Full-wave rectifier analysis

1)

he bridge rectifier ircuit is shown in his this Fig.

V on T ➢➢is an ac(- ve and +ve) terminals

At V_{ad} i ➢➢ abcd

At V_{da} i ➢➢ dbca

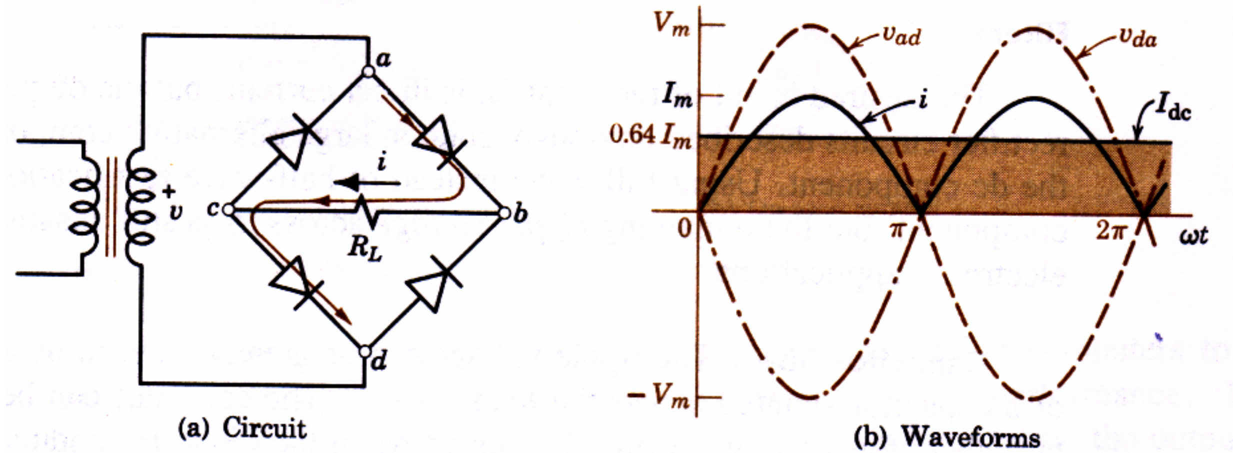


Figure 3.30 A full-wave bridge rectifier.

(2)

- ***i*, through R_L ➢➢ in the same direction**

The dc component is twice as large as in half-wave rectifier

$$I_{dc} = \frac{2}{\pi}\frac{V_m}{R_L} = \frac{2 I_m}{\pi}$$

The disadvantageous of the bridge circuit is:

- **Four diodes are needed**
- **Their power-dissipating voltage drops are always in series with the load.**

•This will reduce the power delivered to the lead

- he circuit hown in this ig. uses
- expensive ransformer ➢➢ v_2 *is* 180^o *out of phase with* v_1
- two diodes nly
- higher perating fficiency

