The Fourier series of the output voltage of a positive half-wave three-phase rectifier is given by:

\[ V_{out} = \frac{3\sqrt{3} V_m}{2\pi} + \sum_{n=1}^{\infty} a_n \sin n\theta + \sum_{n=1}^{\infty} b_n \cos n\theta \]

where

\[ a_n = \frac{2}{\frac{2\pi}{3}} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} \Phi_m \sin \theta \cdot \sin n\theta \, d\theta \]

\[ = \frac{3V_m}{2\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} \frac{1}{2} (\cos(n+1)\theta - \cos(n-1)\theta) \, d\theta \]

\[ = \frac{3V_m}{2\pi} \left\{ \frac{\sin(n+1)\theta}{n+1} - \frac{\sin(n-1)\theta}{n-1} \right\} \frac{5\pi}{6} \]

\[ b_n = \frac{2}{\frac{2\pi}{3}} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} V_m \sin \theta \cos n\theta \, d\theta = \frac{3V_m}{2\pi} \int_{\frac{\pi}{6}}^{\frac{5\pi}{6}} \left( \sin(n+1)\theta - \cos(n-1)\theta \right) \, d\theta \]

\[ = \frac{3V_m}{2\pi} \left\{ -\frac{\cos(n+1)\theta}{n+1} + \frac{\cos(n-1)\theta}{n-1} \right\} \frac{5\pi}{6} \]
Three-Phase Full Bridge Rectifier with Ideal Source $L_s = 0$:
Mode 1:
\[ |v_{AB}| > |v_{BC}| \& |v_{CA}| \]

\[ v_{AB} > 0 \]

D₁ & D₆ conduct

Mode 2:
\[ |v_{CA}| > |v_{AB}| \& |v_{BC}| \]

\[ v_{AC} > 0 \]

D₁ & D₂ conduct

Mode 3:
\[ |v_{BC}| > |v_{AB}| \& |v_{CA}| \]

\[ v_{BC} > 0 \]

D₃ & D₂ conduct

Mode 4:
\[ |v_{AB}| > |v_{BC}| \& |v_{CA}| \]

\[ v_{BA} > 0 \]

D₃ & D₄ conduct
Mode 5:

\[ |v_{CA}| > |v_{AB}| \& |v_{BC}| \]

\[ v_{CA} > 0 \]

D_5 \& D_4 conduct

Mode 6:

\[ |v_{BC}| > |v_{AB}| \& |v_{CA}| \]

\[ v_{CB} > 0 \]

D_5 \& D_6 conduct

Six-pulse Rectifier
1) **Kel:** only one diode in the top half of the bridge may conduct at one time (D1, D3, or D5). The diode which is conducting will have its anode connected to the phase voltage that is highest at that instant.

2) **Kel:** only one diode in the bottom half of the bridge may conduct at one time (D2, D4, or D6). The diode that is conducting will have its cathode connected to the phase voltage that is lowest at that instant.

3) As a consequence of rules 1) and 2) above, D1 & D2 cannot conduct at the same time. Similarly, D3 & D6 cannot conduct simultaneously, nor D5 & D4.

4) The output voltage across the load is one of the line-line voltages of the source. For example, when D1 & D2 are on, the output voltage is $V_{ac}$.

The diodes that are on, are determined by using the line-to-line voltage that is the highest at that instant. For example, when $V_{ac}$ is the highest line-to-line voltage, the output voltage is $V_{ac}$. 
5) There are six combinations of the line-to-line voltages and diodes. Considering one period of the source to be \(360^\circ\), a transition of the highest line-line voltage must take place every \(\frac{360^\circ}{6} = 60^\circ\). Because of the six transitions that occur for each period of the source voltage, the circuit is called a six pulse rectifier.

6) The fundamental frequency of the output voltage is \(6f\), where \(f\) is the frequency of the three-phase source.

The following figures shows the phase voltages and the resulting combinations of line-to-line voltages from a balanced three-phase source. The diodes conduct in pairs (1, 2), (2, 3), (3, 4), (4, 5), (5, 6), (6, 1), ----

Hint: The maximum reverse voltage across diode is the peak line-to-line voltage.
\( V_{out} = \frac{1}{R} \int_{\frac{R}{6}}^{\frac{R}{2}} V_{AB} \, d\theta = \frac{3}{\pi} \int_{\frac{R}{6}}^{\frac{R}{2}} (V_m \sin\theta - V_m \sin\theta \cos\frac{2\pi}{3}) \, d\theta \)

\[
= \frac{3V_m}{\pi} \left( -\cos\theta + \cos\left( \theta - \frac{2\pi}{3} \right) \right)^{\frac{n}{\pi}} \frac{R}{6} V_{in}
\]

\[
= \frac{3V_m}{\pi} \left( \cos\left( \frac{R}{6} \right) + \cos\left( -\frac{R}{6} \right) \right) = 3\sqrt{3} \frac{V_m}{\pi}
\]

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For the output voltage:

\[
V_{out} = V_{out} + \sum_{n=6,12,18,\ldots}^{\infty} V_n \cos(n\omega t + \phi)
\]

\(
V_n = \frac{8\sqrt{3} V_m}{\pi (n^2 - 1)}
\)