EEE213 Power Electronics and Electromechanism

Lab arrangement (Room EE411)

11th April Thursday (9:00-12:00 & 2:00 -5:00) 

Deadline: May 5th, 23:55pm

TA (PhD students) :

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EEE213 Power Electronics and Electromechanism

Assignment 1

Deadline: 12th May2019. Time: 23.55.

Assignment 2

Deadline: 19th May 2019. Time: 23.55.

ALL Tutorial questions (week11 &12) and all inquiries for Assignments

TA (PhD student) : room EE511

1. Yujie Liu: Yujie.liu@xjtlu.edu.cn

EEE213 Power Electronics and Electromechanism

Tutorial 2

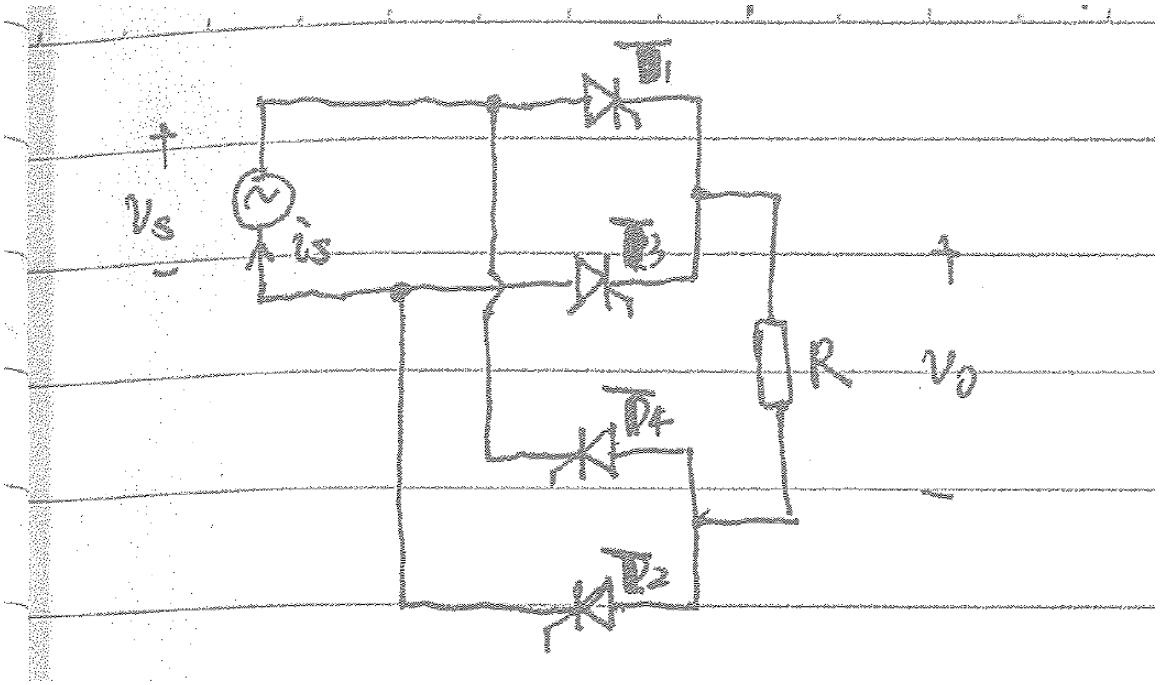
Outline

- Full-wave converter (Lecture 6)
  - Problem 4.1
  - Problem 4.2
- Three-phase full bridge SCR rectifier (Lecture 5)
  - Problem 5.1
  - Problem 5.2

