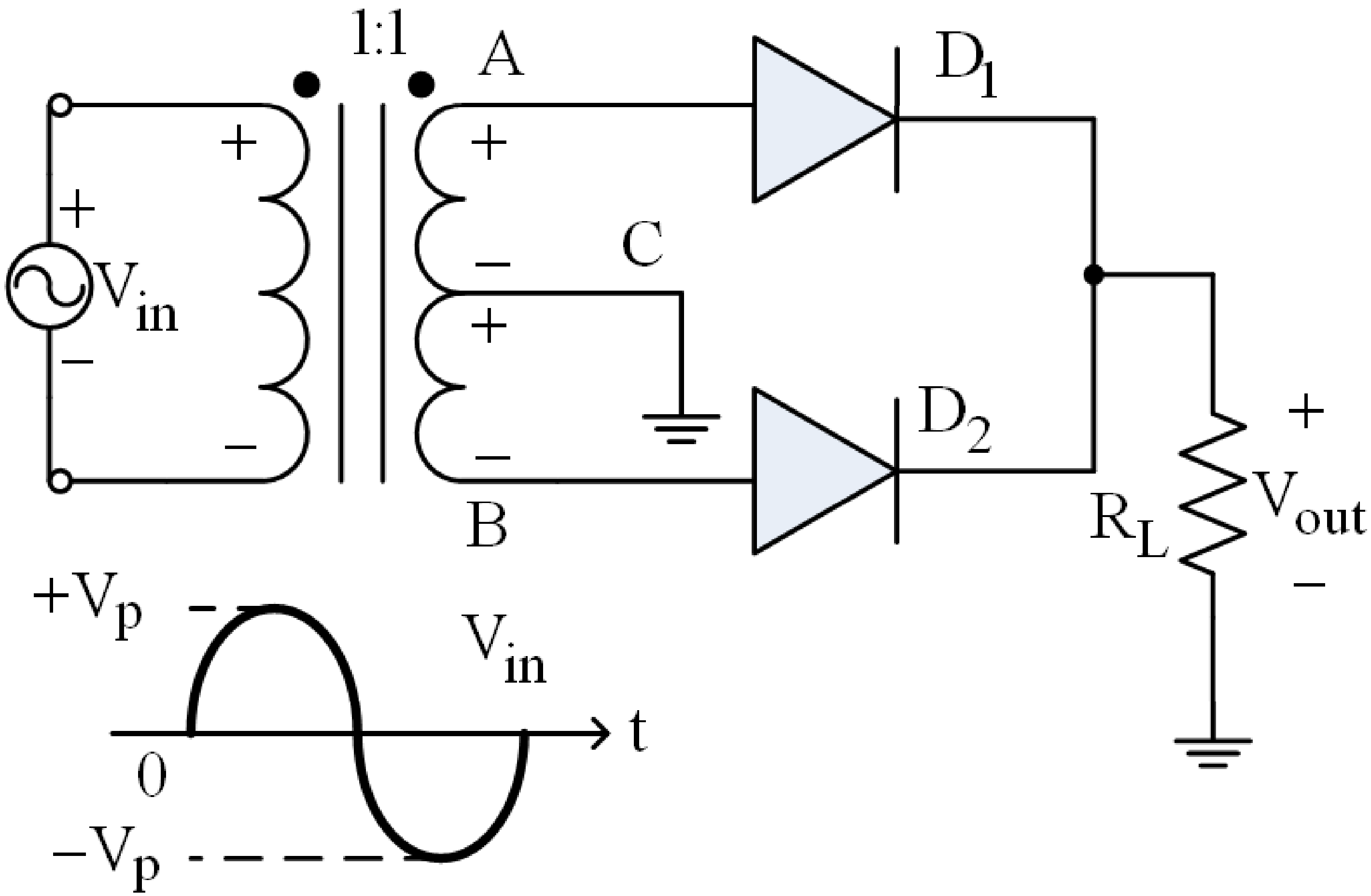
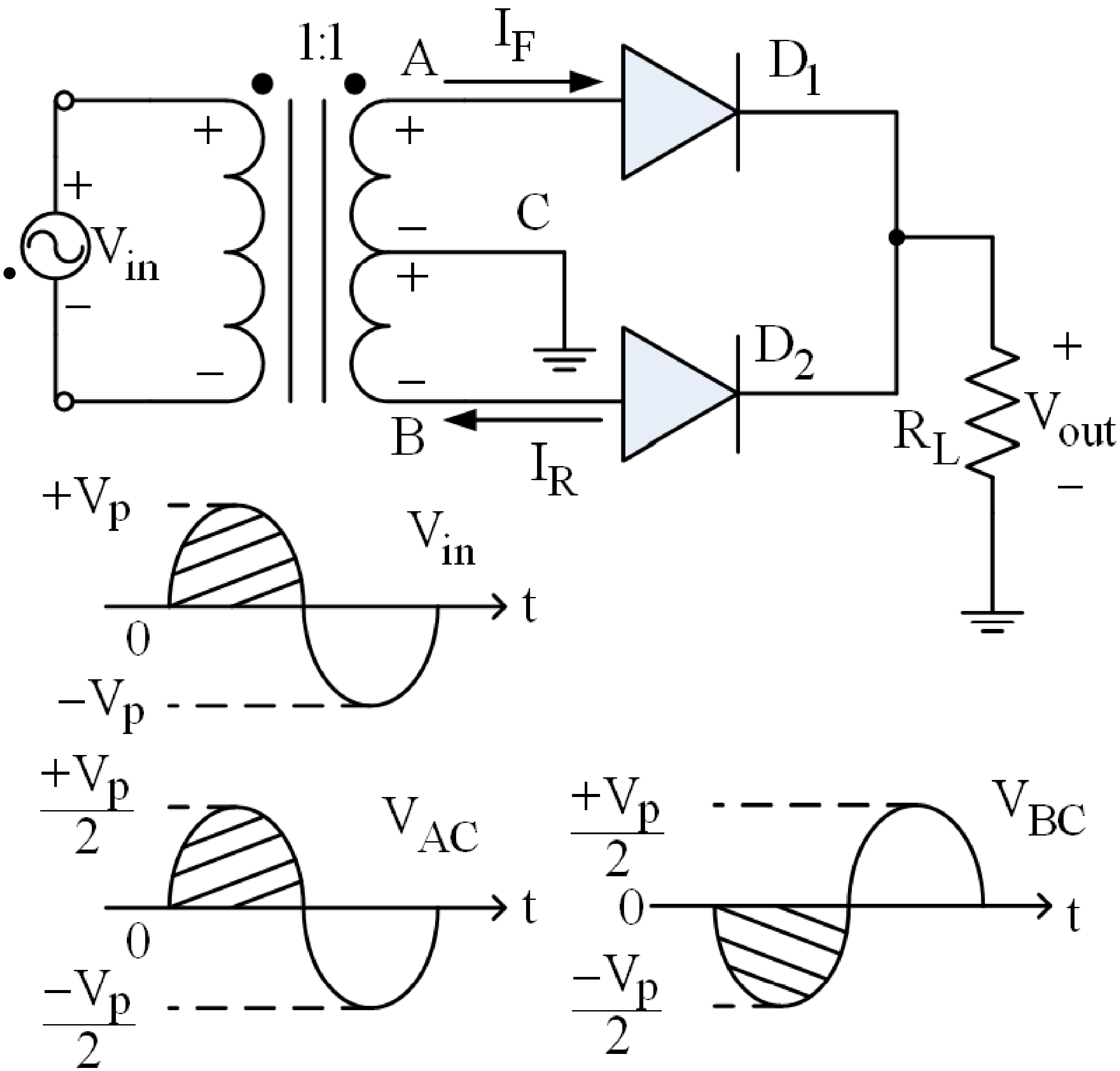
CLASS 10