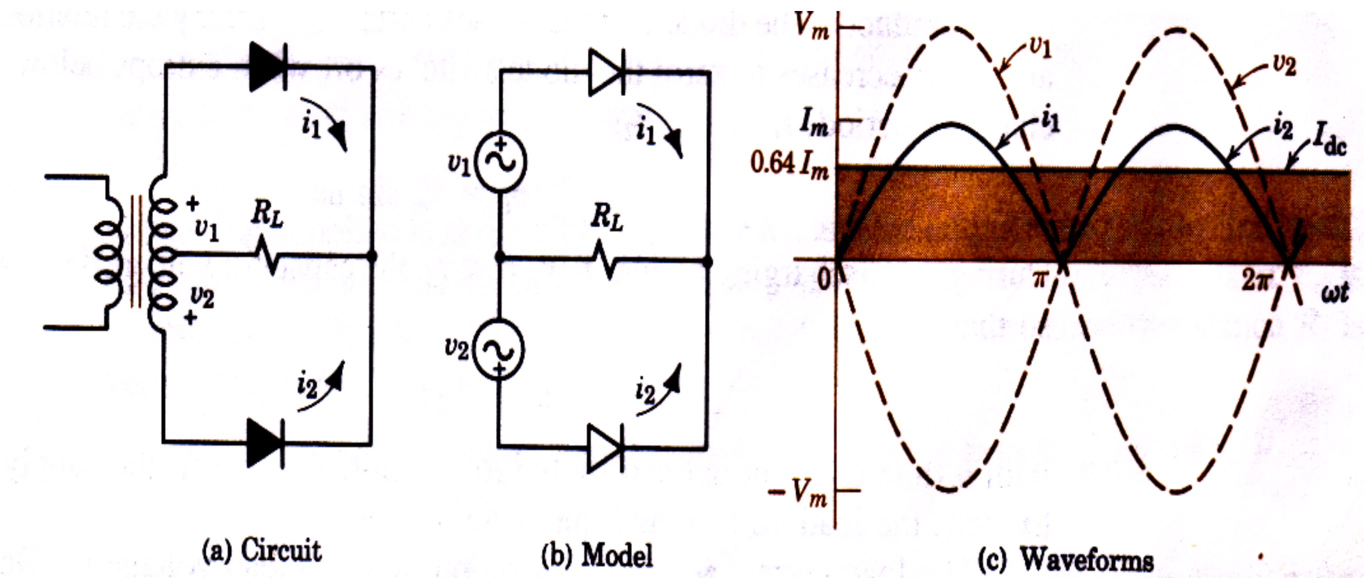


Figure 3.31 A full-wave rectifier with phase inverter.

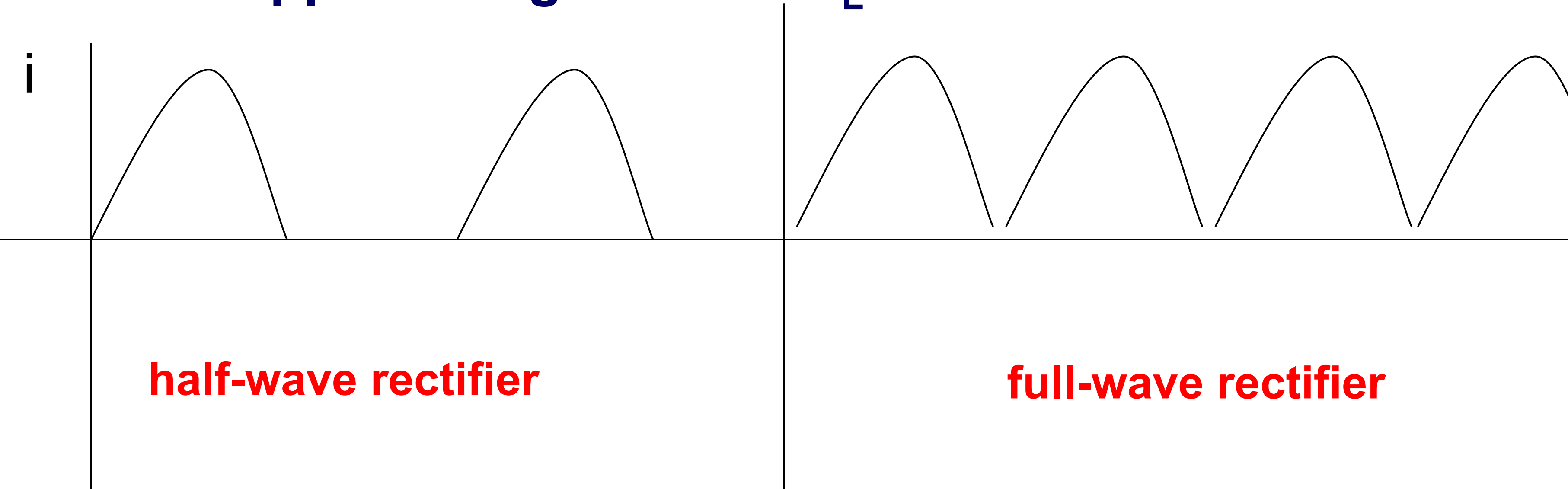
- **When** v_1 **+ *ve*,** i_1 **➢➢ D_1, no current flows through D_2**
- **When** v_2**+ *ve*,** i_2 **➢➢ D_2, no current flows through D_1**
- **The current in R ($I = i_1 + i_2$)** $\therefore\ I_{dc} = 2I_m/\pi$

Filters

Rectification means direct current (dc)

The output current of the half-wave and full-wave rectifier ontain large ac components

There is ripple voltage across R_L



Capacitor Filter

Reduced the ripple voltage

How?

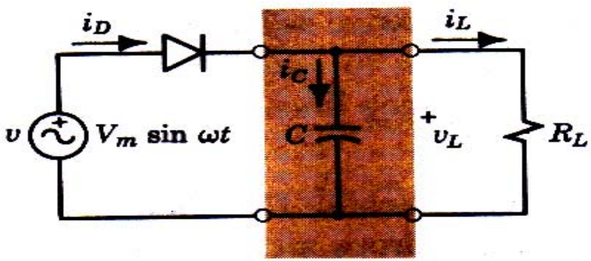
The capacitor is shunted ➢➢ between R_L and diode

- **The charge store in the capacitor ➢➢ when D conducting ➢➢ during the positive period**