Problem 4.1

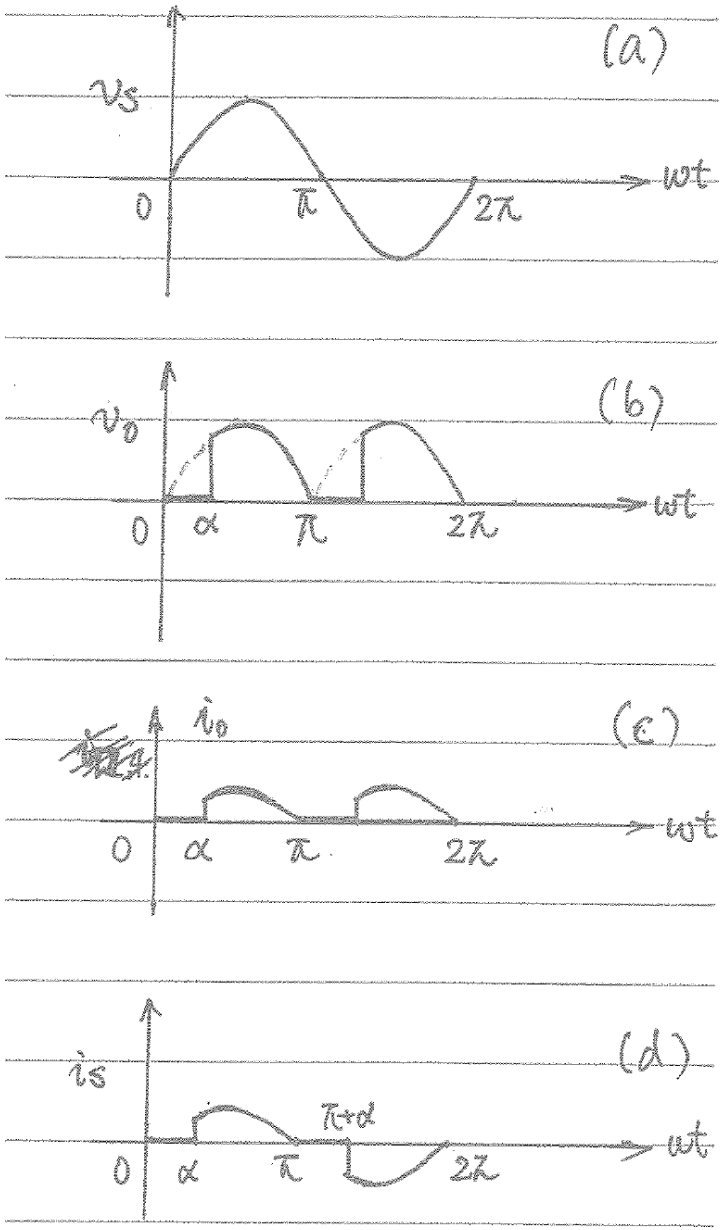
- A full-wave converter is connected to a 100V-50Hz supply v_s. The load is purely resistive with R=10 ohm.
  - (1) Draw the waveforms for the output voltage, the current, and the line current for a firing angle; (Refer to Lecture 6, page 8)
  - (2) Express the line current i_s in a Fourier series;
  - (3) Determine the THD of the line current; (Refer to Lecture 2, page 22)
  - (4) Determine the displacement power factor $cos\phi$ and the line power factor f_P; (Refer to Lecture 2, page 23)
  - (5) If the firing angle is $\alpha = \pi/3$, calculate V_0, THD, $cos\phi$, f_P and the power dissipated by the load.

