{ja} = 0.50\ fF/\mu m^2\ , C_{jb} = 0.45\ fF/\mu m^2$$

Junction / Interconnect	Calculation	Capacitance (fF)
Junction 1	$= 0.5 \times 10^{-3} (6 \times 8 \times 10^{-12}) + 0.45 \times 10^{-9} (2 \times 8 \times 10^{-6})$	31.20×10^{-15}
Junction 2	$= 0.5 \times 10^{-3} (6 \times 3 \times 10^{-12}) + 0.45 \times 10^{-9} (2 \times 6 \times 10^{-6} + 3 \times 10^{-6})$	15.75×10^{-15}
Junction 3	$= 0.5 \times 10^{-3} (6 \times 3 \times 10^{-12}) + 0.45 \times 10^{-9} (2 \times 6 \times 10^{-6} + 3 \times 10^{-6})$	15.75×10^{-15}
Junction 4	$= 0.5 \times 10^{-3} (6 \times 6 \times 10^{-12}) + 0.45 \times 10^{-9} (2 \times 6 \times 10^{-6} + 6 \times 10^{-6})$	26.10×10^{-15}
Poly over field oxide	$= 0.066 \times 10^{-3} \times 1 \times 2 \times 10^{-12}$	0.132×10^{-15}
M1 over field oxide	$= (0.030 \times 10^{-3} \times 5 \times 2 \times 10^{-12}) + (0.030 \times 10^{-3} \times 10 \times 2 \times 10^{-12})$	0.90×10^{-15}
M1 over Poly	$= 0.053 \times 10^{-3} \times 2 \times 1 \times 10^{-12}$	0.106×10^{-15}
	Total Capacitance:	**89.94 fF**