

5.2 Rectifiers and dc supplies

Name: _____ Class: _____ Date: _____

Total: 22 marks

KEY WORDS half-wave rectifier

• bridge rectifier

• filter capacitor

• ripple • zener diode

Objective

Analyse half- and full-wave rectifiers with capacitor filters, size a filter for a ripple specification, and check zener regulation against its current window and power limit.

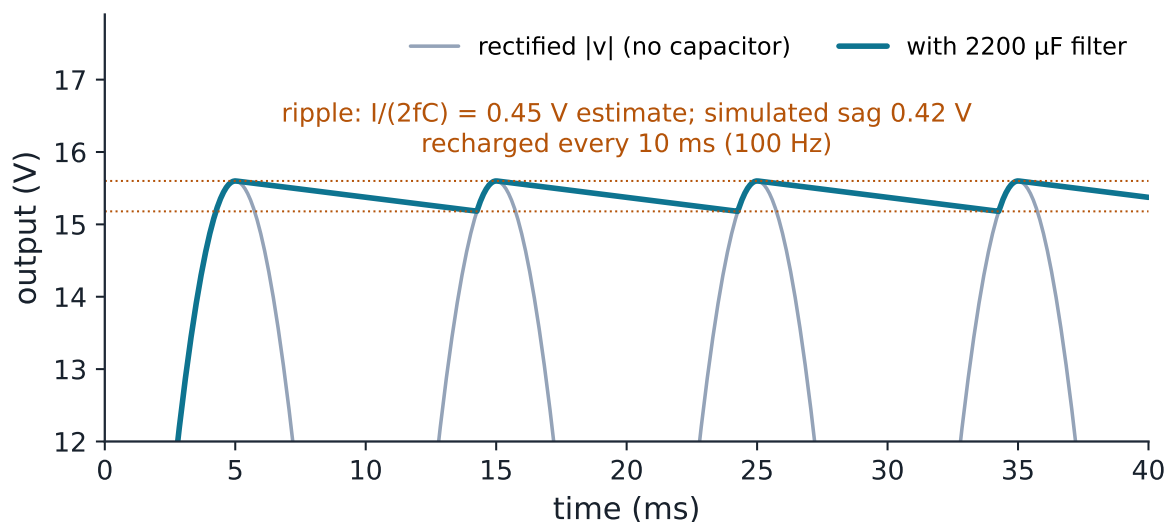
1 Key knowledge and worked examples

■ The rectifier family

A **half-wave rectifier**
wave bridge rectifier

conducts one half-cycle (one diode drop). A **full-wave bridge rectifier** conducts both half-cycles through two diodes at a time (1.4 V total). Peak output = $V_{peak} - \text{diodedrops}$.

Worked example. A 12 V RMS secondary at 50 Hz into a bridge: peak $12\sqrt{2} = 17.0\text{V}$, output peak $17.0 - 1.4 = 15.6\text{ V}$.



Full-wave bridge with 2200 µF at 100 mA: the capacitor bridges the gaps.

■ The filter capacitor and ripple

A **filter capacitor** holds the output between recharge peaks. The **ripple** $\Delta V \approx I/(f_r C)$ where f_r is the recharge rate (f for half-wave, 2f for full-wave).

Worked example. 100 mA load, 2200 μF , bridge (recharges every 10 ms): $\Delta V = 0.1/(100 \times 2200 \mu) = 0.45\text{V}$. The output sits between 15.6 V (peak) and 15.1 V. Design rule: choose C from the spec – $C \geq I/(f_r \cdot \Delta V)$; e.g. requiring 0.2 V at 150 mA needs $C \geq 0.15/(100 \times 0.2) = 7500 \mu\text{F}$.

■ Zener regulation, by the window

A **zener** regulator holds V_Z while I_Z stays within its window: above $I_Z(\text{min})$ (regulation) and below $P_Z(\text{max})/V_Z$ (survival). The check is two inequalities at the extreme loads – and the series resistor dissipates $(V_{in} - V_Z) \times I_R$, which is part of the design too.

2 Practice

2.1 A half-wave rectifier on a 6 V RMS, 50 Hz secondary (one diode): compute the peak output voltage. [2]

2.2 A bridge with 1000 μF supplying 50 mA from a 50 Hz supply: compute the ripple and the recharge interval. [3]

2.3 A 9 V zener regulator ($R = 220 \Omega$ from 12 V) feeds a variable load. Give I_R and the zener current at open circuit. [3]

3 Exam-style questions

3.1 Design a bridge supply: 15 V regulated output from a zener, load 0–120 mA, input 24 V DC, ripple at the filter ≤ 1 V.

Choose the series R for the zener path (zener needs ≥ 5 mA at full load), size the filter capacitor (from a 100 Hz recharge), and check the zener and resistor power at worst case. State which load case is worst for each component. [8]

3.2 A half-wave supply must deliver 20 mA DC with ripple ≤ 0.5 V from a 9 V RMS, 50 Hz secondary (one diode, constant-drop), capacitor filter.

Compute the peak output, the required capacitance, and the diode's average current. Then explain (with the numbers) why the same capacitor on a bridge halves the ripple, and give the peak diode current rationale (the capacitor recharges in a brief slug near the peak). [6]
