NCERT Math 11.9.2 Q8

EE23BTECH11009 - AROSHISH PRADHAN*

Question: An input voltage in the form of a square wave of frequency 1 kHz is given to a circuit, which results in the output shown schematically below. Which one of the following options is the CORRECT representation of the circuit?

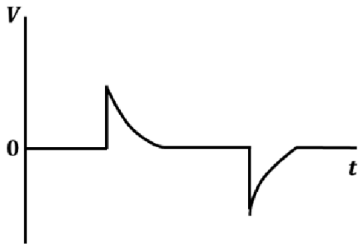
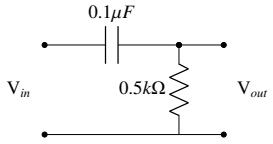
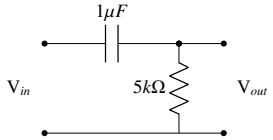


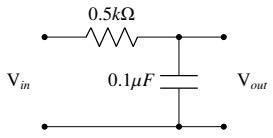
Fig. 1



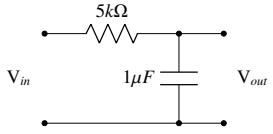
(a)



(b)



(c)



(d)

Solution: When rising edge of square waveform is applied, capacitor is at discharged state:

Symbol	Value	Description
V_{in}		Input Voltage
V_{out}		Output Voltage
f	$1000Hz$	Input Wave Frequency
T	$\frac{1}{f} = 10^{-3}s$	Input Wave Time Period
R	(a) $0.5k\Omega$	Resistance
	(b) $5k\Omega$	
	(c) $0.5k\Omega$	
	(d) $5k\Omega$	
C	(a) $0.1\mu F$	Capacitance
	(b) $1\mu F$	
	(c) $0.1\mu F$	
	(d) $1\mu F$	
τ	RC	Time Constant

TABLE I: Given Parameters

$$\therefore V_C = 0 \tag{1}$$

at rising edge.

$\therefore$ options (c) and (d) are wrong.

Time constants (τ) of circuits (a) and (b) are given below:

Option	R	C	τ
(a)	$0.5k\Omega$	$0.1\mu F$	$5 \times 10^{-5}s$
(b)	$5k\Omega$	$1\mu F$	5×10^{-3}s

TABLE II: Time Constants

$$\because 5\tau_{(a)} = 2.5 \times 10^{-4} < T = 10^{-3} \tag{2}$$

the capacitor charges (i.e. $V_{out} = 0$) before the next wave cycle.

$\therefore$ option (a) is correct.

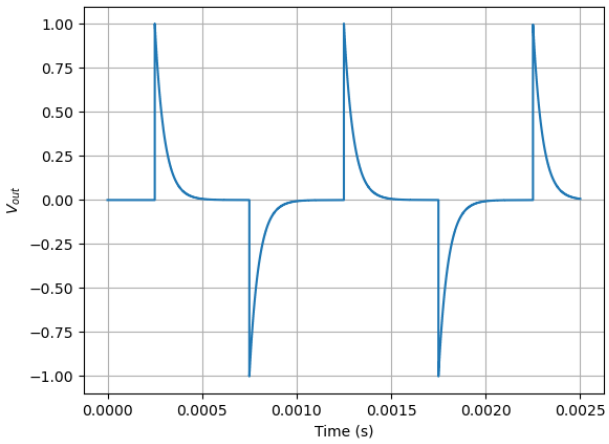


Fig. 2: Response of circuit (a) for $R = 0.5k\Omega$, $C = 0.1\mu F$, $f = 1000Hz$ and $V_{in,max} = 1V$