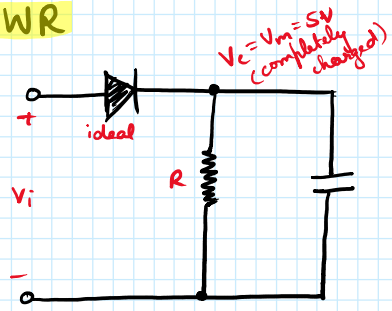
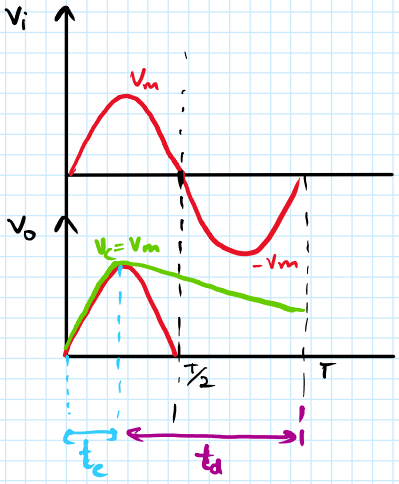
3. Parallel Capacitor Filter - HWR & FWR, Zener Diode Regulator

18 October 2023 14:43

Schunt / Parallel Capacitor Filter

HWR



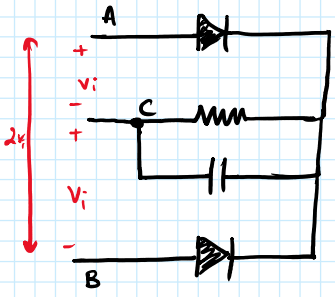


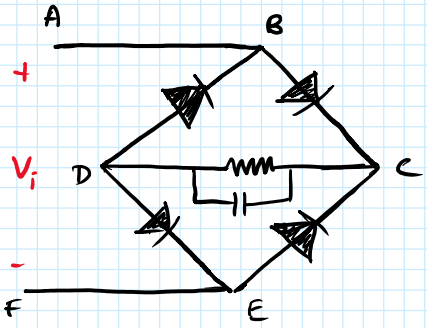
$$\gamma = \frac{V'_{rms}}{V_{dc}} \qquad \gamma = \frac{1}{2\sqrt{3} f C R_L}$$

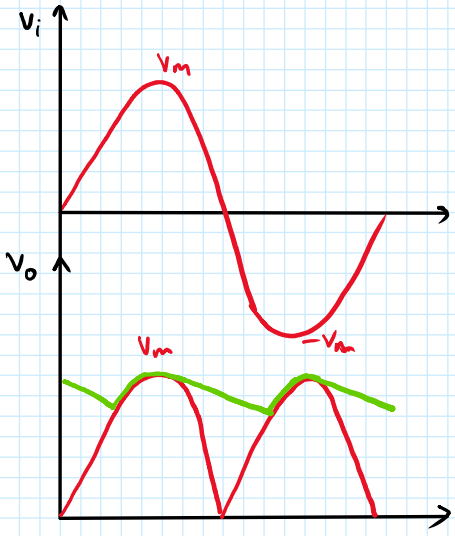
$$V_{dc} = V_m - \frac{I_{dc}}{2fC} \qquad V'_{rms} = \frac{I_{dc}}{2\sqrt{3} fC}$$

$$t_c + t_d = T$$

Centre Tap FWR / Bridge FWR







$$\gamma = \frac{V'_{rms}}{V_{dc}} \qquad \gamma = \frac{1}{4\sqrt{3} fCR_L}$$

$$V'_{rms} = \frac{I_{dc}}{4\sqrt{3} fC} \qquad V_{dc} = V_m - \frac{I_{dc}}{4fC}$$

Problems

① A full wave rectifier with C filter is supplying a load of 500 Ω. If the ripple factor should not exceed 10%, find the value of capacitor required. Assume input AC signal frequency is 50 Hz. What is the new value of γ if capacitor of 500μF is connected across the load?

Soln. $\gamma = \frac{1}{4\sqrt{3} f C R_L}$

$C = \frac{1}{4\sqrt{3} f \gamma R_L}$

$= \frac{1}{4\sqrt{3} \times 50 \times 0.1 \times 500} = 57.73\ \mu F$

If $C = 500\ \mu F$,

$\gamma = \frac{1}{4\sqrt{3} f C R_L} = \frac{1}{\quad}$

[max load current → I_m; load current → I_{dc}; I_{dc}]

② In a full wave rectifier with C filter the output DC voltage is 10V and load current is 10mA. Calculate the value of capacitance required such that the output DC voltage will have ripple ≤ 0.001. Find V_m.

Soln. $R_L = \frac{V_{dc}}{I_{dc}} = \frac{10}{10m} = 1\ k\Omega$

Assume frequency of input AC signal

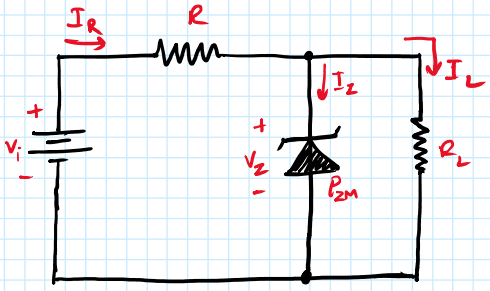
$\gamma = \frac{1}{4\sqrt{3} f C R_L}$

$C = \frac{1}{4\sqrt{3} f \gamma R_L} = \frac{1}{4\sqrt{3} \times 50 \times 0.001 \times 1 \times 10^3} = 2886\mu F$

V_{dc}

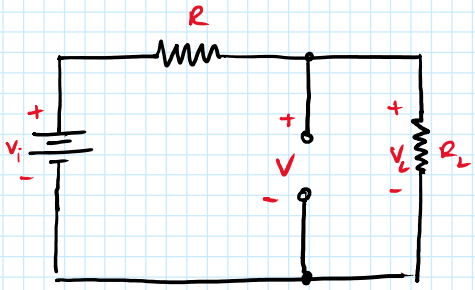
ZENER DIODE REGULATOR

Case ①: Fixed V_i (supply voltage) and fixed R_L (load)



Step ①: Remove the diode to determine state of the diode, by calculating voltage across the resulting open circuit.

$$V = V_L = \frac{R_L \cdot V_i}{R + R_L}$$



Step ②: Substitute the appropriate equivalent circuit and solve for unknowns.

If $V < V_Z$ ⟶ Diode is OFF, open circuit equivalent is substitute

If $V \geq V_Z$ ⟶ Diode is ON, appropriate equivalence model is substituted

Once the diode is ON, it will "lock in" its value of V_Z

By KCL,

Total current $I_R = I_Z + I_L$

$$I_L = \frac{V_L}{R_L} \qquad I_R = \frac{V_R}{R} = \frac{V_i - V_L}{R}$$

$P_Z = V_Z I_Z$

↳ Power dissipated by Zener diode