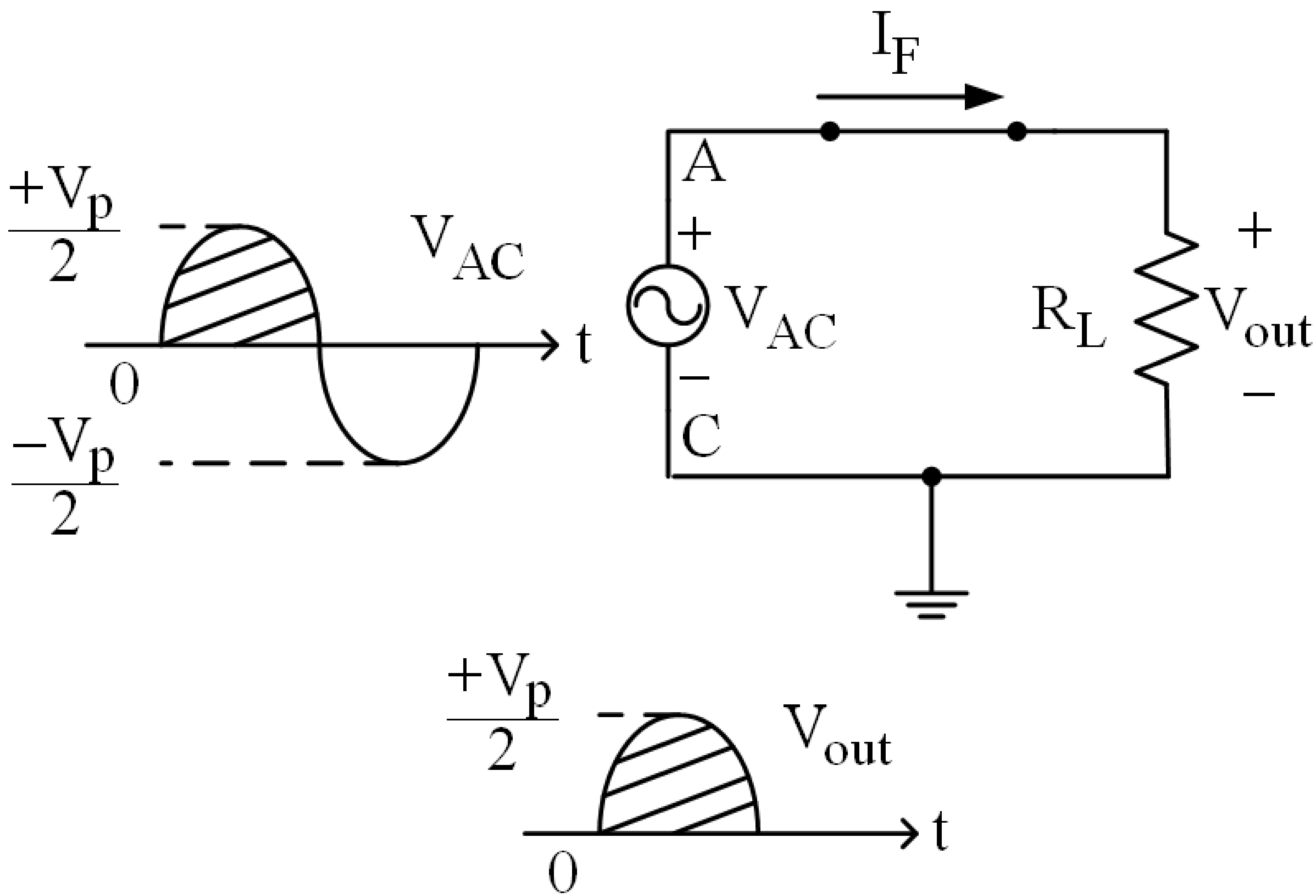
Centre-tap full wave rectifier

Centre-tap full-wave rectifier



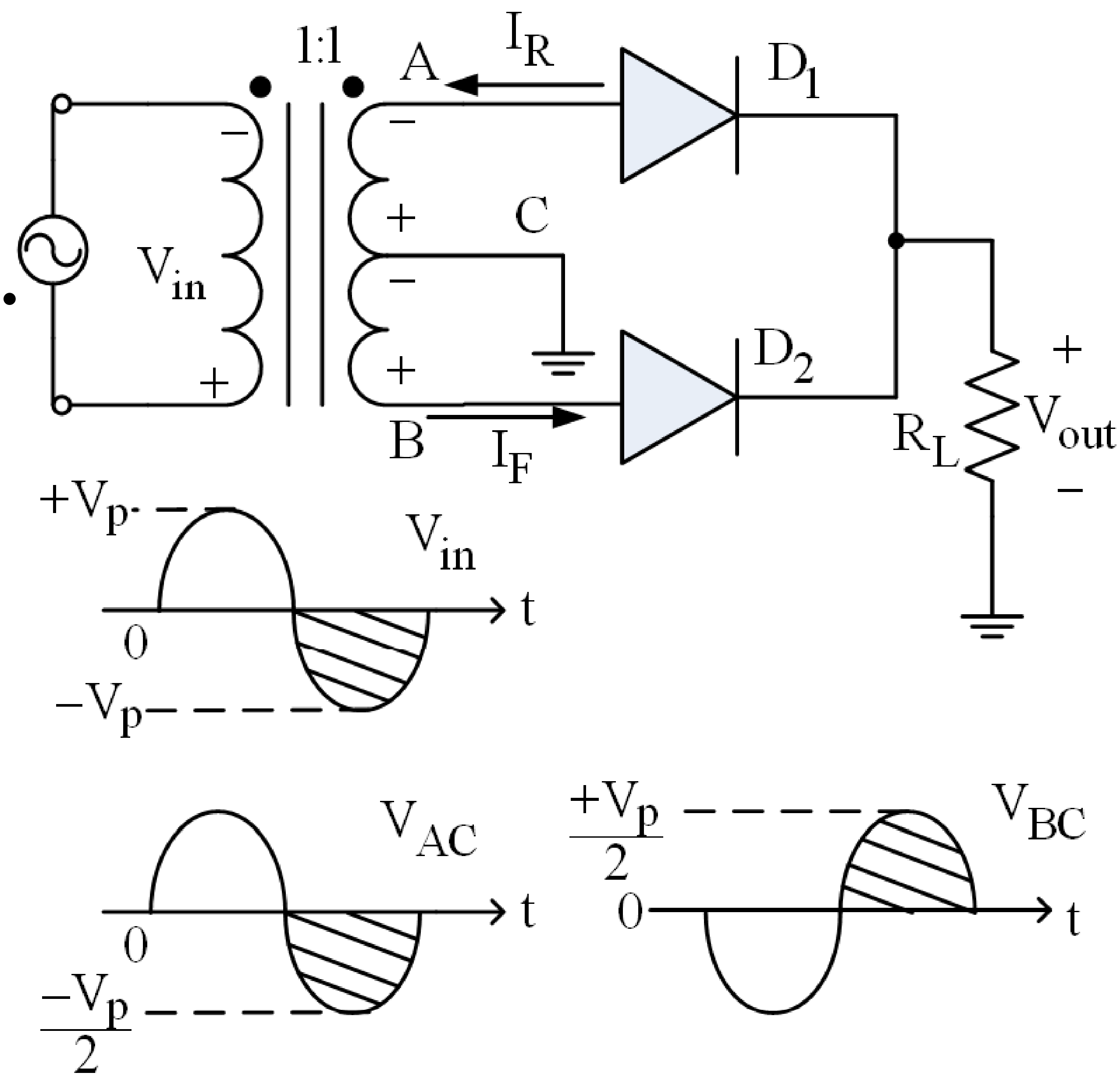
D_1 fb. D_2 rb.

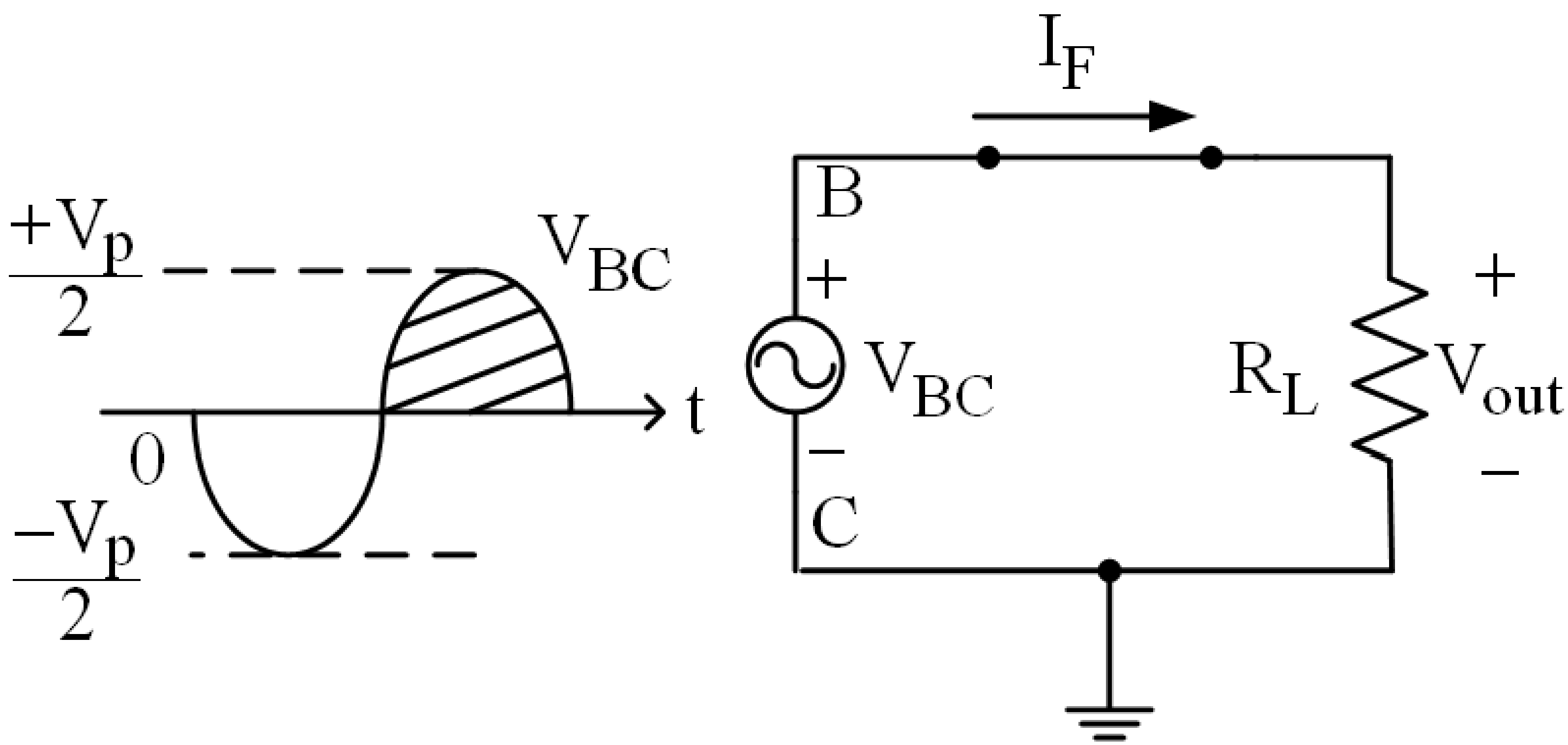




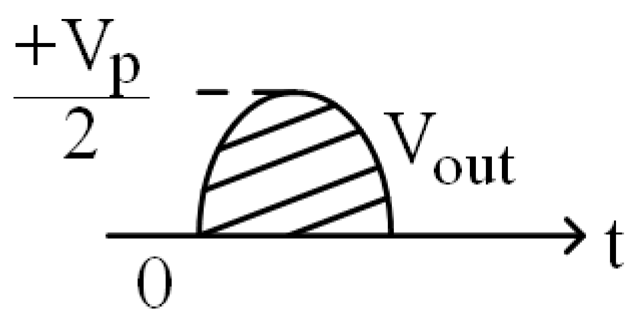
$\frac{+V_p}{2}$
0
$\frac{-V_p}{2}$
V_{AC}
t
I_F
A
+
V_{AC}
−
C
R_L
+
V_{out}
−
$\frac{+V_p}{2}$
V_{out}
0
t

D_2 fb. D_1 rb.

