ECE 398GG – ELECTRICAL VEHICLES

9. Electric Drives for EVs

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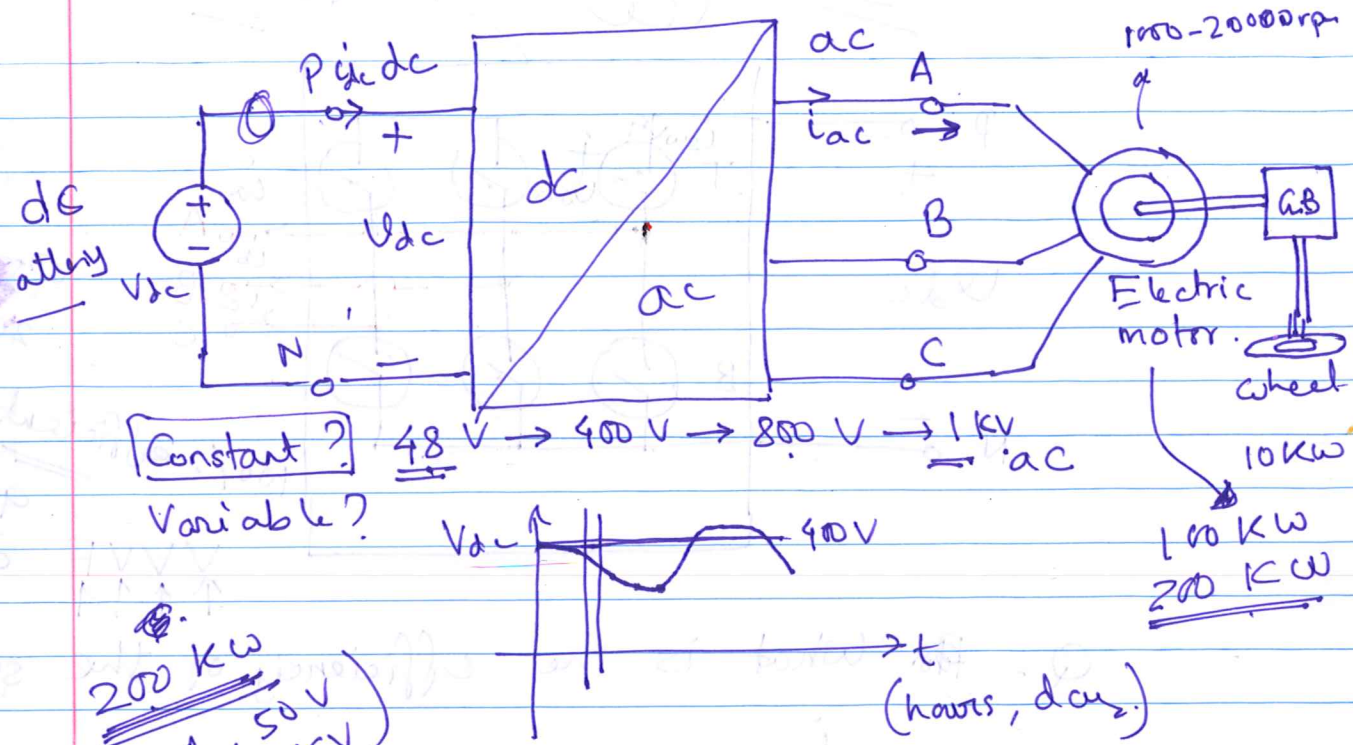
$\omega_0 \propto$ rpm



Constant ? 48 V → 400 V → 800 V → 1 KV ac

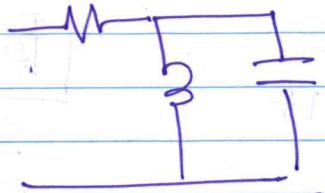
Variable ?

