Homework 4

Page 95, Chinese textbook

Question 12

Considering a three-phase bridge fully-controlled rectifier circuit under a resistive load, if one thyristor cannot be conducted, what does the rectifier voltage waveform u_d look like? If one thyristor has been broken down and is a short circuit now, what is the influence on the other thyristors?

Question 13

Considering a three-phase bridge fully-controlled rectifier circuit with $U_2 = 100V$, under a resistive and inductive load with $R = 5\Omega$ and very large inductance, when $\alpha = 60°$:

1) Draw the waveform of u_d, i_d and i_{VT_1};
2) Calculate U_d, I_d, I_{dVT}, and I_{VT}.

Question 15

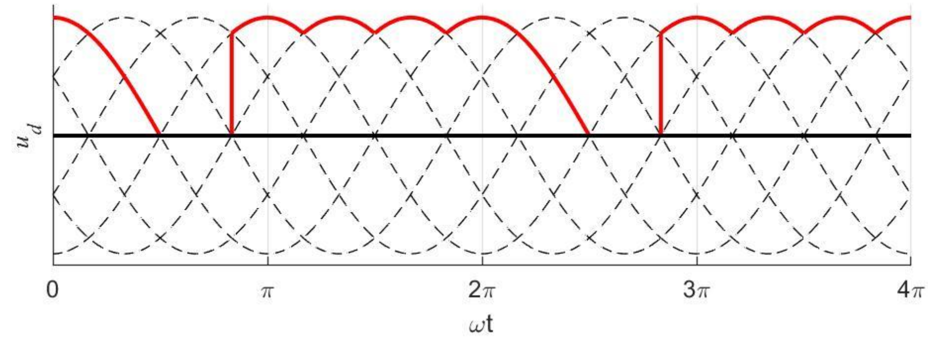
Considering a three-phase half-wave controlled rectifier circuit connected to a EMF load with resistor and inductor, when $U_2 = 100\text{V}$, $R = 1\Omega$, $L = \infty$, $L_B = 1\text{mH}$, $\alpha = 30°$, $E = 50\text{V}$, calculate the value of U_d, I_d, γ and draw the waveform of u_d, i_{VT_1}, i_{VT_2}.

Question 16

Considering a three-phase bridge uncontrolled rectifier circuit connected to a resistive and inductive load, with $R = 2\Omega$, $L = \infty$, $U_2 = 100\text{V}$, $X_B = 0.1\Omega$, calculate the value of U_d, I_d, I_{VD}, I_2 and γ, and draw the waveform of u_d, i_{VD}, and i_2.

Answer 3.12

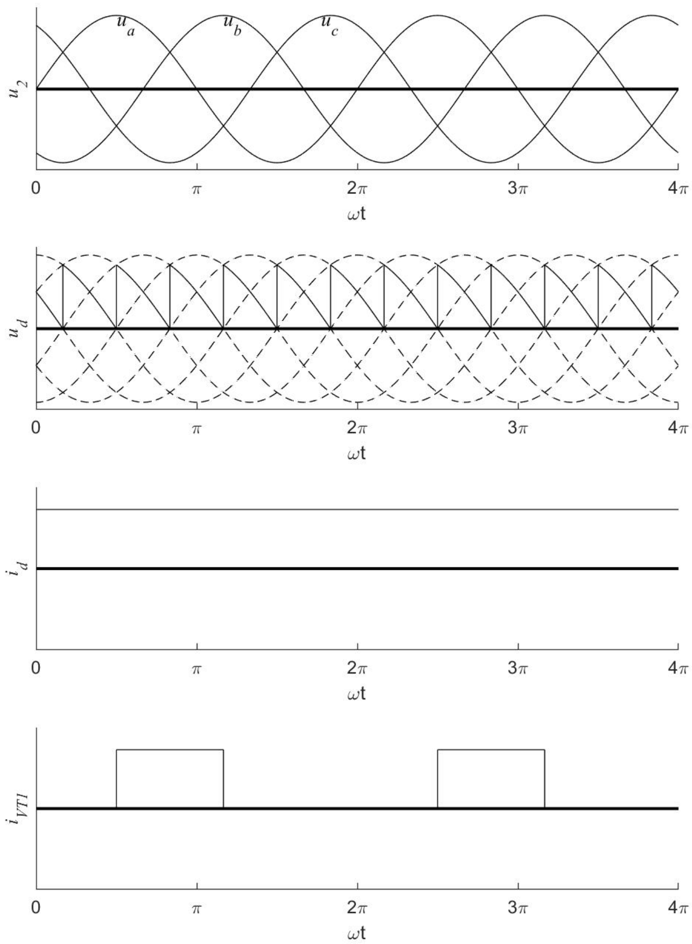
Supposing the VT_1 isn't turned on, the waveform of rectified voltage u_d is



If the VT_1 is broken down to become short circuit and the thyristor VT_3 and VT_5 is turned on, power is shorted-circuited, which will make the VT_3 and VT_5 break down.