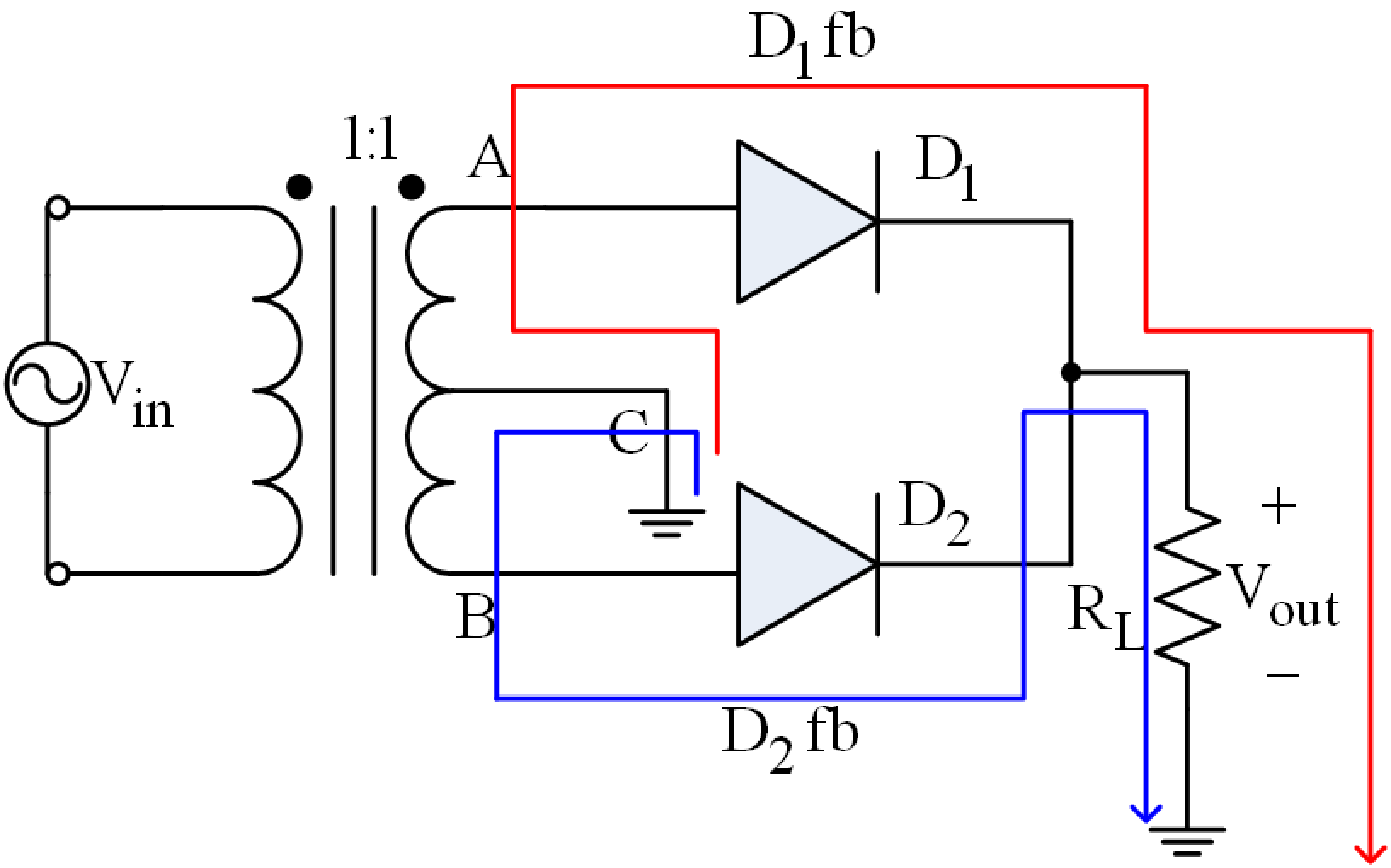




$\frac{+V_p}{2}$
V_{BC}
t
0
$\frac{-V_p}{2}$
I_F
B
+
V_{BC}
−
C
R_L
+
V_{out}
−

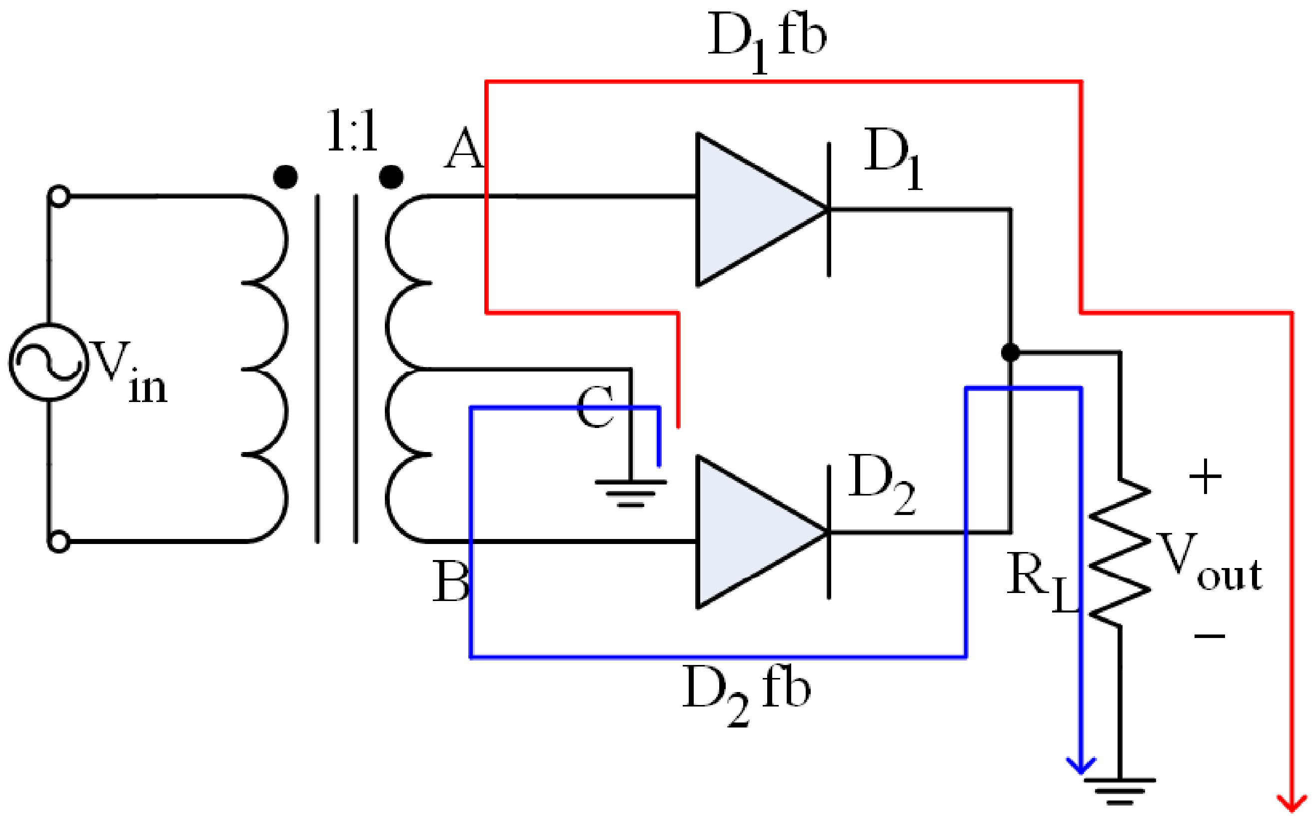


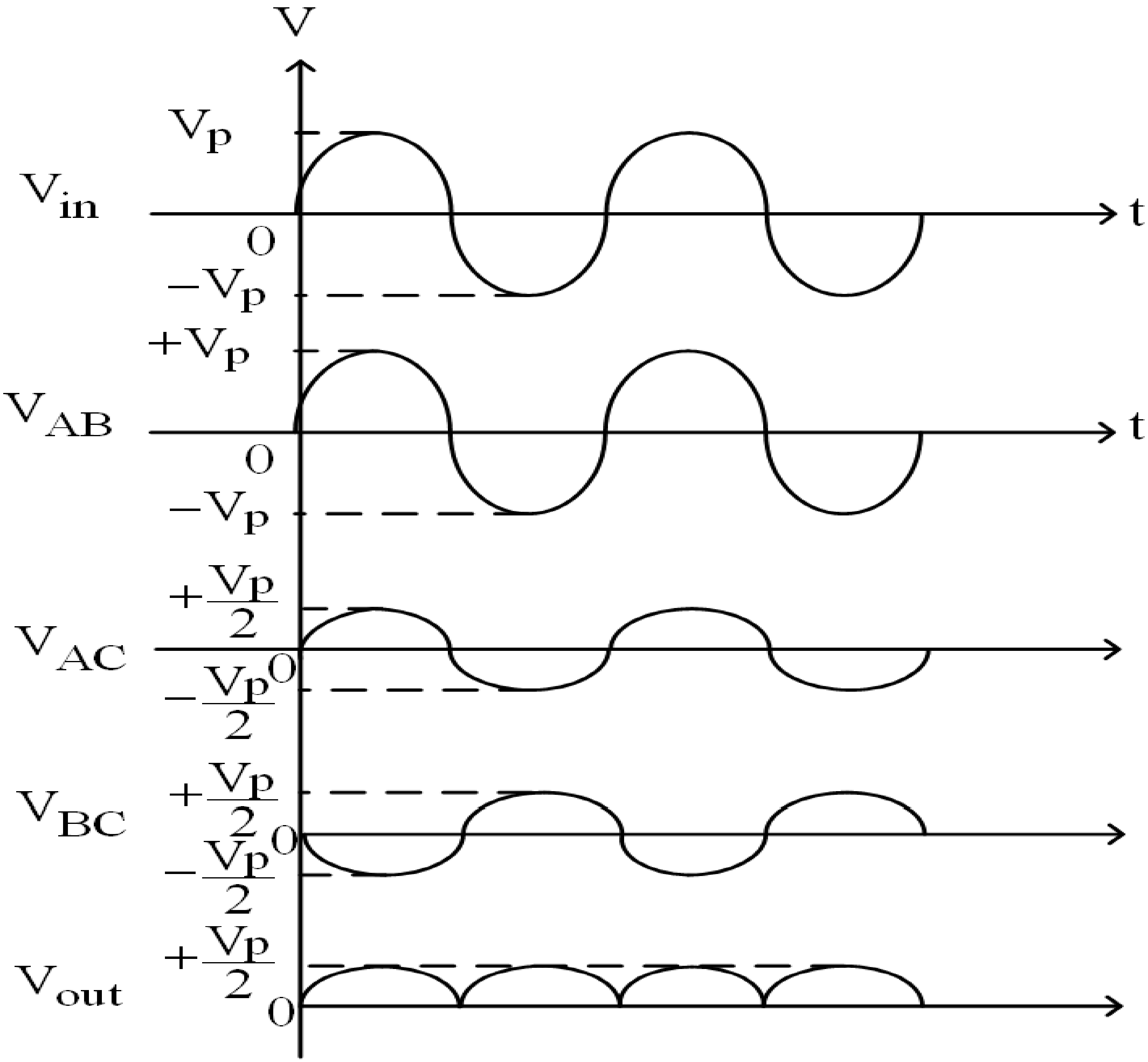
$\frac{+V_p}{2}$
V_{out}
t
0



D1 fb
1:1
A
D1
Vin
C
D2
+
Vout
RL
B
−
D2 fb

Current flowing through R_L will always be in the same direction, independent of whether D_1 or D_2 that was fb.

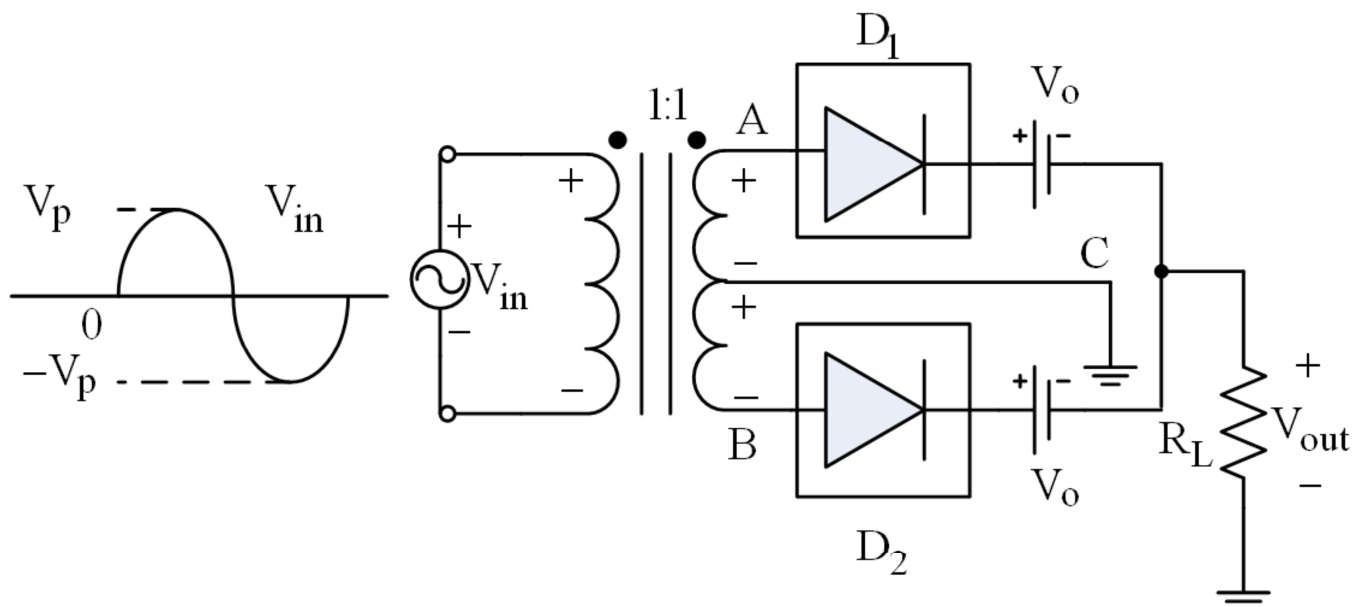



V
Vp
Vin
t
0
−Vp
+Vp
VAB
t
0
−Vp
+Vp/2
VAC
0
−Vp/2
+Vp/2
VBC
0
−Vp/2
+Vp/2
Vout
0

Centre-tap full wave rectifier with potential barrier effect considered

During the +ve half cycle, D_1 will be fb if $V_{AC} > V_o$. D_1 is a s/c. $V_{AC} = V_o + V_{out}$. $V_{out} = V_{AC} - V_o$.