200 KW
400 A, 50 V
20 A, 1 KV

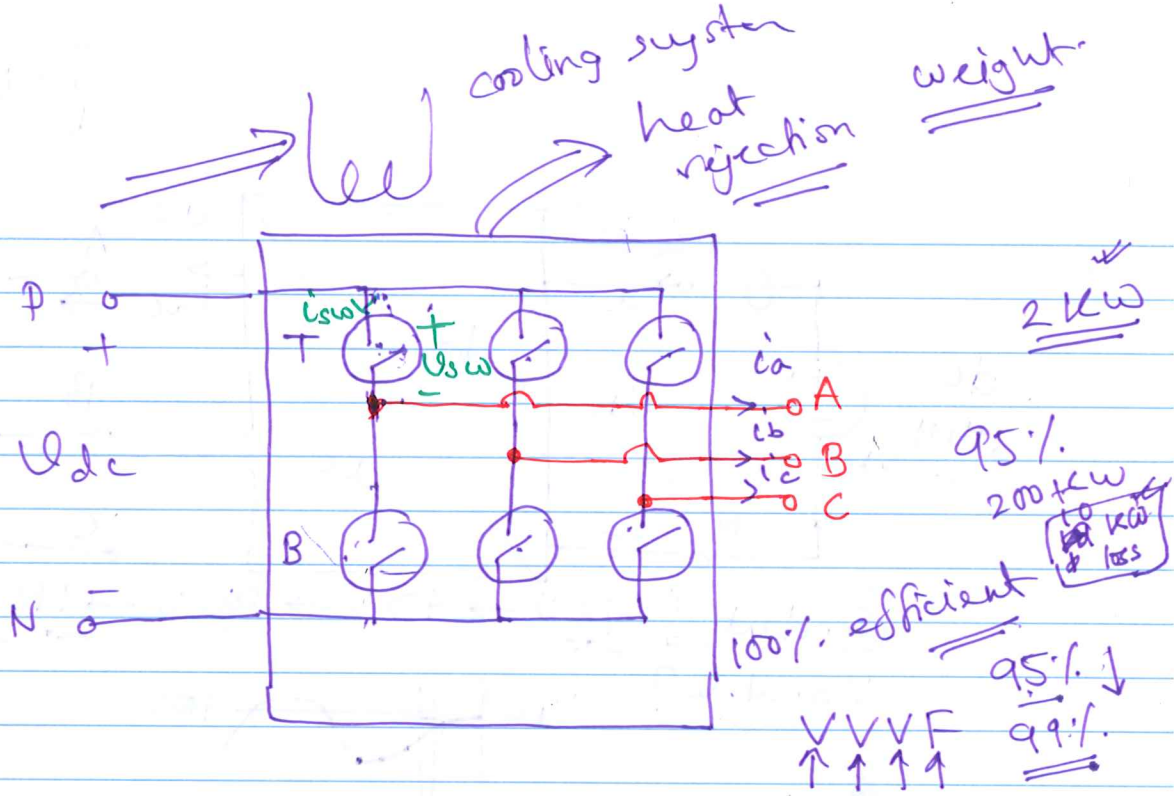
$P_{input} = v_{dc} \cdot i_{dc}$

$V_a = V_m \cos \omega_0 t$

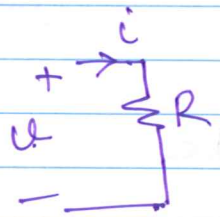
$i_a = I_m \cos(\omega_0 t + \phi)$



* Non-linear circuit → frequency transformation
  - ↳ Power electronics → processing power
  - ↳ X signal electronics → information



