InkPhysics

QUESTION WORKBOOK

Rectification and smoothing

Magnetic fields · Year 13

CIE 21.2.1, 21.2.2, 21.2.3, 21.2.4

19 questions · 50 marks

PRINT EDITION

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SECTION A · Warm-up

A1 State the function of a diode in a circuit and explain why a single diode in series with an alternating supply produces half-wave rectification. [2]

A2 Sketch the output of a half-wave rectifier fed with a sinusoidal input, and the output of a full-wave rectifier fed with the same input. Label the difference between them. [2]

A3 State one disadvantage of half-wave rectification compared with full-wave rectification, and one advantage in terms of components. [2]

A4 A sinusoidal 50 Hz supply is full-wave rectified. State the number of voltage peaks per second in the output. [1]

A5 A sinusoidal 50 Hz supply is half-wave rectified, with no smoothing. State the time between successive peaks of the output, and the length of time in each cycle for which the output is zero. [2]

A6 State what is meant by the ripple of a smoothed supply and what causes it. [2]

SECTION B · Standard

B1 A bridge rectifier contains four diodes. Explain how it produces full-wave rectification. Refer to which diodes conduct in each half-cycle. [3]

B2 Explain how a capacitor connected across the load smooths the output of a full-wave rectifier. [3]

B3 A smoothing capacitor of 2200 μF discharges through a load of 500 Ω. Calculate the time constant of the discharge. [2]

B4 State and explain the effect on the ripple of a smoothed supply of increasing the capacitance of the reservoir capacitor. [2]

B5 A smoothed power supply works well with a 2.0 kΩ load. Explain why the ripple increases when the load is changed to 200 Ω. [2]

B6 An oscilloscope connected across the load of a rectifier circuit shows positive humps 10 ms apart. The ac supply has a frequency of 50 Hz. Deduce whether the rectification is half-wave or full-wave. [2]

B7 A smoothed full-wave supply holds its output near 15 V across a load that draws an almost steady current of 60 mA. The reservoir capacitor is 1000 µF and peaks arrive every 10 ms. Estimate the fall in the output voltage between successive peaks. [3]

B8 A student smooths a half-wave rectified 50 Hz supply and a full-wave rectified 50 Hz supply using identical capacitors and identical loads. Explain which output shows the larger ripple. [3]

SECTION C · Stretch

C1 A full-wave rectified 50 Hz supply is smoothed by a 470 µF capacitor across a 1.0 kΩ load. Calculate the time between successive peaks and the discharge time constant, and use the two values to justify whether the smoothing is effective. [4]

C2 An unsmoothed full-wave rectifier is fed from a supply of rms voltage 12 V. State the peak output voltage, and describe how the smoothed output would sit relative to the unsmoothed humps if both were drawn on the same axes. [3]

C3 A 100 µF capacitor smooths a full-wave rectified 50 Hz supply across a 2.0 kΩ load. Calculate the fraction of the peak voltage remaining after one 10 ms interval between peaks, and comment on the size of the ripple. [4]

C4 A full-wave rectified 50 Hz supply feeds a 500 Ω load. The design requires the output to stay above 95% of the peak voltage at all times. Three reservoir capacitors are available: 100 µF, 220 µF and 470 µF. Using $V = V_0 e^{-t/RC}$, deduce the smallest of the three capacitors that meets the requirement. [5]

C5 One of the four diodes in a bridge rectifier fails so that it no longer conducts. Deduce and explain the effect on the smoothed output across the load. [3]