During the -ve half cycle, D_2 will be fb if $V_{BC} > V_o$. D_2 is a s/c. $V_{BC} = V_o + V_{out}$. $V_{out} = V_{BC} - V_o$.

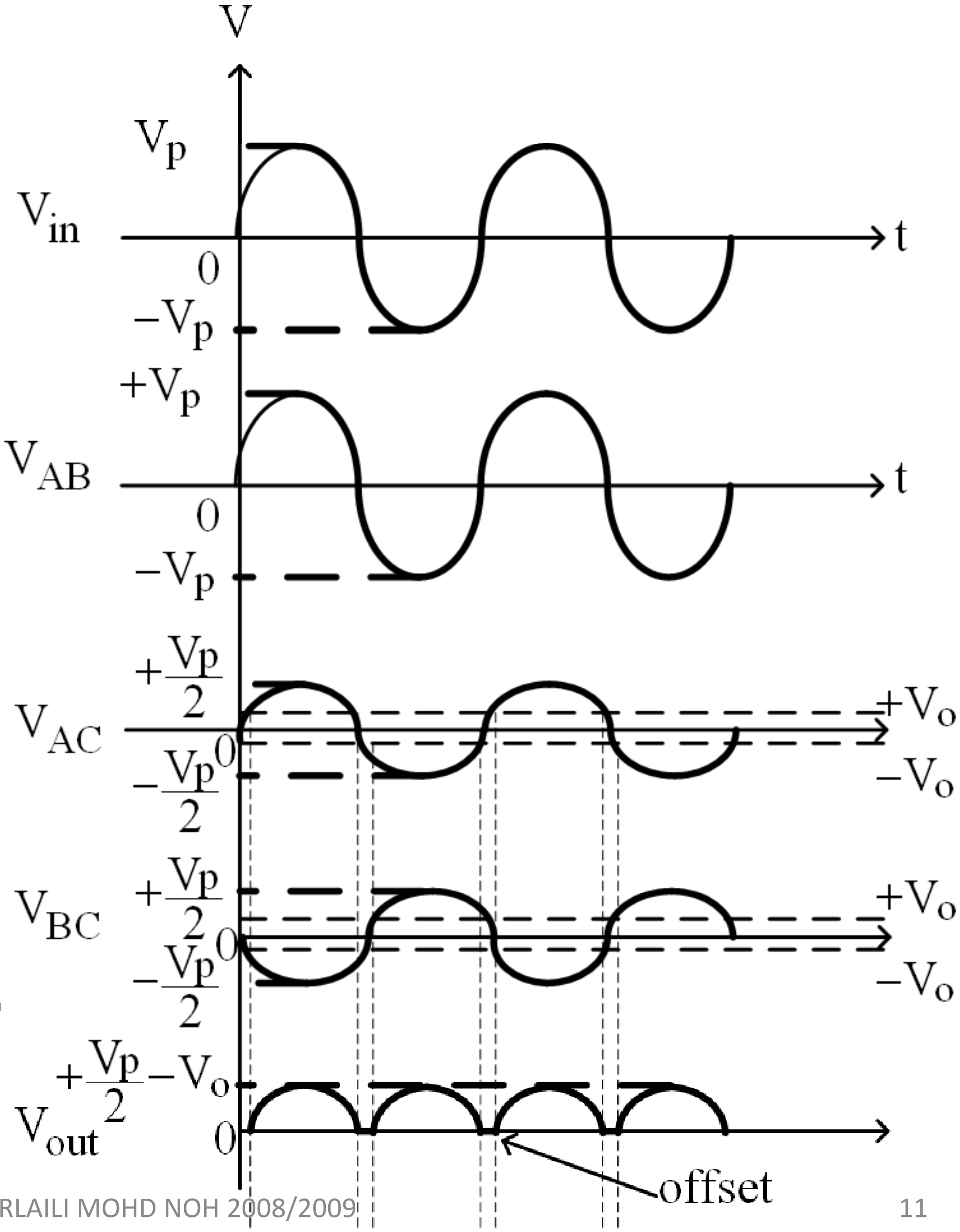


During the +ve half cycle, D_1 will be fb.

$V_{out} = V_{AC} - V_o$. Max. V_{AC} is $V_p/2$. Hence, $V_{out(max)} = V_p/2 - V_o$.

During the -ve half cycle, D_2 will be fb.

$V_{out} = V_{BC} - V_o$. Max. V_{BC} is $V_p/2$. Hence, $V_{out(max)} = V_p/2 - V_o$.



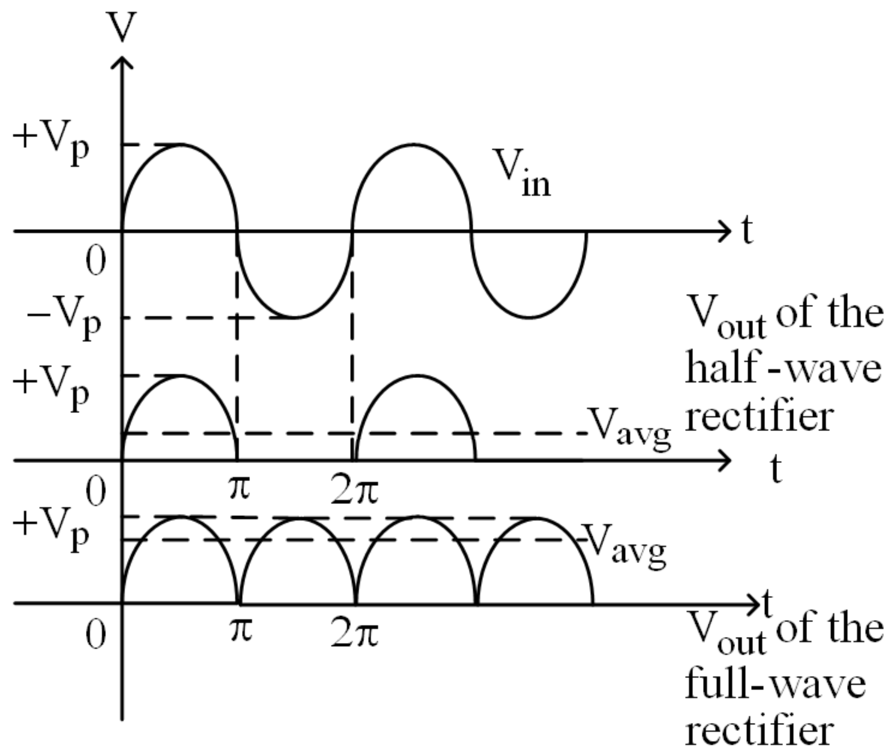
Average voltage of a full-wave rectifier

$$V_{avg} = \frac{Area}{T} = \frac{Area}{2\pi}$$

$$V_{avg} = \frac{1}{2\pi} \times 2\int_0^{\pi} V_p \sin\theta \quad d\theta$$

$$= \frac{V_p}{\pi}\left[-\cos\theta\right]_0^{\pi}$$

$$= \frac{2V_p}{\pi}$$



If the input to the half-wave rectifier is the same as the input to the full-wave rectifier, i.e. V_{in}, the out signal of the half-wave rectifier has an average value of, $V_{avg} = V_p/\pi$.