Q. What is the efficiency of the system?



$v = iR$

$p = v \cdot i$

p ← instantaneous power

Top switch to be ON

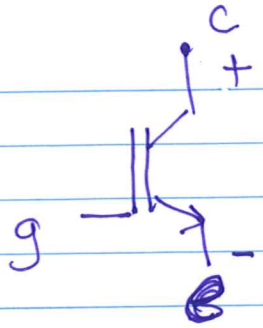
Bottom switch to be OFF

$$P_{sw} = V_{sw} \cdot i_{sw}$$

Switch ON $\Rightarrow V_{sw} = 0$

Switch OFF $\Rightarrow i_{sw} = 0$

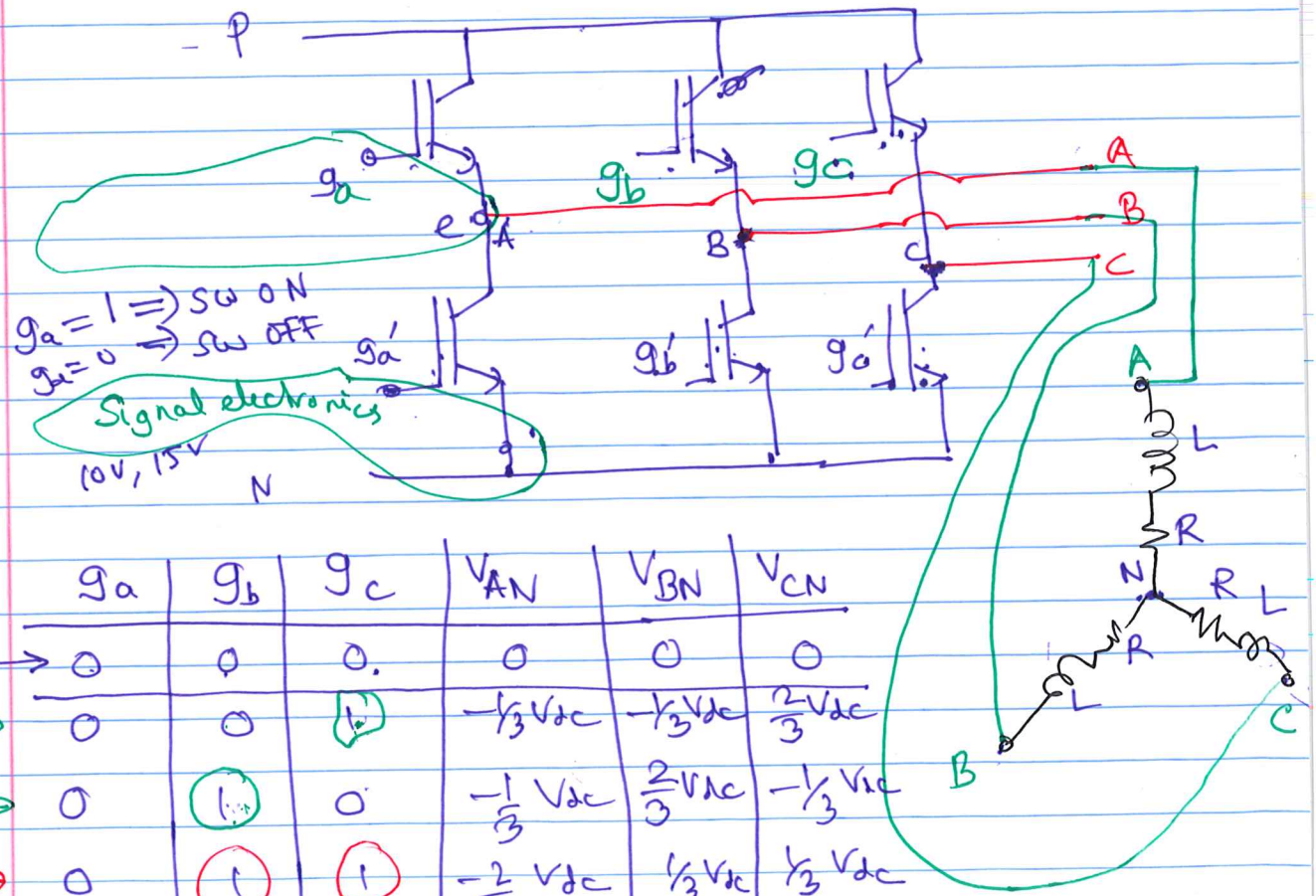
$\forall t \Rightarrow P_{sw} = 0$.