Full-wave controller



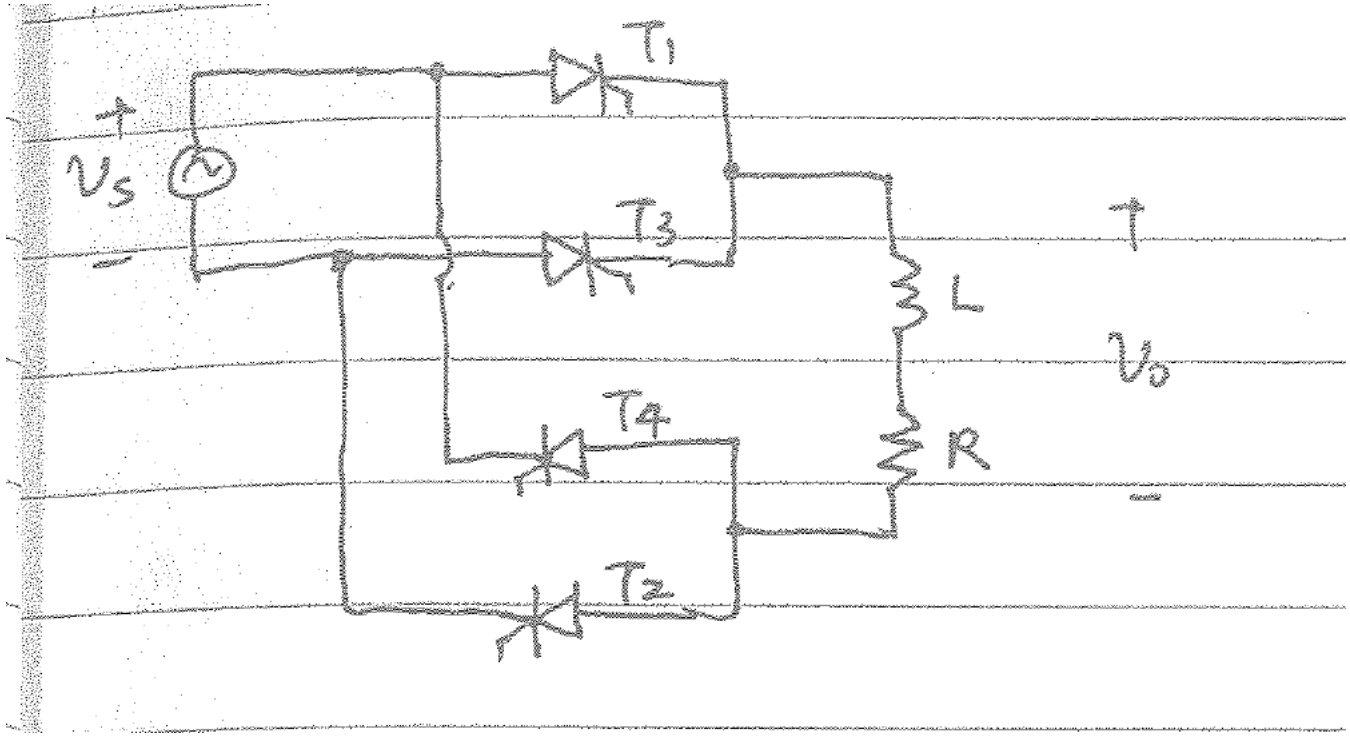
- The positive half-cycle goes through T1, R and T2, while the negative half-cycle goes through T3, R and T4.