Thus, $V_{avg\_Half\text{-}wave} = ½\ V_{avg\_Full\text{-}wave}$

Duration=1/frequency

$T = 1/f$

$T_{Half\text{-}wave} = T_{input}$

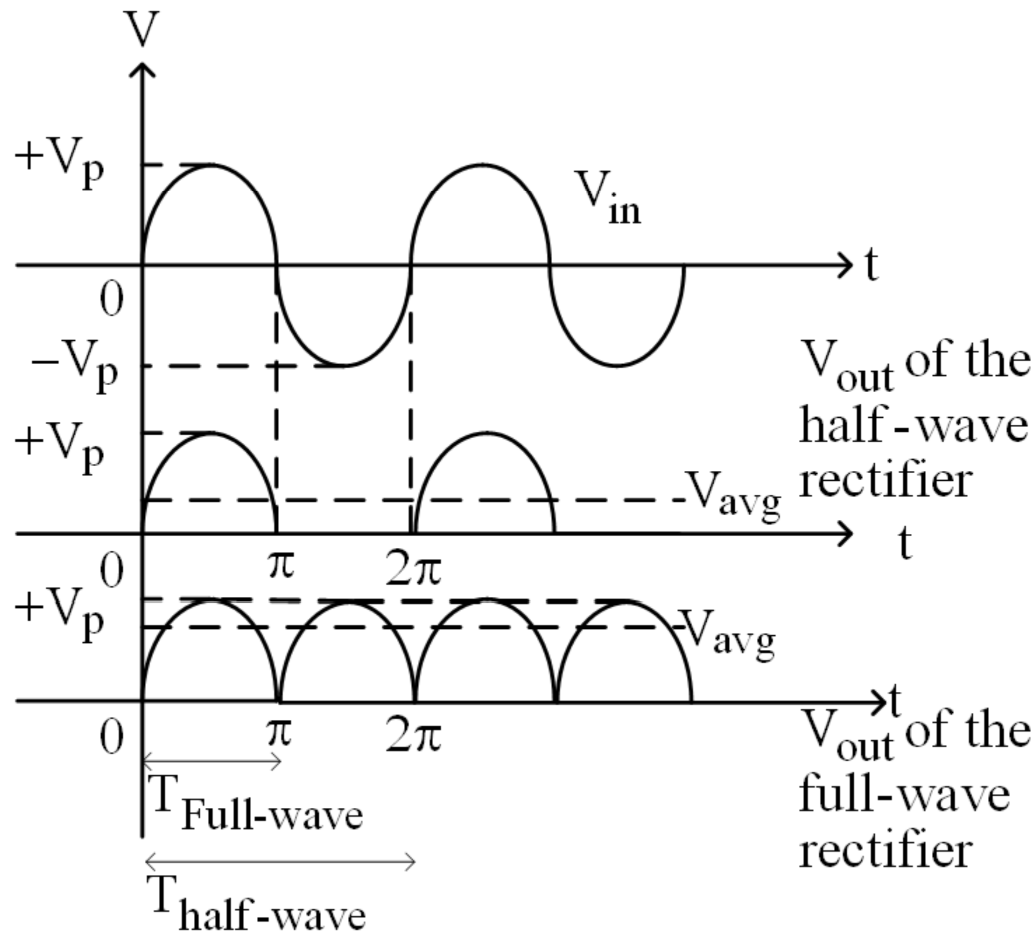
$f_{Half\text{-}wave} = f_{input}$

$T_{Full\text{-}wave} = \frac{1}{2} T_{Half\text{-}wave}$

$f_{Full\text{-}wave} = 2f_{Half\text{-}wave}$

Hence,

$f_{Full\text{-}wave} = 2f_{input}$



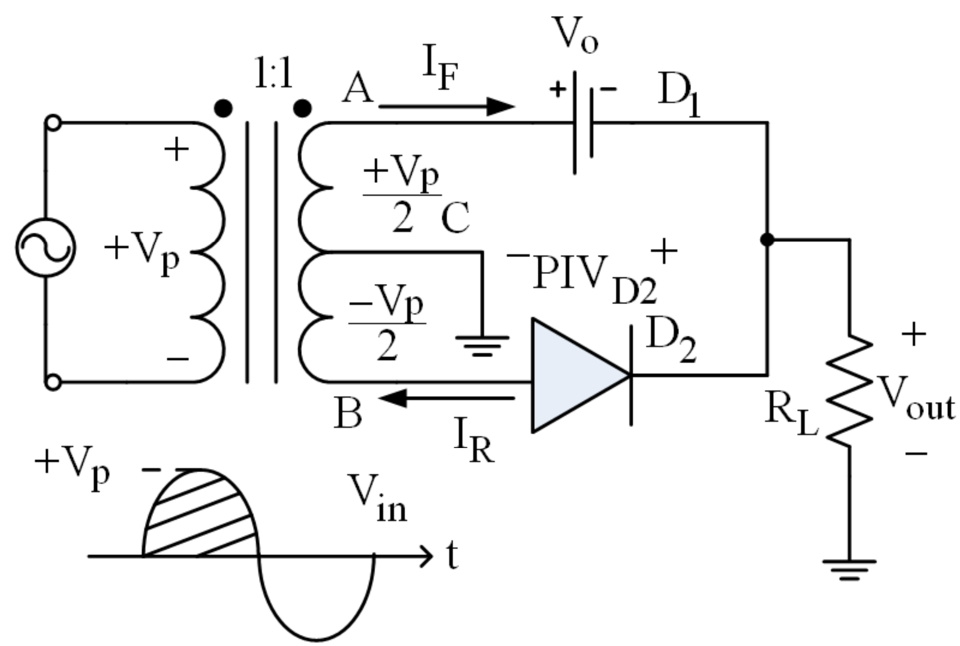
PIV_{D2} can be determined by analyzing the circuit when V_{in} is at its +ve half cycle.

$$PIV_{D2} = V_{out} - (-V_p/2)$$

$$V_{out} = (V_p/2) - V_o$$

$$PIV_{D2} = (V_p/2) - V_o - (-V_p/2)$$

$$PIV_{D2} = V_p - V_o$$



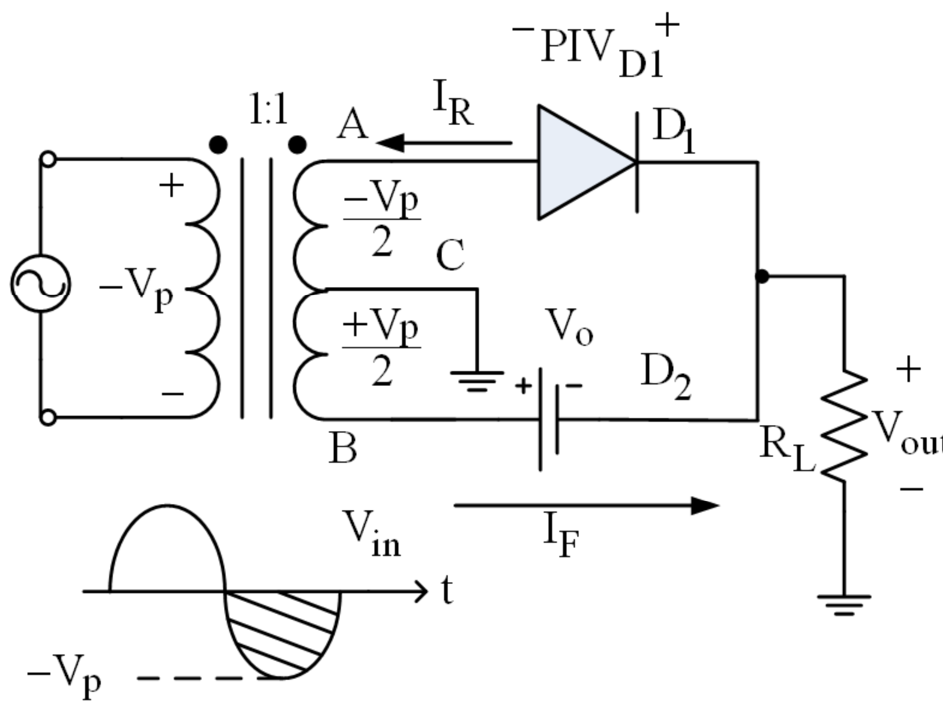
PIV_{D1} can be determined by analyzing the circuit when V_{in} is at its –ve half cycle.