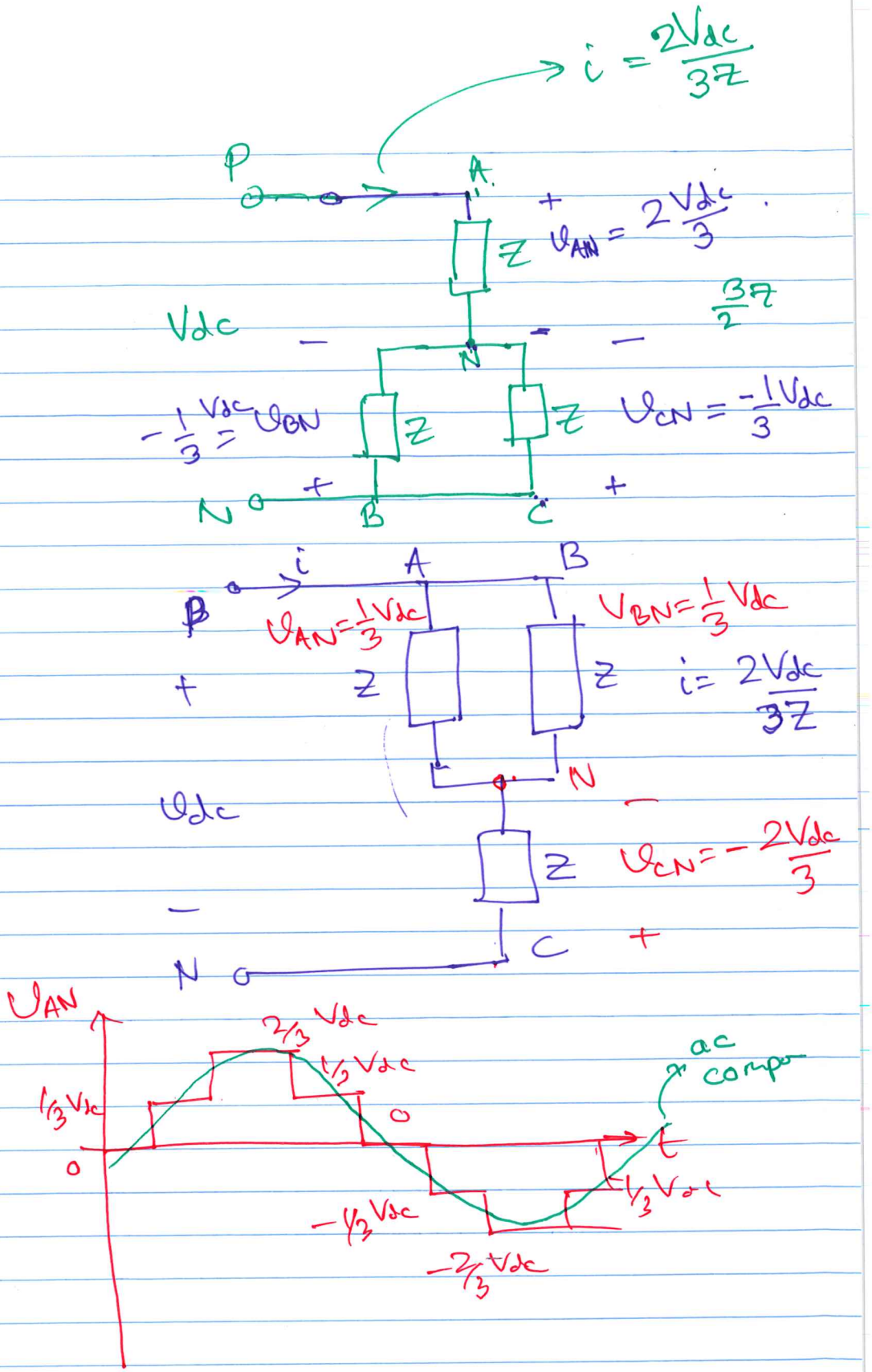
IGBT (Silicon device)

Power Semiconductor device

$V_{ge} > V_{th}$ SiC (Silicon carbide MOSFET)



g_a	g_b	g_c	V_{AN}	V_{BN}	V_{CN}
0	0	0	0	0	0
0	0	1	$-\frac{1}{3}V_{dc}$	$-\frac{1}{3}V_{dc}$	$\frac{2}{3}V_{dc}$
0	1	0	$-\frac{1}{3}V_{dc}$	$\frac{2}{3}V_{dc}$	$-\frac{1}{3}V_{dc}$
0	1	1	$-\frac{2}{3}V_{dc}$	$\frac{1}{3}V_{dc}$	$\frac{1}{3}V_{dc}$
1	0	0	$\frac{2}{3}V_{dc}$	$-\frac{1}{3}V_{dc}$	$-\frac{1}{3}V_{dc}$
1	0	1	$\frac{1}{3}V_{dc}$	$-\frac{2}{3}V_{dc}$	$\frac{1}{3}V_{dc}$
1	1	0	$\frac{1}{3}V_{dc}$	$\frac{1}{3}V_{dc}$	$-\frac{2}{3}V_{dc}$
1	1	1	0	0	0


$i = \frac{2V_{dc}}{3Z}$
P
A
+
Z
$v_{AN} = \frac{2V_{dc}}{3}$
$\frac{3Z}{2}$
V_{dc}
−
N
$-\frac{1}{3}V_{dc} = v_{BN}$
Z
Z
$v_{CN} = \frac{-1}{3}V_{dc}$
N
+
B
C
+
i
A
B
B
$v_{AN} = \frac{1}{3}V_{dc}$
$V_{BN} = \frac{1}{3}V_{dc}$
+
Z
Z
$i = \frac{2V_{dc}}{3Z}$
N
v_{dc}
−
Z
$v_{CN} = -\frac{2V_{dc}}{3}$
−
C
+
N
v_{AN}
$\frac{2}{3}V_{dc}$
$\frac{1}{3}V_{dc}$
$\frac{1}{3}V_{dc}$
0
0
ac comp
t
$-\frac{1}{3}V_{dc}$
$\frac{1}{3}V_{dc}$
$-\frac{2}{3}V_{dc}$