Capacitor Filter: Working and Analysis with waveforms

Reference: Electronics Devices and Circuits 1 by Ravish Singh

2. Capacitor filter or C filter:- 14

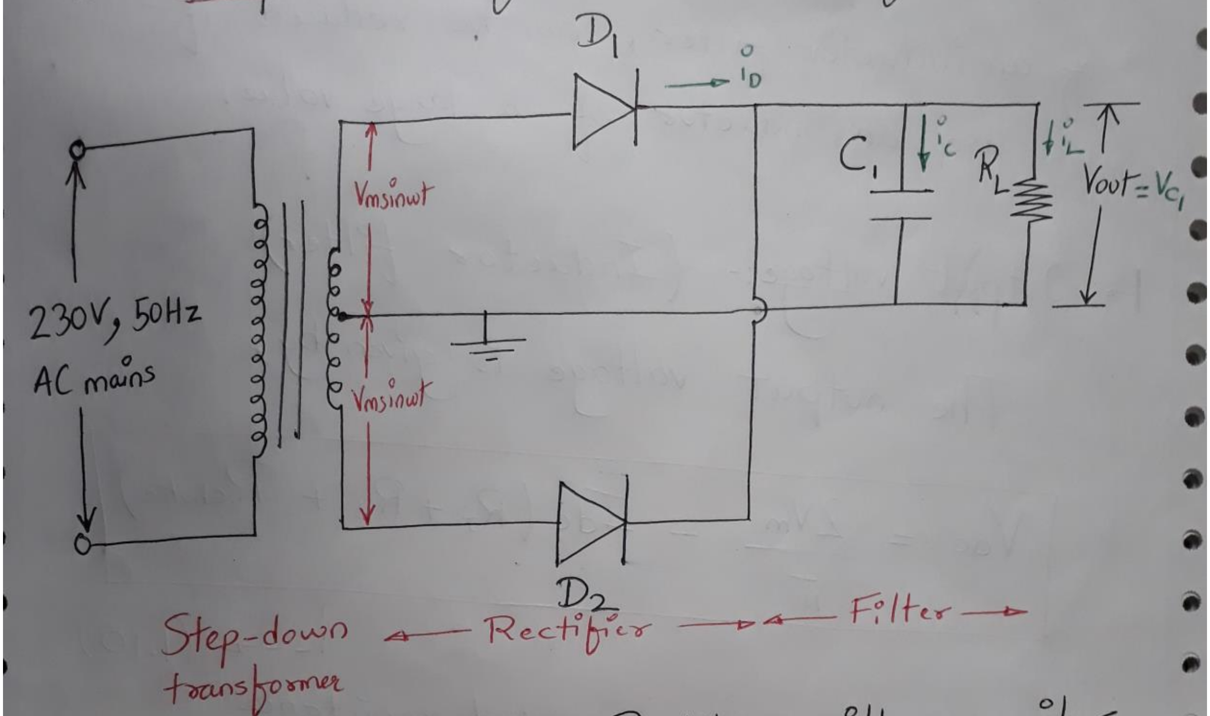

fig 2.1 : Full-wave Rectifier with capacitor filter

- We have seen that an inductor filter is suitable only for heavy loads (ie a load with smaller values of resistance).
- An inexpensive filter for light loads (ie a load with larger value of resistance) is available in the form of a capacitor filter.

• In a capacitor filter, the capacitor C_1 is connected in parallel with the Load R_L as shown in fig 2.1.

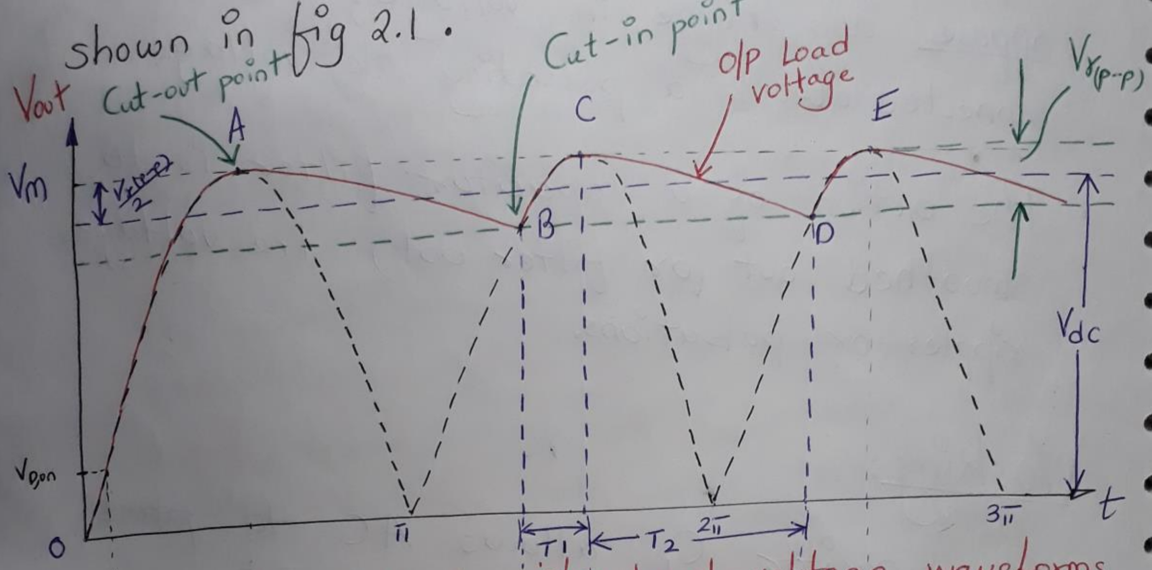

fig 2.2 : Approximate O/P Load-voltage waveforms in a full-wave capacitor-filtered rectifier

