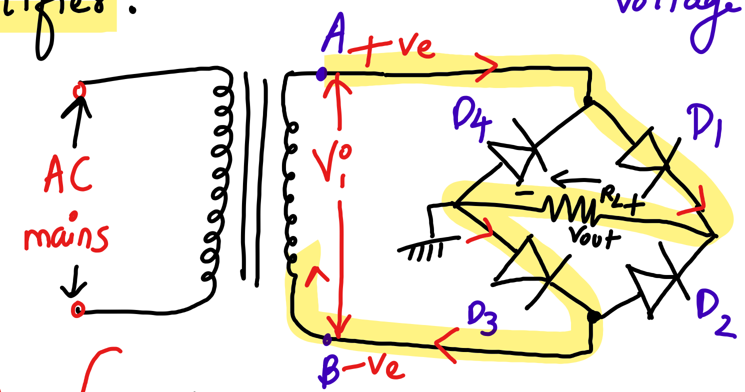
EEEE lec 34b   7/11/23

Full-wave bridge rectifier:

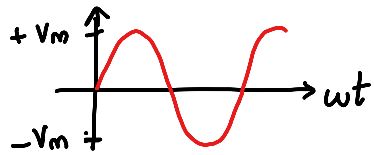
V_i^o : Secondary transformer voltage

"Two diodes conducts together"



$A^{+ve} - D_1 - R_L - D_3 - B$
↓
Iout path during +ve h.c

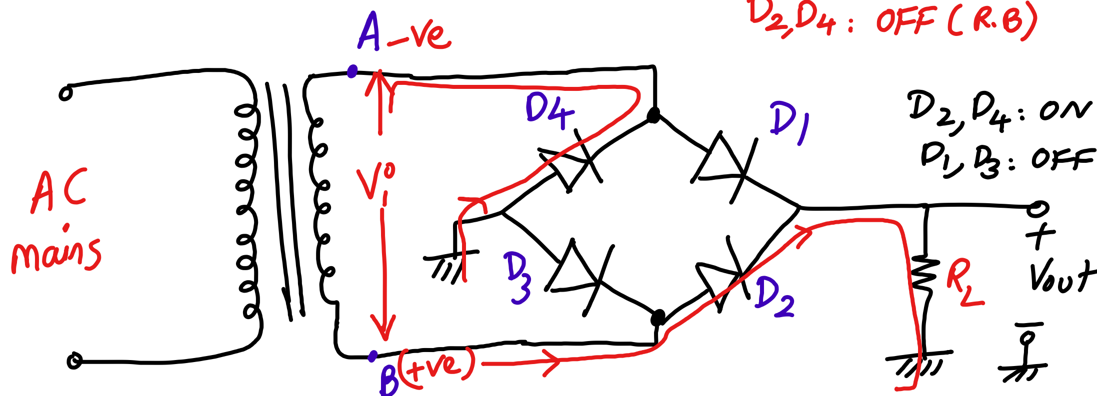
$V_i^o = V_m \sin\omega t$



$V_{out} = I_{out} R_L$

D_1 & D_3 : ON (F.B)

D_2, D_4 : OFF (R.B)



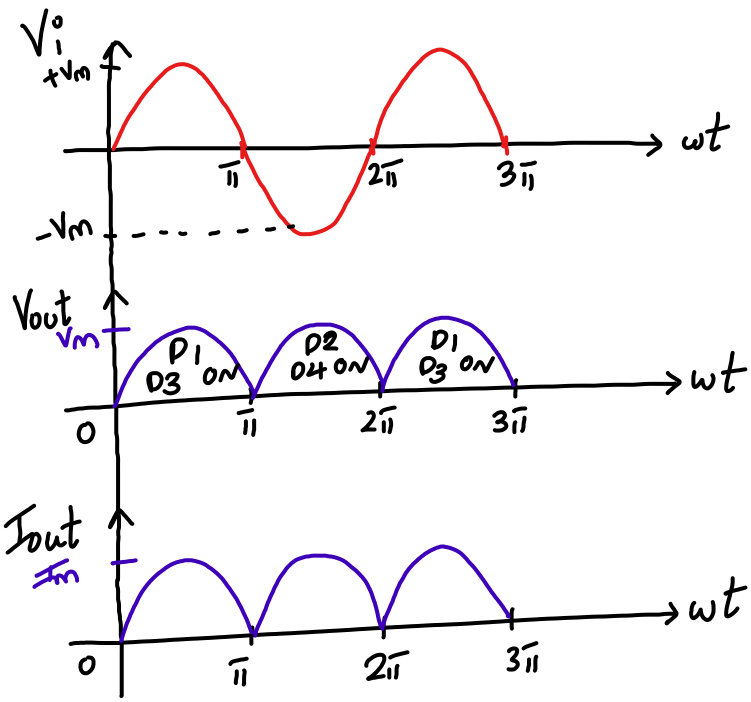
D_2, D_4 : ON (F.B)

