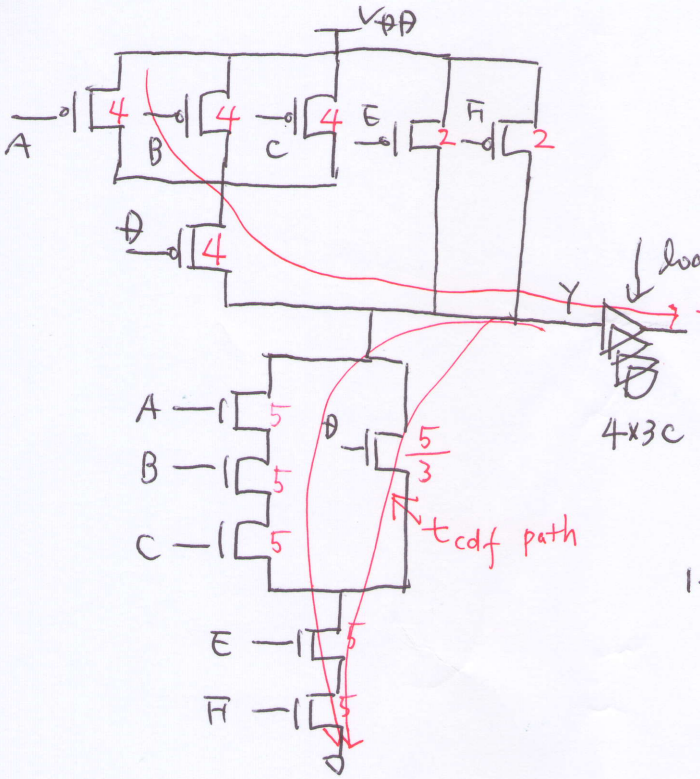
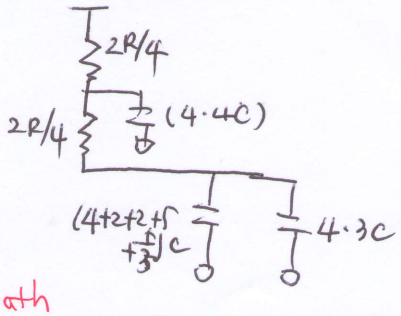
1. a) b)

6 6



1. c)

7

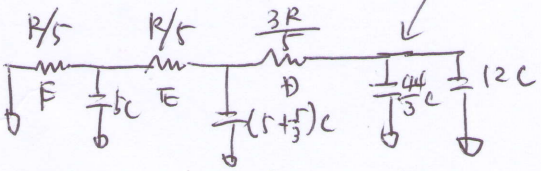


$t_{pdr} = \frac{R}{2}\cdot 16C + (\frac{R}{2}+\frac{R}{2})\cdot(\frac{44}{3}C + 12C)$

$= \frac{104}{3}RC = \frac{104}{3}\cdot\frac{1}{6}ps = 17.3\ ps$

1. d)

7



$t_{cdf} = RC + \frac{4}{3}RC + \frac{2}{5} + R\cdot\frac{80}{3}C$

$= (\frac{423}{15}RC) = 47ps$

1. c) 1. d) ⇐ Results depend on the circuit topology!!

1. e) $g_{A_2} = \frac{9}{3} = 3$

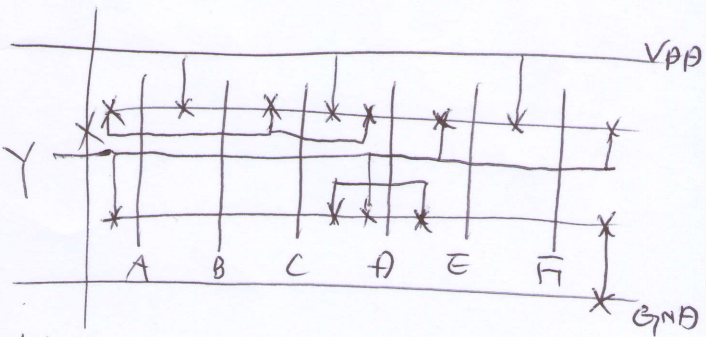
$g_{D_2} = \frac{17/3}{3} = \frac{17}{9}$

$g_{E_2} = \frac{17}{3}$

1. f) $p_5 = \frac{4+2+2+5+\frac{5}{3}}{3} = \frac{44}{9}$

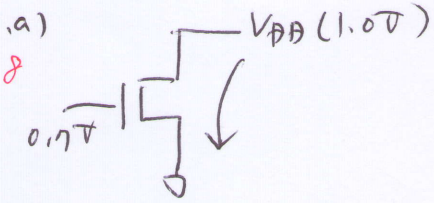
1. layout

10



2. a)

8



$V_{gs}(0.1) - V_{to}(0.3) < V_{ds}(1.0)$

⇒ saturation 2

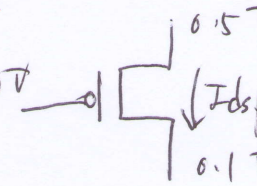
$I_{dsn} = \frac{1}{2}\beta_n (V_{gs} - V_{to})^2 (1 + \lambda V_{ds})$ (2)

$= \frac{1}{2}\cdot 1mA\,(0.1-0.3)^2(1+0.02\cdot 1)$

$= 21.6\ uA$

2. b)

12



6 $V_{tp} = -(V_{to} + \gamma(\sqrt{\phi_s + V_{sb}} - \sqrt{\phi_s}))$

$= -(0.3 + 0.3(\sqrt{0.6+0.5} - \sqrt{0.6})) = -0.38V$

2 $V_{gsp} - V_{tp} > V_{dsp}$ ⇒ saturation

$-0.5 - -0.38 \quad -0.4$

$I_{dsp} = \frac{1}{2}\beta_p (= \beta_n)(V_{gsp} - V_{tp})^2 (1 + \lambda V_{dsp})$ (2) (2)

$= \frac{1}{2}\cdot 1mA/V^2(-0.5+0.38)(1+0.02\cdot(-0.4)) = -7.26mA$

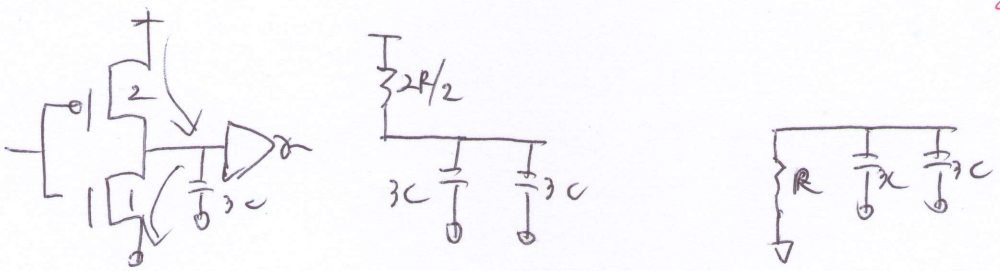
3. # of inverters = the smallest even integer $\lceil t_{skew} / \max(t_{pdr}, t_{pdf}) \rceil$

13 (4) (1.3/1) (5)

$= 2$

$t_{pdr} = 6RC$ (2)

$t_{pdf} = 6RC = 1\,ps$ (2)



4 (4分)

① True (doping density ↑ ⇒ conductance ↑ ⇒ resistance ↓)

② False (drain(source)-to-gate connection generates more dropped output)

③ True (hot electron effect ⇒ Vt ↑ ⇒ subthreshold leakage ↓)

④ True or False ('F' corner for power, 'S' corner for speed)

⑤ True (Isub between drain and body is increased)