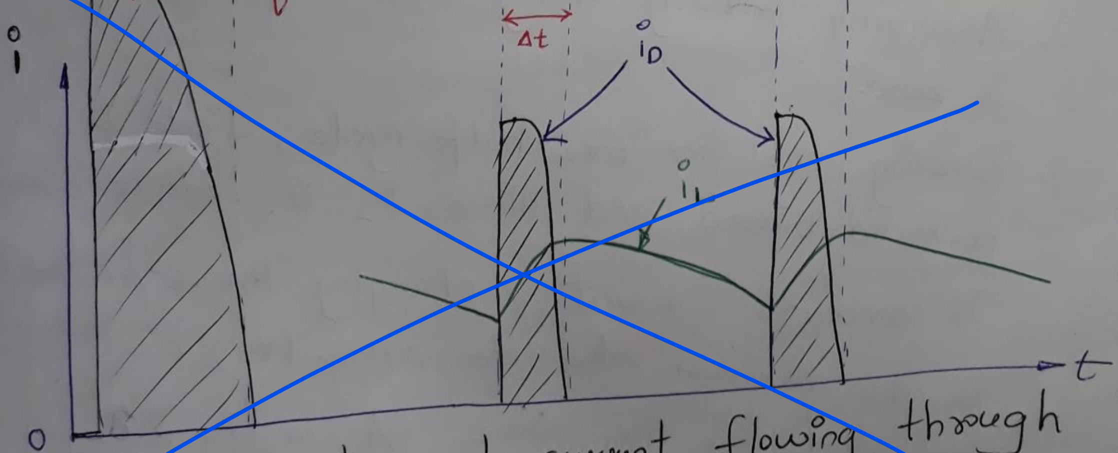

fig 2.3: Waveforms of current flowing through (i_D) diode and O/P load current (i_L)

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- The operation of a capacitor filter depends upon the property of a capacitor to oppose any change in voltage, when it is connected across a pulsating dc voltage.

- The action of a capacitor filter is to smoothed out (or filter out) the voltage ripples or pulsations.

Working:

1. The capacitor C_1 allows AC to pass through it whereas it blocks DC.
2. Assuming initially voltage across capacitor C_1 is zero.
3. During the positive half cycle, diode D_1 is forward-biased and diode D_2 is reverse-biased. D1 conducts current, charging the capacitor C_1 to its maximum value of voltage (V_m) as indicated by the curve OA in fig 2.2

- Since there is no resistance in the charging path, except diode forward resistance (which is small), the charging is instantaneous ie charging time is v.small.

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4. After point A, the ac input voltage begins to decrease, but capacitor C_1 is already charged to the value V_m.
5. But since voltage across the capacitor C_1 cannot change immediately, therefore after point A, capacitor voltage (V_{C_1}) is more than the input voltage. (which means cathode voltage of the diode D_1 is more than anode voltage) Hence, diode D_1 is reverse biased in the positive half cycle itself.
6. Hence, charging of C_1 is stopped and now capacitor C_1 starts discharging slowly through the Load resistor (R_L), thus the o/p Load voltage (V_{out}) decreases by a small value.

   (Discharging time constant $\tau_d = C_1 R_L$ is much greater than charging time constant $\tau_c = C_1 R_f$) $R_f \rightarrow$ forward resistance of diode $D_1 \rightarrow$ v. small.
7. At the same time positive half cycle is over and negative half-cycle begins.

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- Now diode D_1 continues to be in reverse bias. Next diode D_2 is also still reverse-biased due to voltage across capacitor.

8. Therefore, capacitor C_1 continues to discharge and reaches the point B as shown by section A-B in fig 2.2

9. ~~After point~~

9. At point B in the waveform, the instantaneous voltage of the rectified o/p is greater than the capacitor voltage, thus diode D_2 is forward-biased and starts charging the capacitor upto the peak voltage V_m as shown by section B-C in fig 2.2.

10. This process repeat's during subsequent cycle and we get a "filtered" o/p as shown in the fig 2.2.

11. In the waveforms (fig 2.2), at point A, diode stops conducting, hence it is known as 'cut-out' point / cut-off point.

• At point B, diode starts conducting, hence it is known as 'cut-in point'. 19

12. The output load voltage Vout is almost a DC voltage with small ripple voltage (V_{rp-p}) as shown in fig 2.2.
The ripple (ie ac component) present in the o/p voltage of a capacitor filter is due to charging and discharging of a capacitor.

13. The smaller the ripple voltage (V_{rp-p}), the better is the filtering action.

14. One way to reduce the ripple is by increasing the discharging time constant which is equal to $R_L \cdot C_1$.

15. ~~Figure (2.3) shows waveforms of current flowing through the diode (i_D) and o/p load current (i_L). During the charging time (from point B to point C), the rectifier supplies the charging current I_C~~