D_1, D_3 : OFF (R.B)

$B - D_2 - R_L - D_4 - A$
↓
Iout path during -ve h.c

$V_{out} = V_i^o \ (V_m \sin\omega t)$ if $0 \le \omega t \le \pi$

$= V_i^o \ (V_m \sin\omega t)$ if $\pi \le \omega t \le 2\pi$



FWBR I/p - o/p waveform's

Due to 'R' load, nature of Vout & Iout are similar

FWR with 'R' load analysis:

('B' written above "WR": FWBR)

Derive a) Expression for rectification efficiency (η)

b) Expression for ripple factor (γ)

c) Expression for TUF

① $V_{out(avg)} = V_{dc} = \frac{1}{T}\int_0^T V_{out}\, d\omega t$

$$\boxed{V_{out(avg)} = V_{dc} = \frac{2V_m}{\pi}}$$ --- FWBR

$$\boxed{I_{dc} = \frac{2I_m}{\pi}}$$ --- FWBR

② $I_{out(avg)} = \frac{V_{out(avg)}}{R_L}$ $\left(V_{out(avg)} = I_{out(avg)} R_L \right)$

③ $V_{out(rms)} \rightarrow$ Rms value of AC component of output

$$V_{out(rms)} = \left[\frac{1}{T} \int_0^T V_{out}^2(\omega t)\, d\omega t \right]^{1/2}$$

$$\boxed{V_{out(rms)} = V_{rms} = \frac{V_m}{\sqrt{2}}} \qquad \boxed{I_{rms} = \frac{I_m}{\sqrt{2}}}$$

$\hookrightarrow$ FWBR

④ Rectification efficiency (η):

It is the ratio of DC power at the output to the applied input AC power

$$\% \eta = \frac{P_{DC}}{P_{AC}} \times 100$$

$$P_{DC} = \frac{V_{dc}^2}{R_L} \qquad V_{dc} \rightarrow \frac{2V_m}{\pi}$$

$$P_{AC} = \frac{V_{rms}^2}{R_L} \qquad V_{rms} \rightarrow \frac{V_m}{\sqrt{2}}$$

$$\% \eta = \frac{\frac{4\cancel{V_m^2}}{\pi \cancel{R_L}}}{\frac{\cancel{V_m^2}}{2\cancel{R_L}}} \times 100$$

$$\boxed{\% \eta = \frac{8}{\pi^2} \times 100 = 81.05\%}$$

FWBR

⑤ Ripple factor (γ):

It is the ratio of rms value of o/p AC component to the DC component of the rectifier output

Smaller the AC component → more effective is the rectifier

$$\gamma = \frac{I_{ac}}{I_{dc}} \quad ; \quad I_{ac} = \sqrt{I_{out(rms)}^2 - I_{dc}^2}$$

$$I_{out(rms)}^2 = I_{rms}^2$$

ie $$\frac{I_{ac}}{I_{dc}} = \sqrt{\frac{I_{rms}^2}{I_{dc}^2} - 1}$$

i.e $$\boxed{\gamma = \sqrt{\frac{I_{rms}^2}{I_{dc}^2} - 1}}$$

for FWBR,

$$\gamma = \sqrt{\frac{(I_m/\sqrt{2})^2}{(2I_m/\pi)^2} - 1}$$

$$\gamma = \sqrt{\frac{\cancel{I_m^2}\pi^2}{2 \times 4\cancel{I_m^2}} - 1} = \sqrt{\frac{\pi^2}{8} - 1} = 0.483$$

$\boxed{\gamma = 0.483}$ FWBR