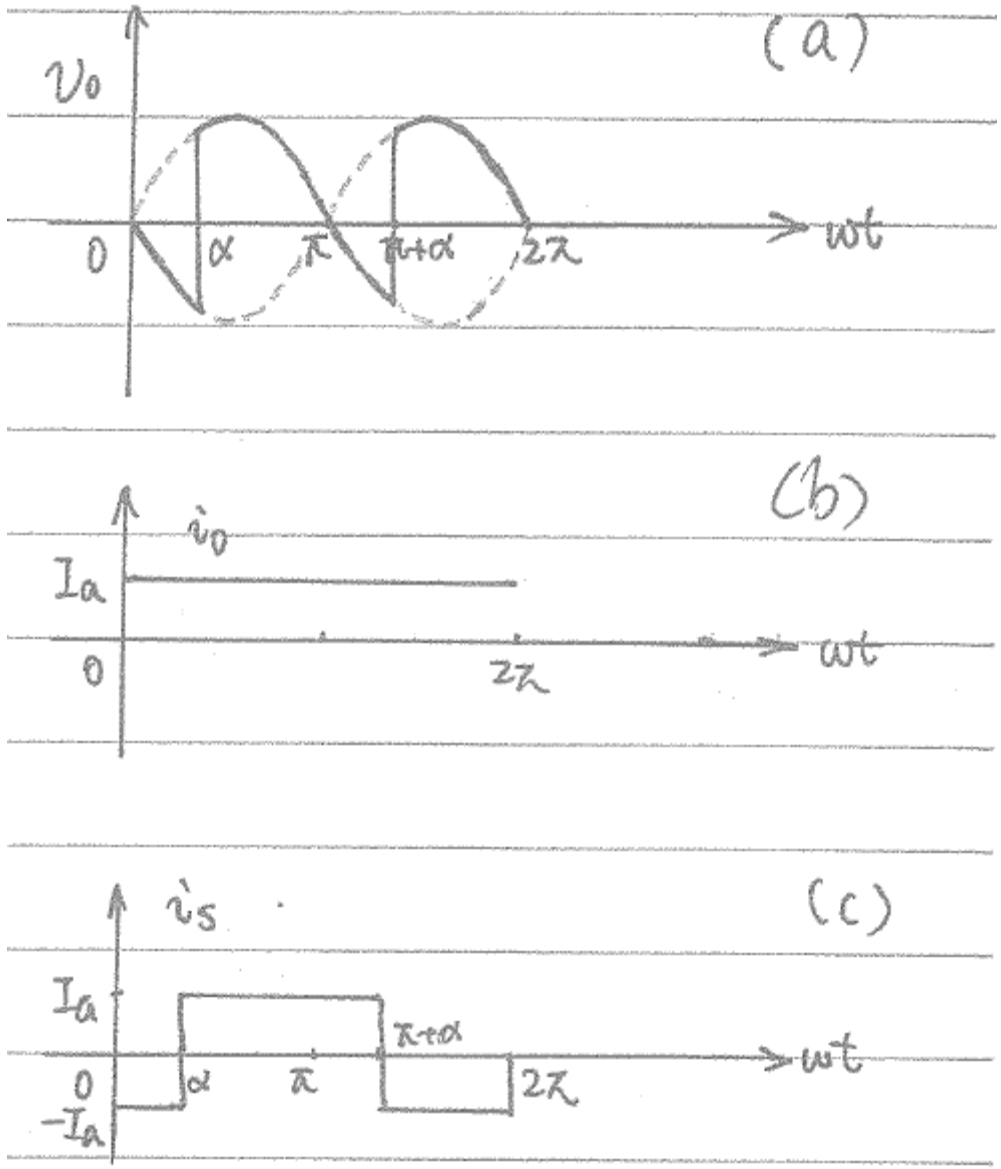
Waveforms


(a)
v_s
0
π
2π
ωt
(b)
v_0
0
α
π
2π
ωt
(c)
i_0
0
α
π
2π
ωt
(d)
i_s
0
α
π
$\pi+\alpha$
2π
ωt

Problem 4.2

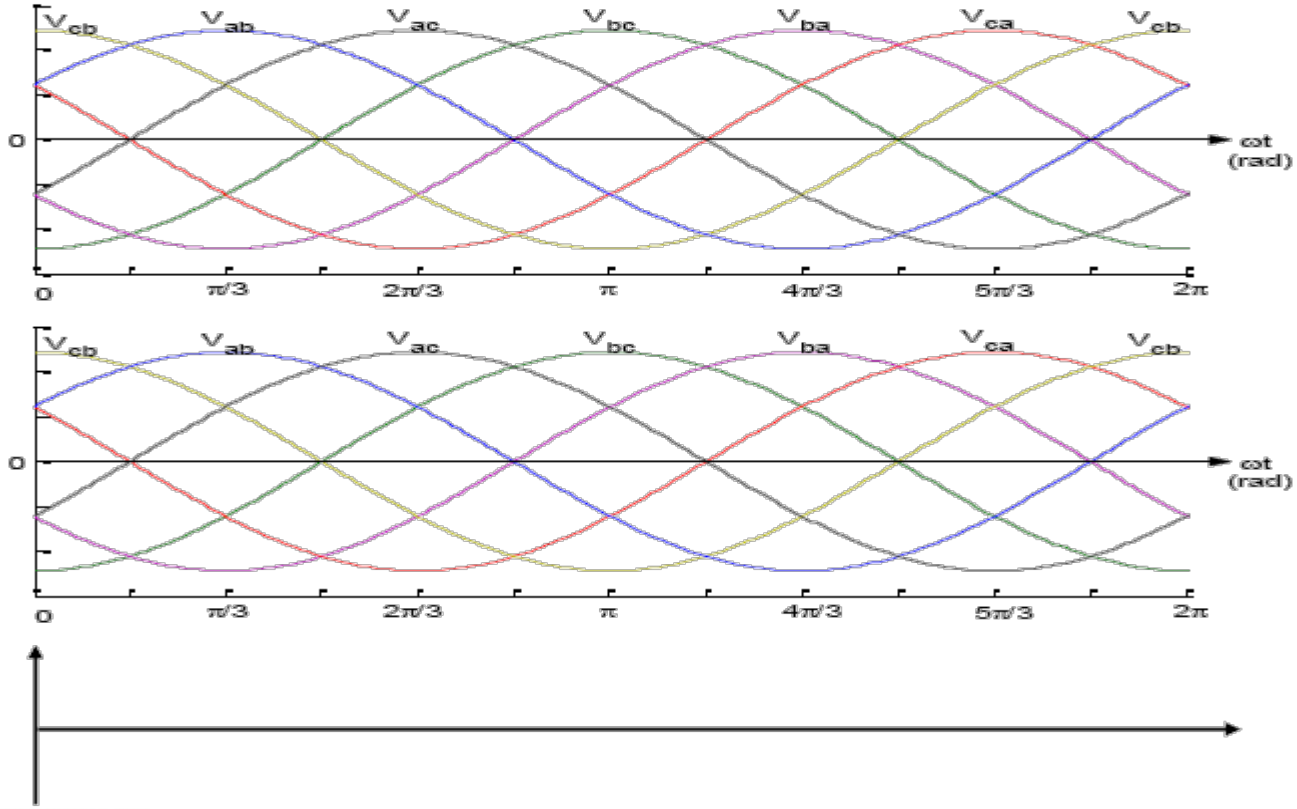
- Repeat the previous question when a very large inductor is put into series with the resistor.