$$PIV_{D1} = V_{out} - (-V_p/2)$$

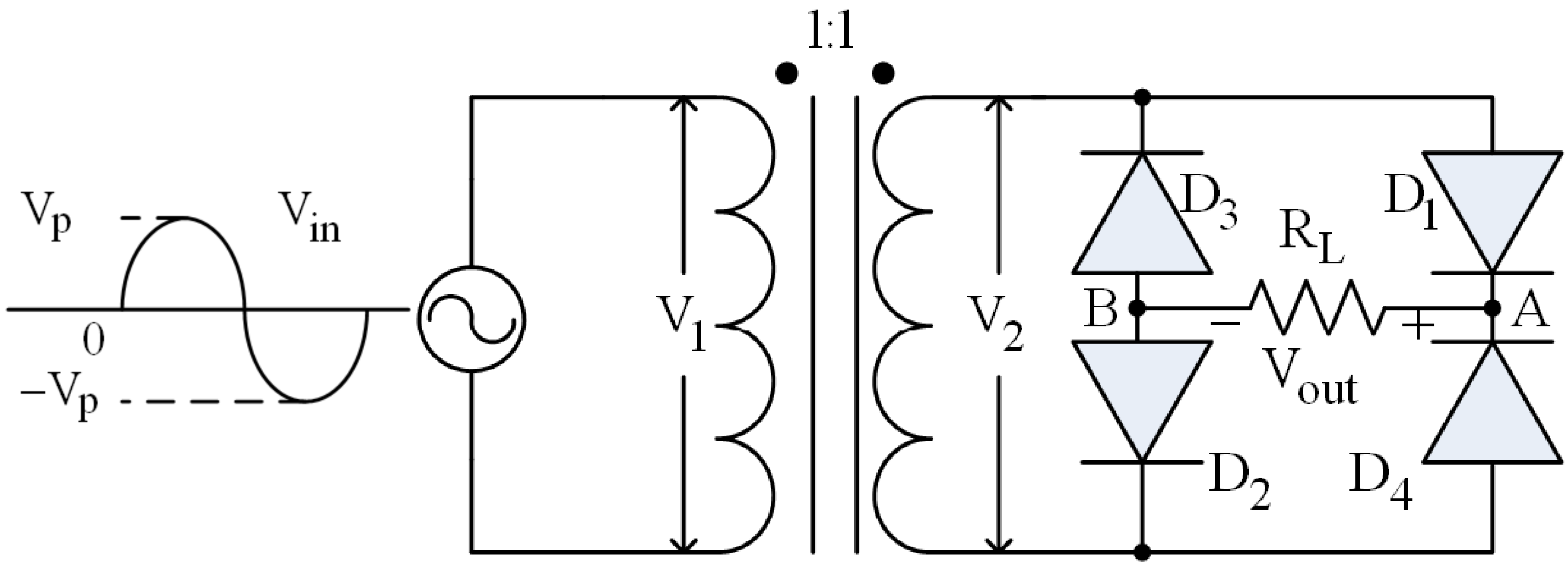
$$V_{out} = (V_p/2) - V_o$$

$$PIV_{D1} = (V_p/2) - V_o - (-V_p/2)$$

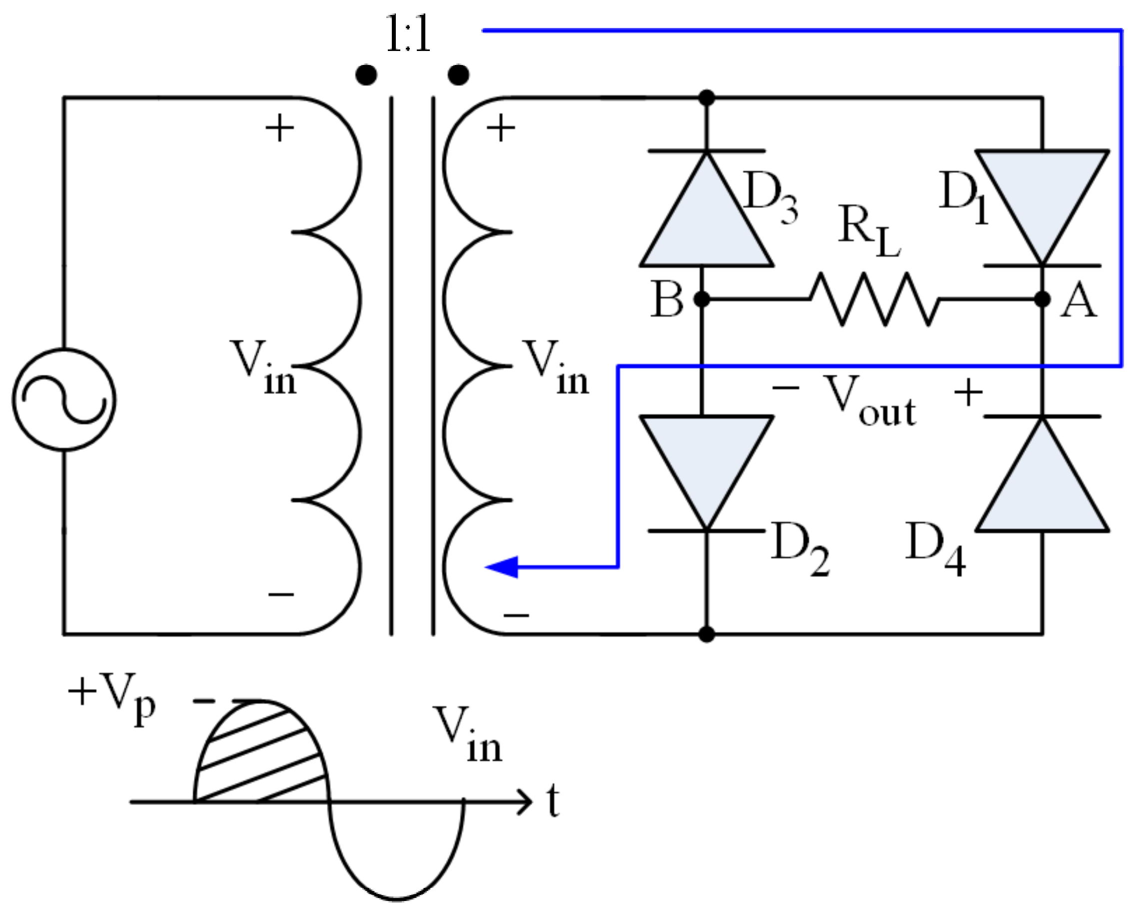
$$PIV_{D1} = V_p - V_o$$



Bridge full-wave rectifier



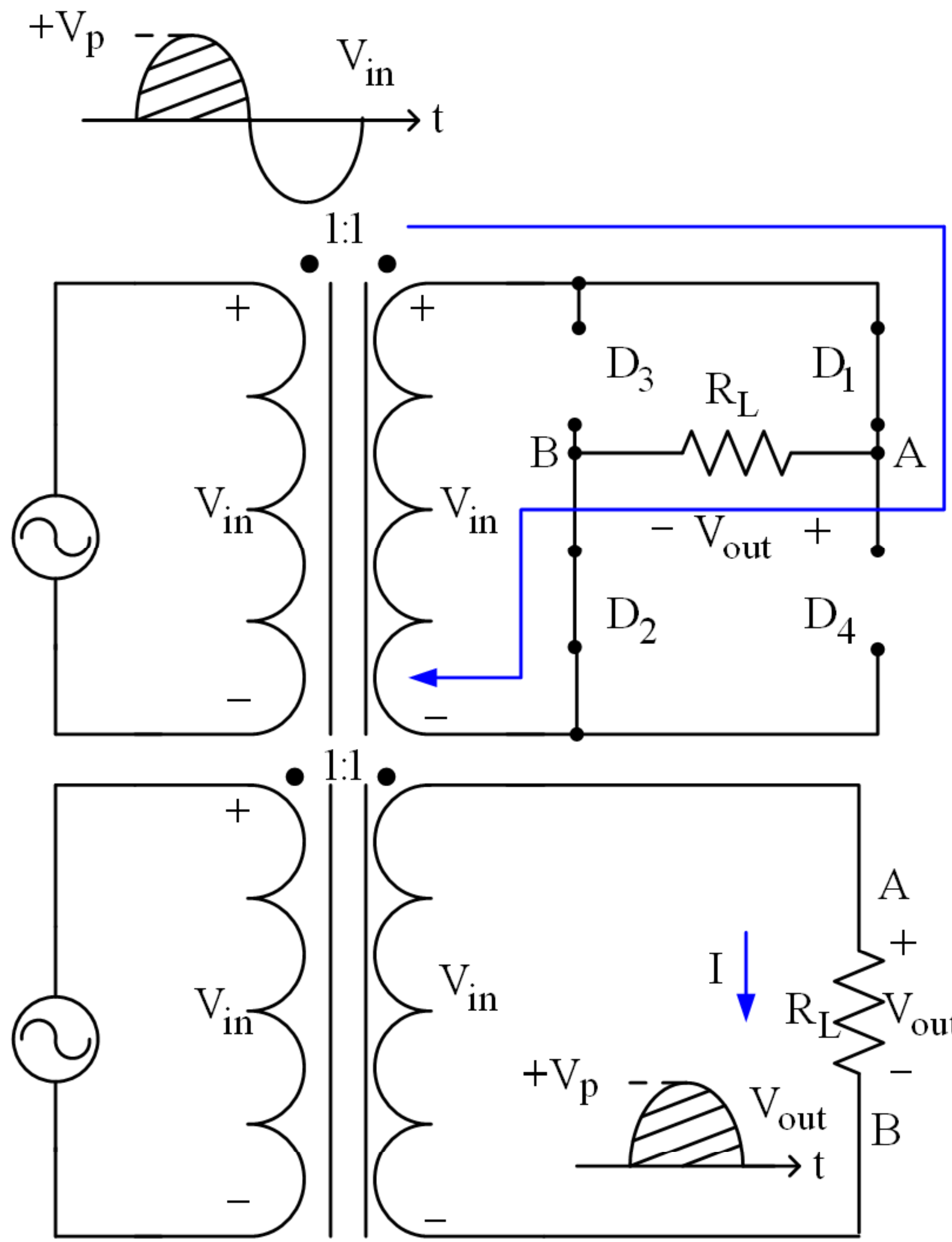
During +ve half cycle, D_1 and D_2 are fb. V_{out} is +ve at A and -ve at B.



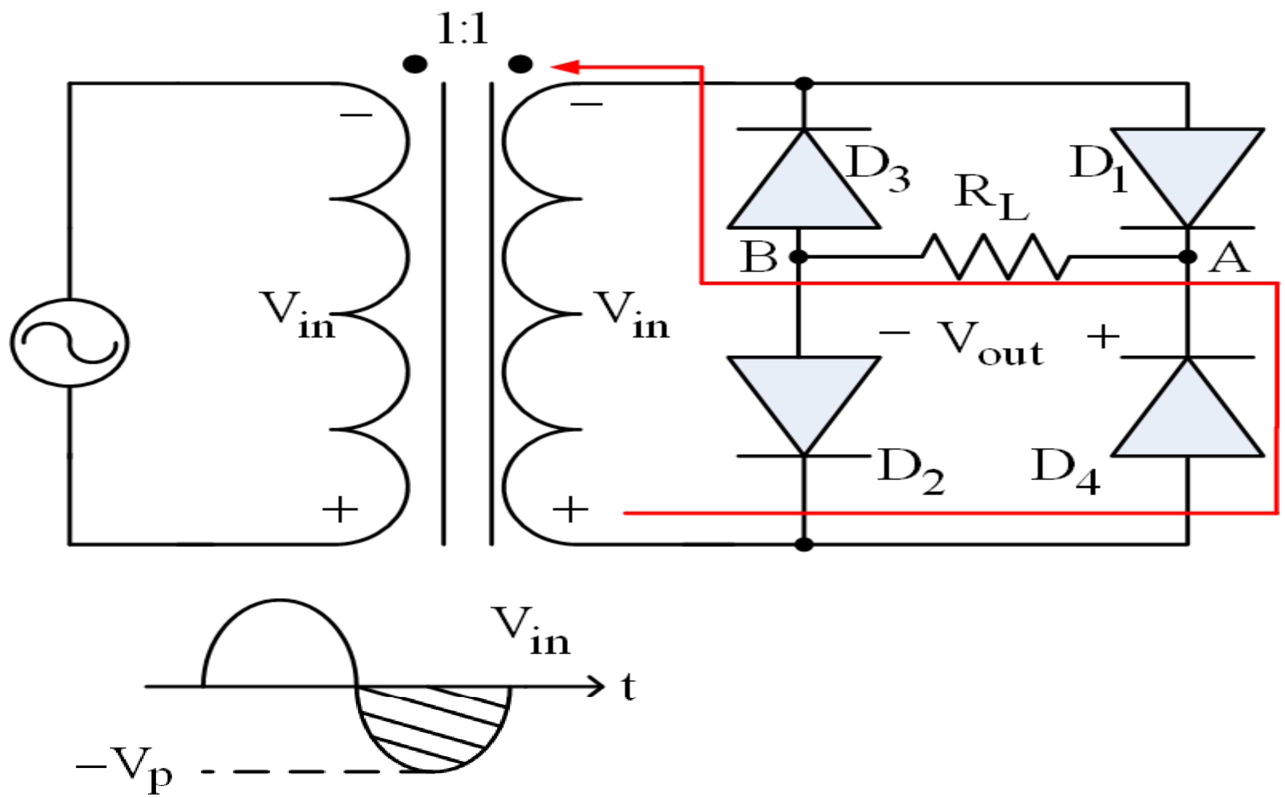
$$V_{out} = V_{in}$$

If $V_{in} = V_p$,

$$V_{out} = V_p$$



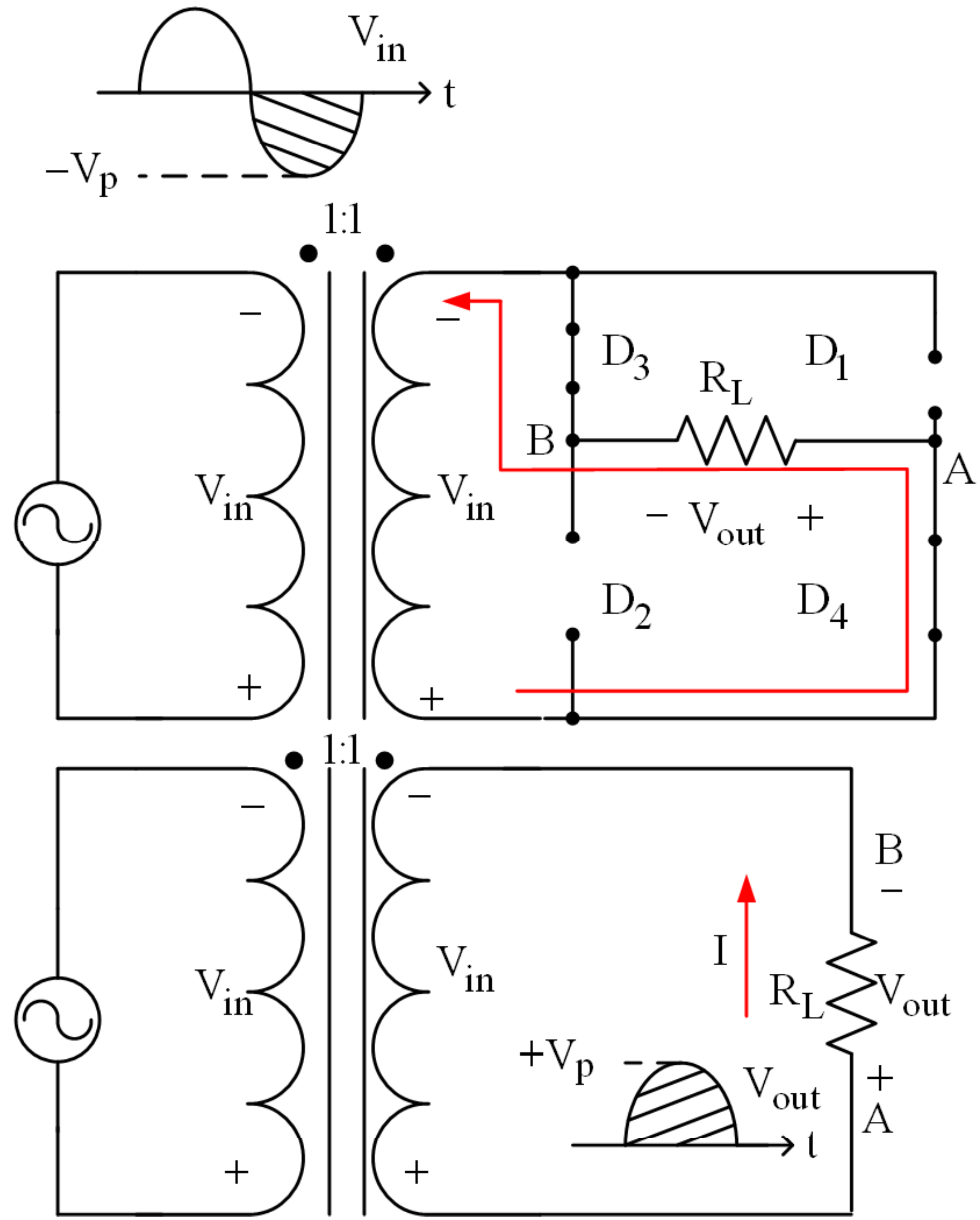
During -ve half cycle, D_3 and D_4 are fb. V_{out} is still +ve at A and -ve at B.