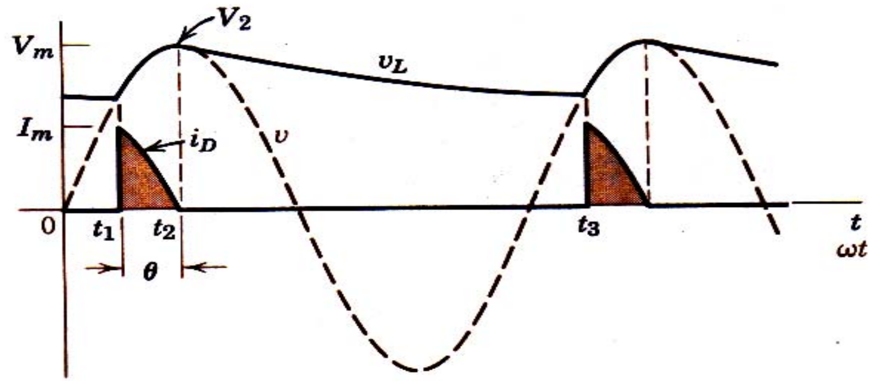
- **The charge release from the capacitor ➢➢ when D nonconducting**

➢➢ during the negative period

At the steady state.



(a) Circuit



(b) Voltage and current waveforms

Figure 3.32 A capacitor filter.

At $t = 0$ ➢➢ $v_s = 0$ ➲ D ➢➢ off ➲ $i_D = 0$ ➲ $v_s < V_C = V_L$ (C-dis)

At t = t_1 ➢➢ $v_s > V_C = V_L$ ➲ D ➢➢ on ➲ i_D *rises to satisfy*

i_c= Cdv/dt ➢➢ $V_L = V_m \sin\omega t$ ➢➢ during ➢➢ $t_1 > t > t_2$ (C-charges)

At t = t_2 ➲ D ➢➢ off ➲ $i_D = 0$ ➲ $v_s < V_C = V_L$ *(C-dis)*

During the discharging period,➢➢ $t_2 > t > t_3$ ➢➢ $V_C = V_L$ decays exponentially

$$V_L = V_2 e^{-(t-t_2)/R_L C}$$

- **At t = t_3 ➢➢ *vs* < VC = VL *(C-dis)***

➢➢ the cycle repeats

$$V_L = V_2 e^{-(t-t_2)/R_L C}$$

rom this equation :

T = RC is the periodic time ⮚⮚ deepens on the values of R and C

i_L never goes to zero it α v_L

- **The dc components ⮚⮚ I_{dc} and V_{dc} are larger as compared to the half-wave rectifier alone**

The ripple voltage ⮚⮚ V_r ⮚⮚ voltage conducting diode ⮚⮚ reduced by se of the capacitor

V_r ⮚⮚ very small when RC > T (the period of the supply voltage ⮚⮚ the decay ir

$V_C = V_L$ small ⮚⮚ approximately straight line

Capacitor Filter – Approximate Analysis

ASSUMPTION

- ***RC large*** ➢➢ v_r **small** ➢➢ $t_2 - t_1$ **small** ➢➢ $v_c \cong$ **constant**

  All the current ➢➢ **supplied by the capacitor**

  - **The charge transferred to R_L**

$$\Delta q = I_{dc}T = C\Delta v_c = Cv_r$$

$$v_r = \frac{I_{dc}T}{C} = \frac{I_{dc}}{fC} = \frac{V_{dc}}{fR_LC}$$

EXAMPLE 9

A load ($R_L = 3330\ \Omega$) is to be supplied with 50 V at 15 mA with a ripple voltage no more than 1% of the dc voltage. Design a rectifier–filter to meet these specifications.

Assuming a 120-V, 60-Hz supply and the half-wave rectifier with capacitor filter of Fig. 3.32a, Eq. 3-46 is applicable. Solving for C,

$$C = \frac{V_{dc}/V_r}{fR_L} = \frac{100}{60 \times 3330} = 500\ \mu\text{F}$$

For a peak value of 50 V, the rms value of transformer secondary voltage should be $50/\sqrt{2} = 35.4$ V. The transformer turn ratio should be

$$\frac{N_1}{N_2} = \frac{V_1}{V_2} = \frac{120}{35.4} = 3.39$$

Practice Problem 3-8

Redraw Fig. 3.32b to show the load voltage V_L and the diode current i_D for a full-wave rectifier-capacitor filter supply. For a full-wave rectifier:

(a) How many current pulses are there per second?
(b) Derive the equation for V_r for this case.
(c) What size capacitor is needed to meet the specifications of Example 9?

Answers: (a) $2f$; (b) $V_r = V_{dc}/2fR_LC$; (c) 250 μF.

HOMEWORK

1. Redraw the circuit in Ex. 8 p. 82 when a capacitor of 1F is shunted between the diode and R_L

2. Calculate the ripple voltage of this circuit

3. Derive an equation to solve the ripple voltage for the full-wave rectifier circuit

4. Practice Problem 3-8 . Drawing and calculations