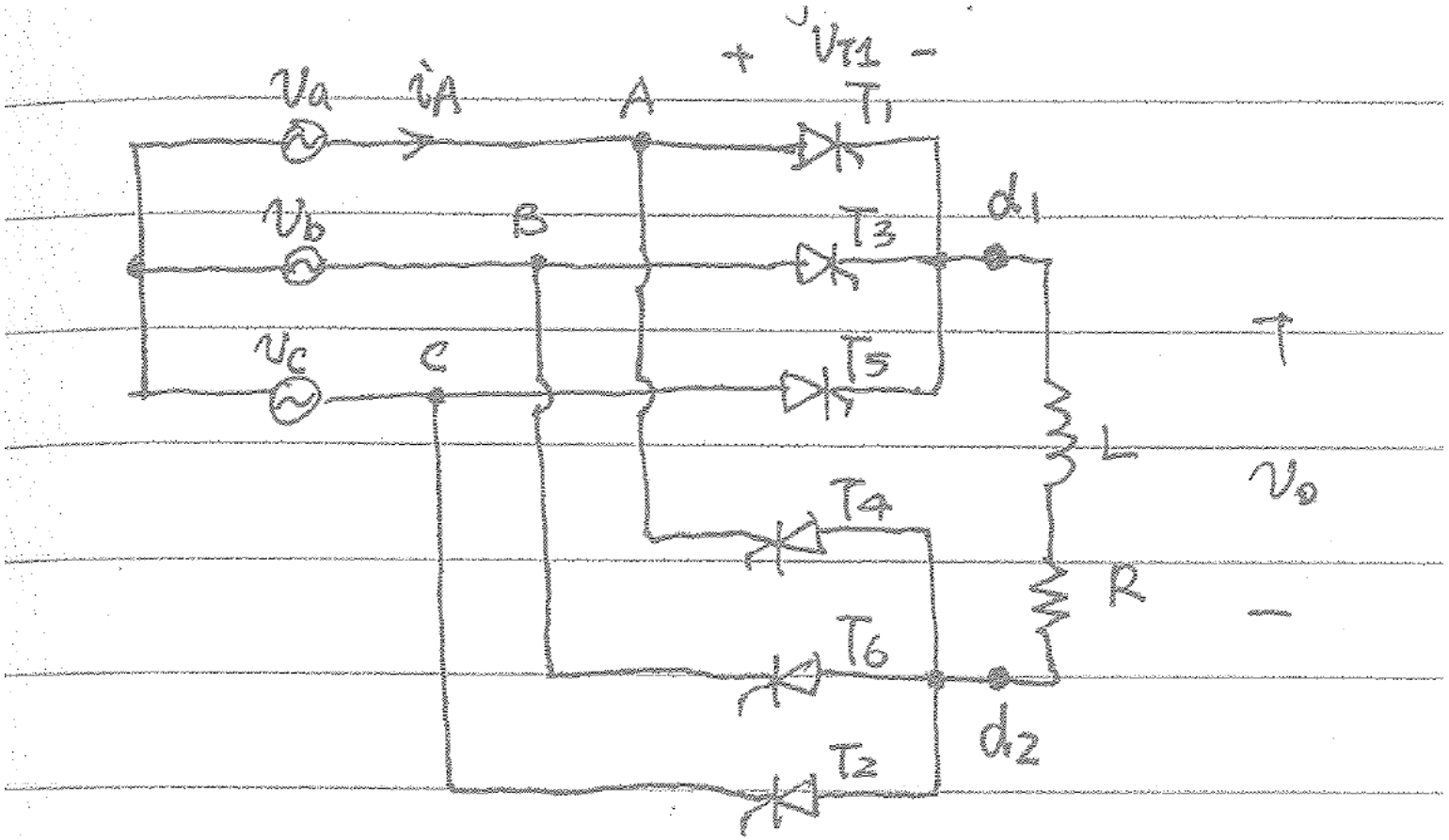

T1
+
Vs
T3
L
+
Vo
T4
R
T2

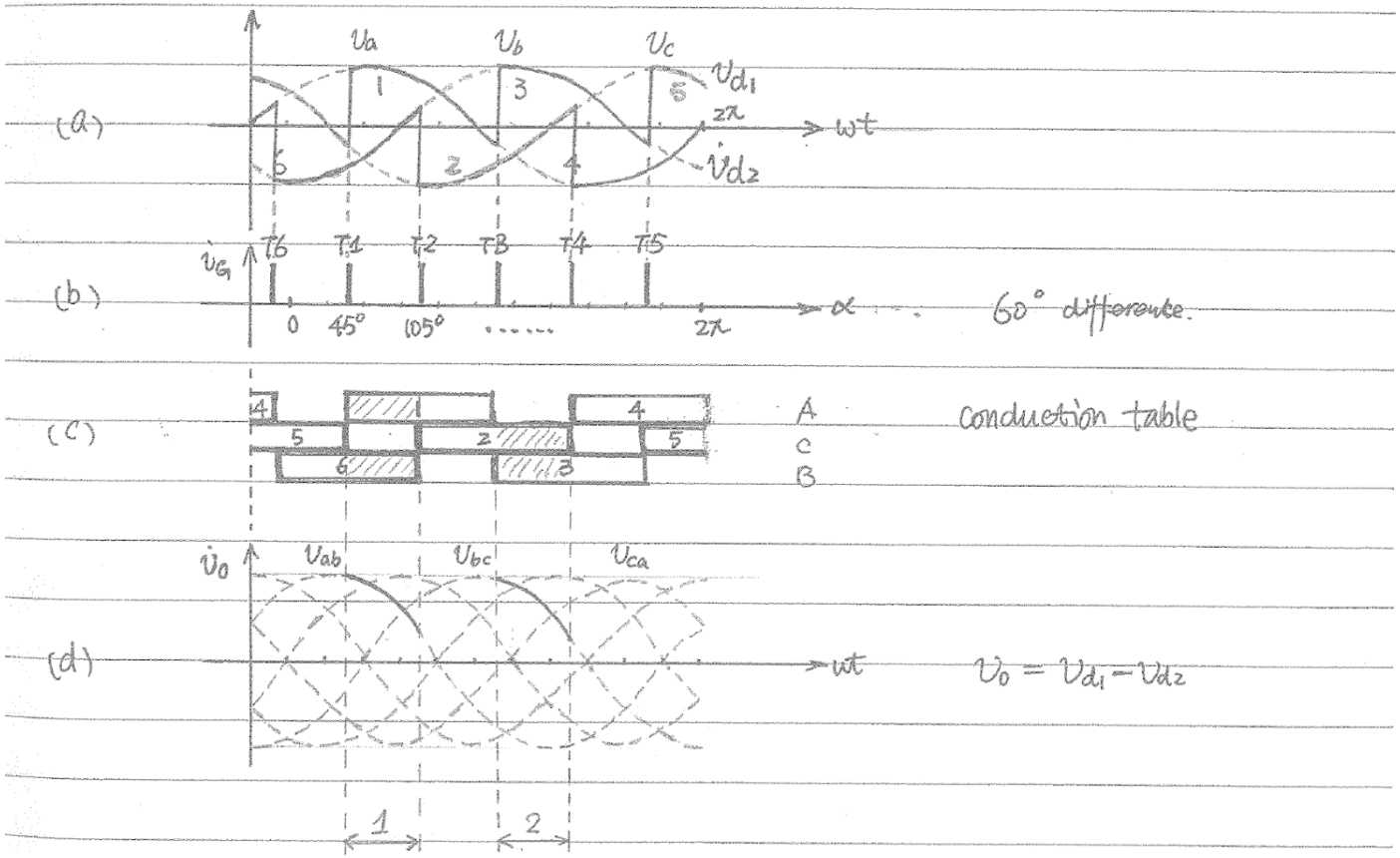

(a)
v_o
0
α
π
$\pi+\alpha$
2π
ωt
(b)
i_o
I_a
0
2π
ωt
(c)
i_s
I_a
0
$-I_a$
α
π
$\pi+\alpha$
2π
ωt