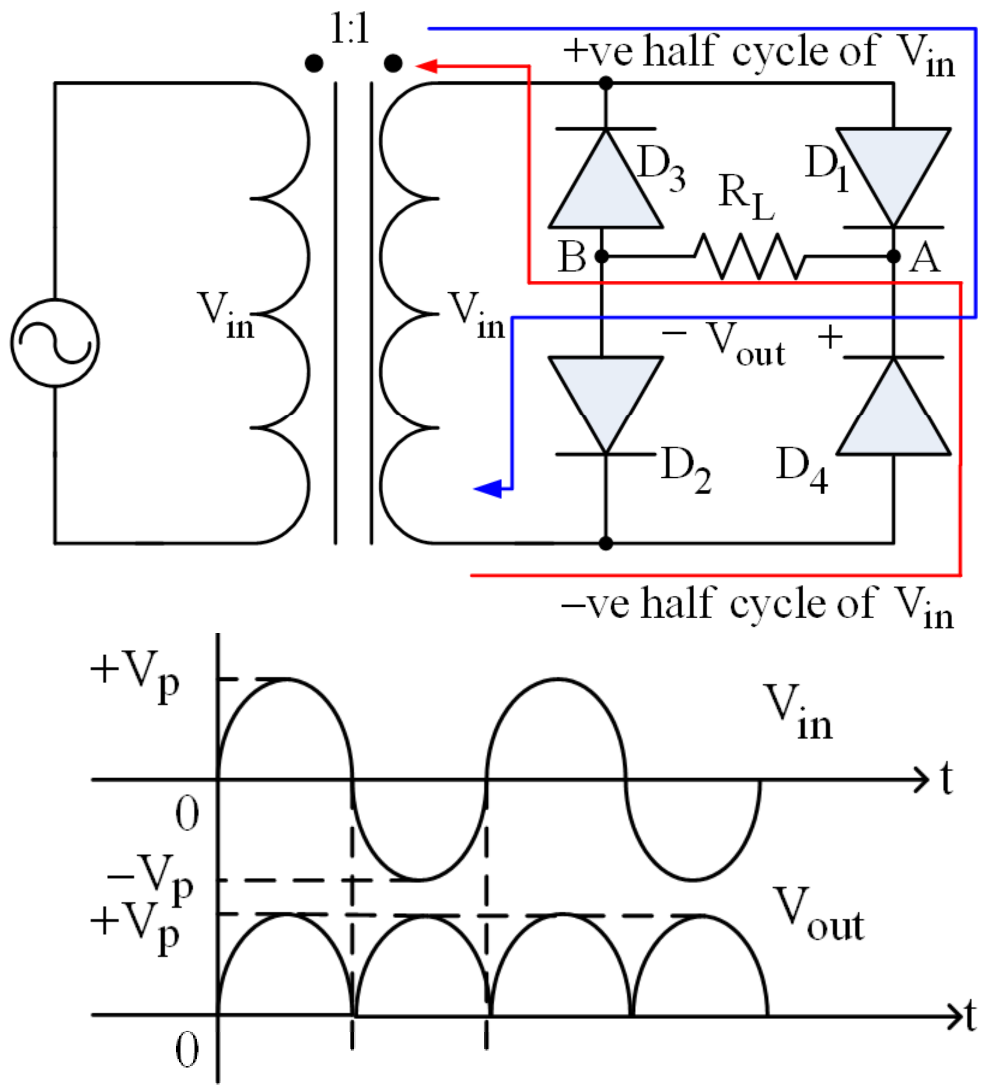
$$V_{out} = V_{in}$$

If $V_{in} = V_p$,

$$V_{out} = V_p$$



Overall performance

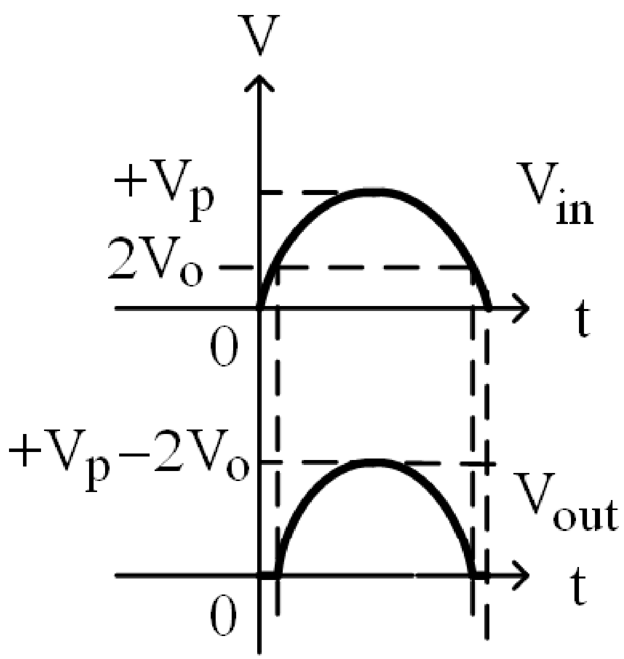


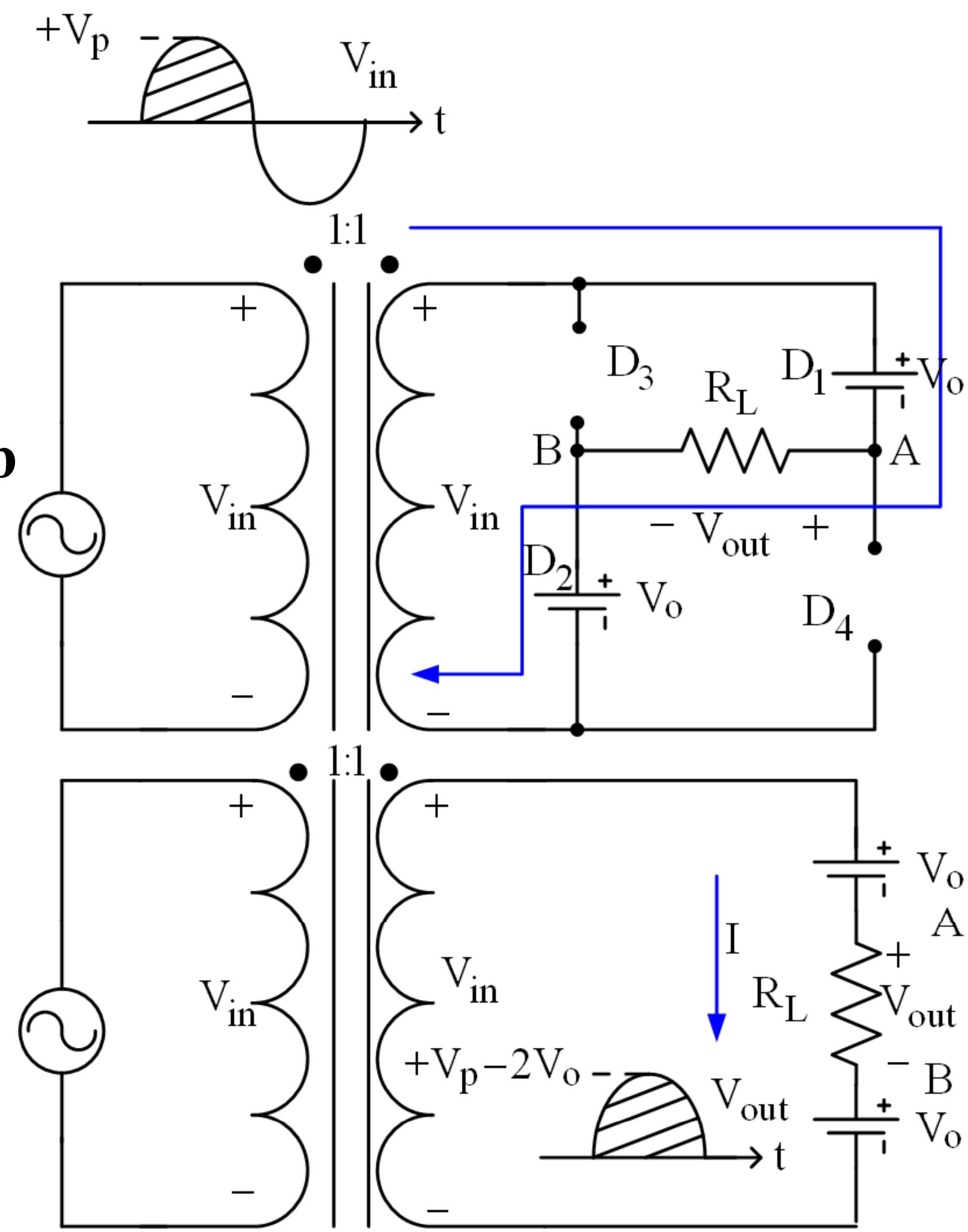
If potential barrier of the diode is considered:

