2018 Ph H2 Q12

Section: Electricity

Topic: Alternating current, oscilloscopes, RMS voltage

(a)(i) From oscilloscope trace with Y-gain 1 V/div, determine peak voltage.
(ii) From timebase 0.5 s/div and waveform, determine frequency.
(iii) Explain why red LED lights for positive current, green LED for negative.

(b) Signal generator connected to series resistors 68 Ω and 82 Ω. Determine the r.m.s. voltage across the 82 Ω resistor.

Worked solution

(a)(i)
Peak = number of vertical divisions × Y-gain.
= 3.0 × 1.0 V = 3.0 V.

Answer: 3.0 V

(a)(ii)
Period T = number of horizontal divisions × timebase.
= 4.0 × 0.5 s = 2.0 s.
Frequency f = 1/T = 0.50 Hz.

Answer: 0.50 Hz

(a)(iii)

LEDs conduct only in one direction (they are diodes). During the positive half-cycle, current flows forward through the red LED, so it lights. During the negative half-cycle, current direction reverses, forward biasing the green LED instead. Thus they light alternately depending on current direction.

Answer: Red LED lit in positive half-cycle, green in negative

(b)

Peak voltage across whole circuit = 3.0 V.
RMS voltage across whole circuit = $V_p/\sqrt{2}$ = 3.0/$\sqrt{2}$ = 2.12 V.
Voltage divides in proportion to resistance: V_{82} = V_total × (82/(68+82)).
= 2.12 × 82/150 = 1.16 V.

Answer: 1.16 V

Final answers

(a)(i) Vp = 3.0 V

(a)(ii) f = 0.50 Hz

(a)(iii) Red LED lit in positive cycle, green in negative cycle

(b) V_rms across 82 Ω = 1.16 V

Revision tips

- Oscilloscope: peak voltage = vertical divisions × Y-gain.

- Frequency = 1/period; period from horizontal divisions × timebase.

- LEDs conduct only in forward bias, so each lights in alternate half-cycles.

- RMS voltage = $V_p/\sqrt{2}$ for sine wave.

- Series resistors divide voltage in proportion to resistance.