Answer 3.13

(1) The waveform of u_d, i_d and i_{VT1}:



(2) The result of U_d, I_d, I_{dVT}, and I_{VT}.

$$U_d = 2.34 U_2 \cos\frac{\pi}{3} = 2.34 \times 100 \times \cos\frac{\pi}{3} V = 117V$$

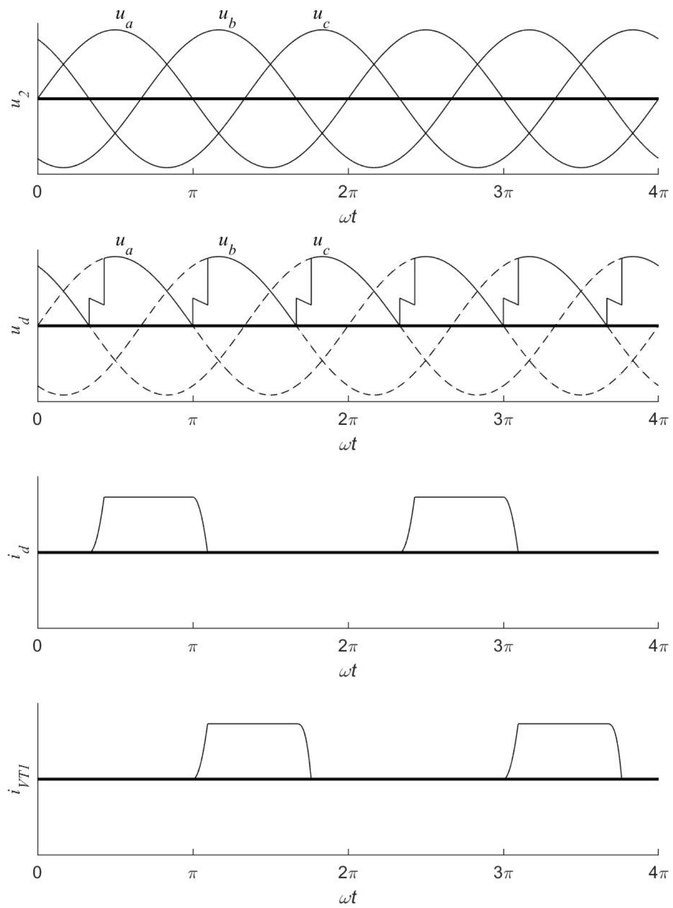
$$I_d = \frac{U_d}{R} = \frac{117V}{5\Omega} = 23.4A$$

$$I_{DVT} = \frac{I_d}{3} = \frac{23.4A}{3} = 7.8A$$

$$I_{VT} = \frac{I_d}{\sqrt{3}} = \frac{23.4A}{\sqrt{3}} = 13.51A$$

Answer 3.15

the waveform of u_d, i_{VT_1}, i_{VT_2}:



Given that L_B = 1mH, it's known that

$$
\begin{cases}
U_d = 1.17U_2 \cos\alpha - \Delta U_d \\
\Delta U_d = \dfrac{3X_B I_d}{2\pi} \\
I_d = \dfrac{(U_d - E)}{R}
\end{cases}
$$

Solutions of equations are:

$$
\begin{cases}
U_d = 94.3V \\
\Delta U_d = 6.7V \\
I_d = 44.63A
\end{cases}
$$

We can get the relationship that

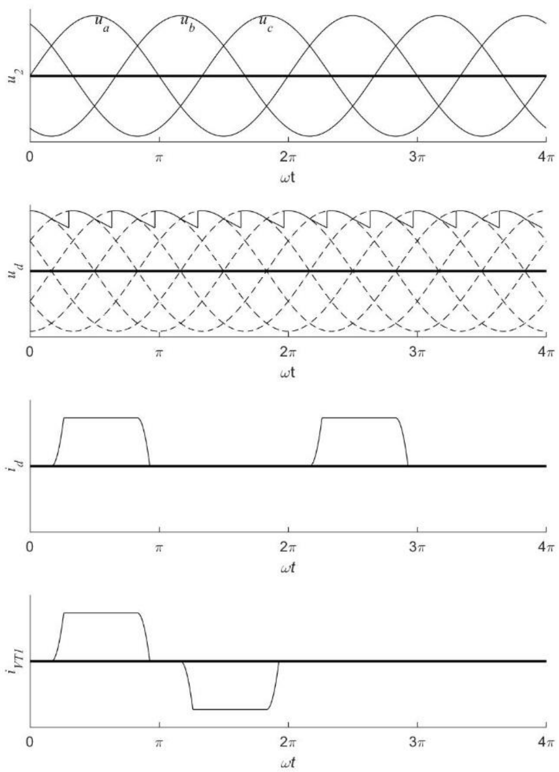
$$
\begin{cases}
\alpha = \dfrac{\pi}{6} \\
\gamma = 11.28^{\circ}
\end{cases}
$$

for the reason that

$$
\cos\alpha - \cos(\alpha + \gamma) = \frac{2I_d X_B}{\sqrt{6}U_2}
$$

Answer 3.16

The waveform of u_d, i_{VD}, and i_2:



A three-phase bridge uncontrolled rectifier circuit is equivalent to A three-phase bridge controlled rectifier circuit with $\alpha = 0$.

$$\begin{cases} U_d = 2.34 U_2 \cos\alpha - \Delta U_d \\ \Delta U_d = \dfrac{3 X_B I_d}{\pi} \\ I_d = \dfrac{U_d}{R} \end{cases}$$

Solutions of equations are:

$$\begin{cases} U_d = 486.9V \\ \Delta U_d = 97.38A \end{cases}$$

We can get the relationship that

$\gamma = 26.93^{\circ}$

for the reason that

$$\cos\alpha - \cos(\alpha + \gamma) = \frac{2 I_d X_B}{\sqrt{6} U_2}$$

Therefore, the RMS value of the current of diode and the secondary winding of transformer is

$$I_{VD} = \frac{I_d}{3} = \frac{97.38A}{3} = 32.46A$$

$$I_2 = \sqrt{\frac{2}{3}} I_d = \sqrt{\frac{2}{3}} \times 97.38A = 79.5104A$$