$$V_{in} = 2V_o + V_{out}$$

$$V_{out} = V_{in} - 2V_o$$

D_1 and D_2 will only be fb if $V_{in} > 2V_o$



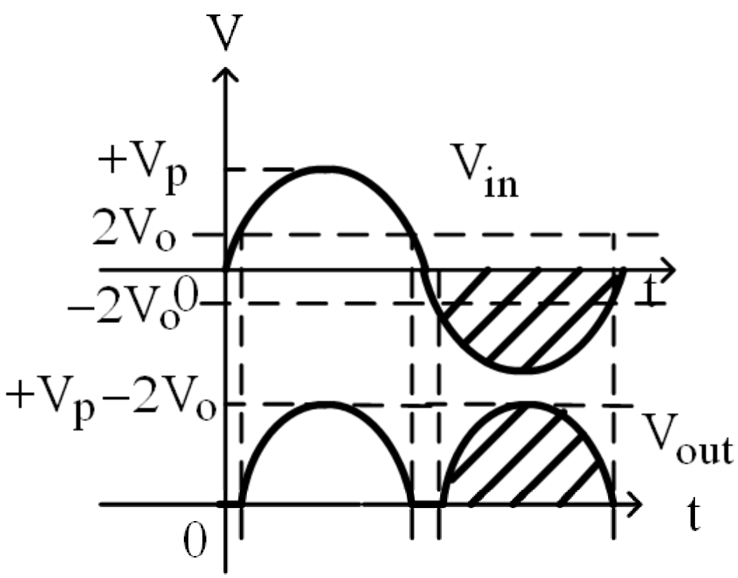


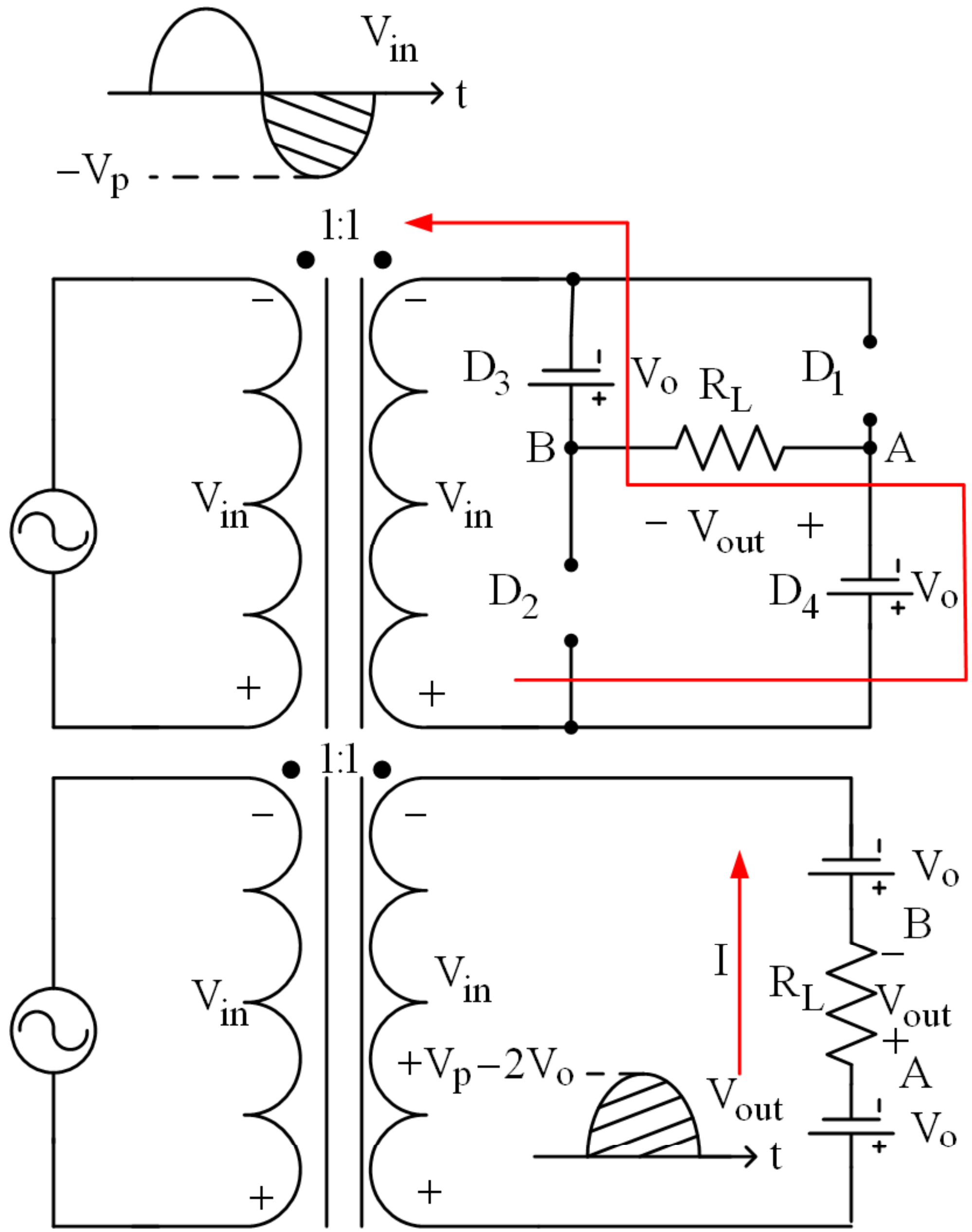
If potential barrier of the diode is considered:

$$V_{in} = 2V_o + V_{out}$$

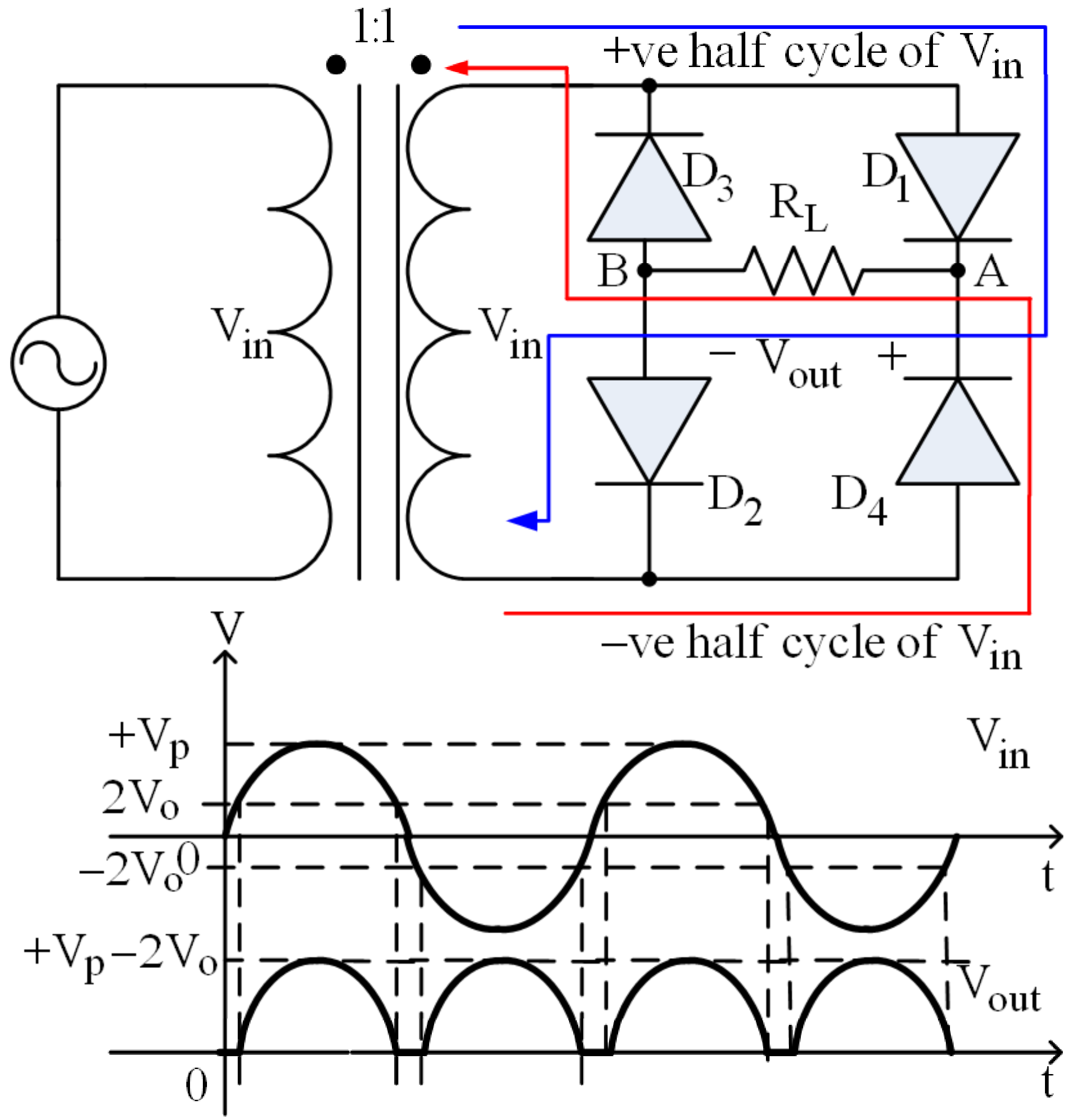
$$V_{out} = V_{in} - 2V_o$$

D_3 and D_4 will only be fb if $V_{in} > 2V_o$





Overall performance:



PIV of the diodes in the bridge full-wave rectifier

To determine PIV_{D1} and PIV_{D2}, analyze the circuit when V_{in} is at its negative half cycle.

When determining PIV of the diodes,

$V_{in} = V_p$.

$V_p - V_{out} = 0$

$PIV_{D2} - V_{out} + PIV_{D1} - V_p = 0$

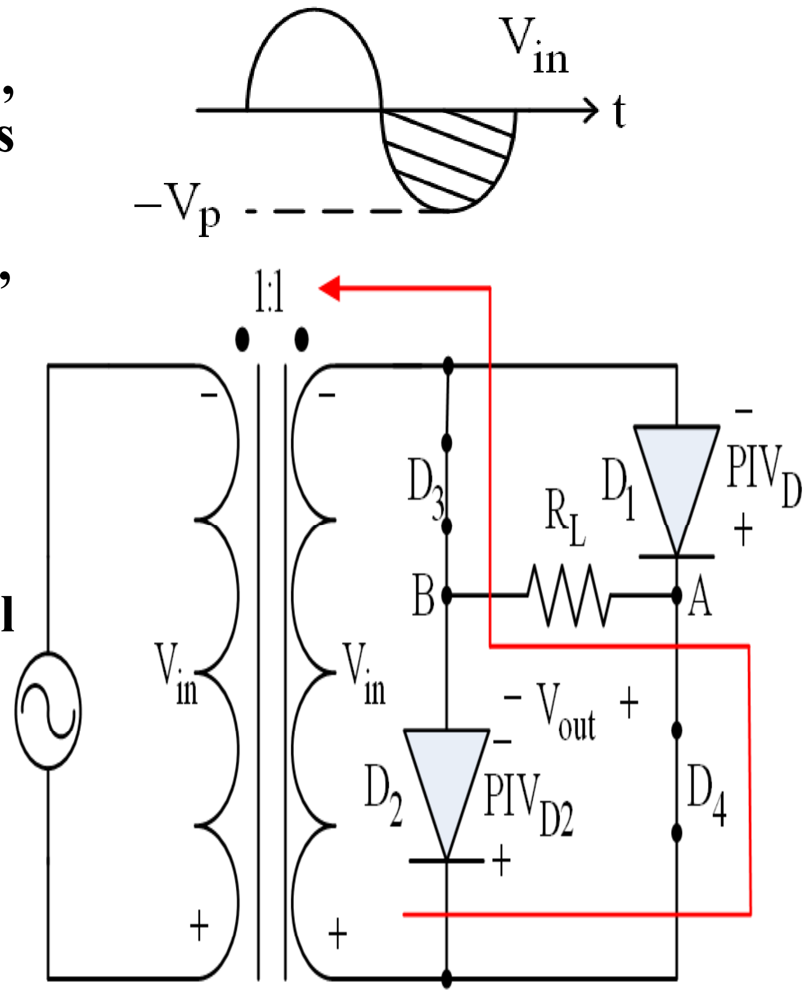
$PIV_{D2} + PIV_{D1} - V_p = V_{out}$

Assuming the diodes are identical and therefore $PIV_{D2} = PIV_{D1}$

$V_p - (PIV_{D2} + PIV_{D1} - V_p) = 0$

$2V_p - 2PIV = 0$

$PIV = V_p$



If the potential barrier of each diode is taken into consideration:

$V_p - 2V_o - V_{out} = 0$

$PIV_{D2} - V_{out} + PIV_{D1} - V_p = 0$

$PIV_{D2} + PIV_{D1} - V_p = V_{out}$

$V_p - 2V_o - (PIV_{D2} + PIV_{D1} - V_p) = 0$

Assuming the diodes are identical and therefore $PIV_{D2} = PIV_{D1} = PIV$

$2V_p - 2V_o - 2PIV = 0$

$PIV = V_p - V_o$