Problem 5.1

- A three-phase full bridge SCR rectifier supplies a DC power to an RL load. The output current ripple is negligible. The firing angle is 45°.
  - Draw the waveforms for the output voltage, the voltage across SCR1, and the line current of phase A.




+
v_{T1}
−
v_a
i_A
A
T_1
v_b
B
T_3
d_1
v_c
C
T_5
T
L
v_o
T_4
R
−
T_6
d_2
T_2



In this region 1 ($75° \leq \omega t \leq 135°$)

(c) $\longrightarrow$ Thyristor 1 & 6 are conducting, $v_{d1} = v_a$, $v_{d2} = v_b$ $\Big\}$ $v_o = v_{ab}$

In region 2 ($195° \leq \omega t \leq 255°$)

Thyristor 2 & 3 are conducting. $v_{d1} = v_b$, $v_{d2} = v_c$ $\Big\}$ $v_o = v_{bc}$

The output voltage can be drawn according to this ~~easy~~ analysis.

(e) The voltage across T1. ☆ $V_T = V_{anode} - V_{cathode}$

There are situations:

<1> T1 is conducting $\Rightarrow v_{T1} = 0$.

range: $75° \sim 195°$.

<2> T1 closed, T3 is conducting

$-v_{T1} = v_{d1} - v_a = v_b - v_a$

$\Rightarrow v_{T1} = v_a - v_b = v_{ab}$

range: $195° \sim 315°$.

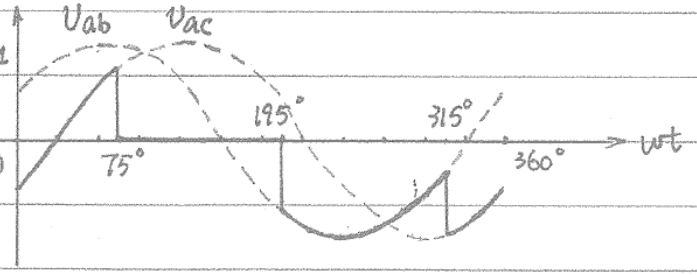
<3> T1, T3 closed, T5 is conducting.

$v_{T1} = v_a - v_{d1} = v_a - v_c = v_{ac}$

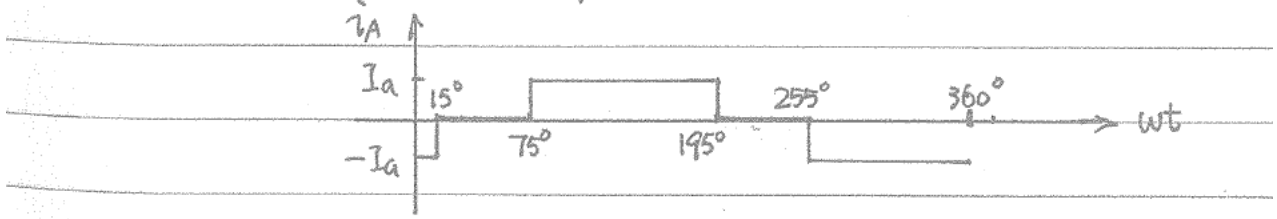
range: $315° \sim 435°$

$\Leftrightarrow 315° \sim 360° + 0° \sim 75°$.

Plot: v_{T1}

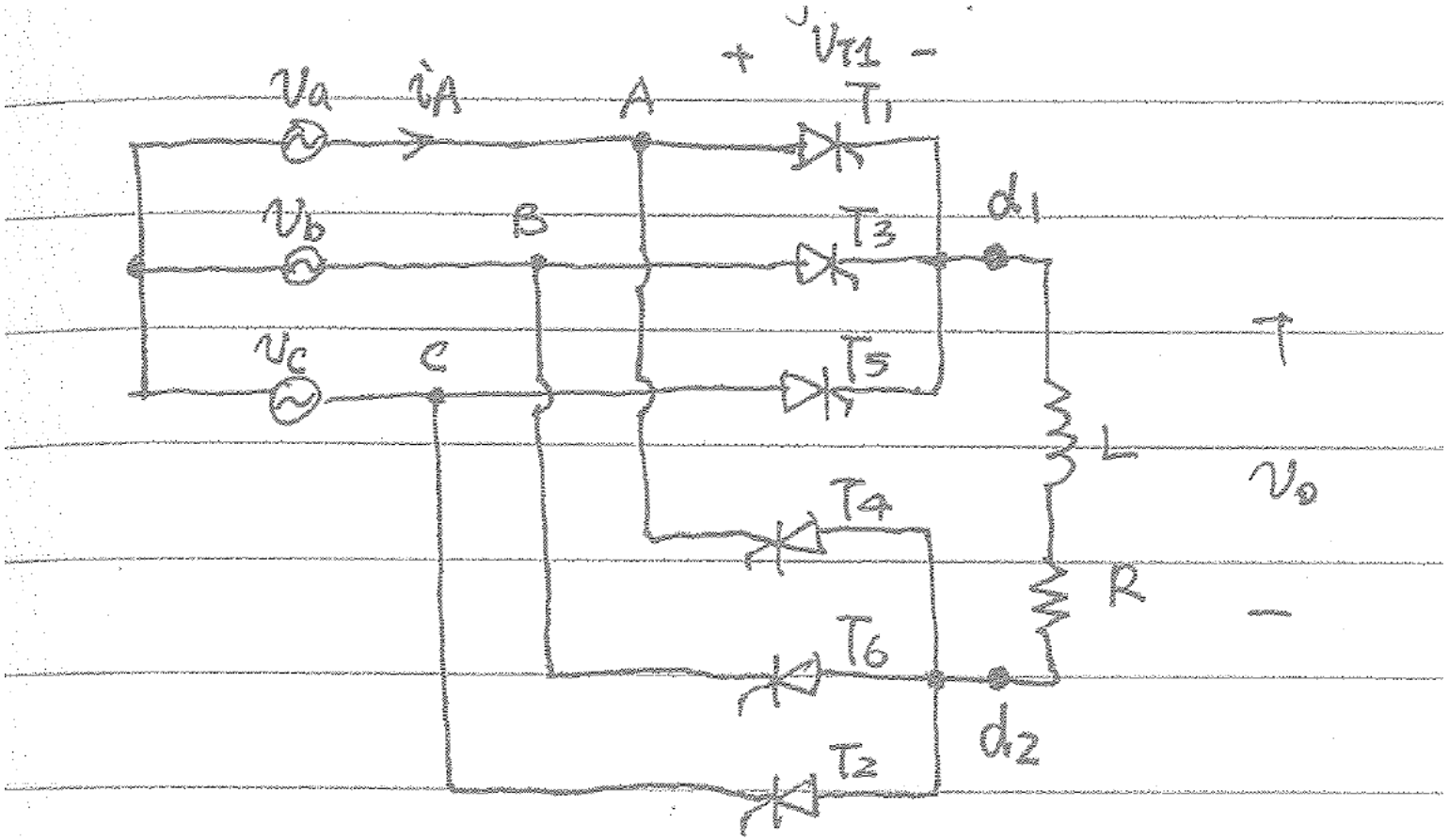


(f) Line current for phase A.



Problem 5.2

- A resistive load R=10 in series with a very large inductor is supplied by a bridge rectifier connected to a three-phase power supply with a phase voltage of 100V. It is required to obtain an average voltage of 150V. Calculate
  - 1)The firing angle needed; (Lecture 5, page 24)
  - 2)The average current;
  - 3)The rms output voltage and current; (Lecture 5, page 24)
  - 4)The power consumed by R;
  - 5)The average and rms values of a thyristor current; (Lecture 5, page 11)
  - 6)The rms line current;
  - 7)The input power factor.
  - Draw the waveforms for the output voltage, a thyristor voltage and a line current.


v_{T1}
+
−
v_a
i_A
A
T_1
v_b
B
T_3
d_1
v_c
C
T_5
L
v_o
T_4
R
−
T_6
d_2
T_2