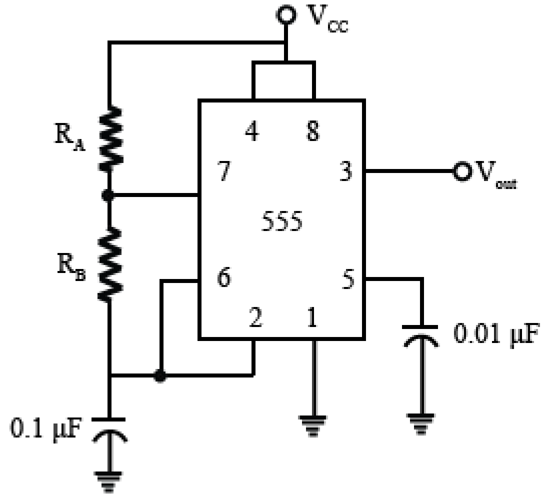
1) Consider the circuit diagram of a multivibrator as shown in the figure below :



The output is produced with frequency of 2 kHz and duty cycle of 75 %, then find the value of resistance R_B and R_A are respectively

Solution:

For astable multivibrator

$$f = \frac{1.44}{(R_A + 2R_B)C} Hz$$

therefore, $2 \times 10^3 = \frac{1.44}{(R_A + 2R_B)C}$

$(R_A + 2R_B)C = 7.2 \times 10^{-4}$

$R_A + 2R_B = 7.2 \times 10^3 \quad (\because C = 0.1\mu F) \quad \ldots(i)$

now, Duty cycle D

$$D = 0.75 = \frac{R_A + R_B}{R_A + 2R_B}$$

$R_B = 0.5R_A \quad \ldots(ii)$

From equation 1 and 2 we get,

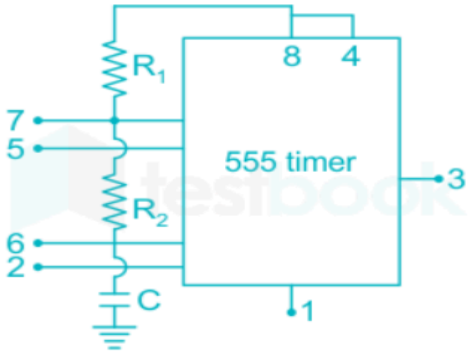
$R_B = 1.8\ k\Omega$

$R_A = 3.6\ k\Omega$

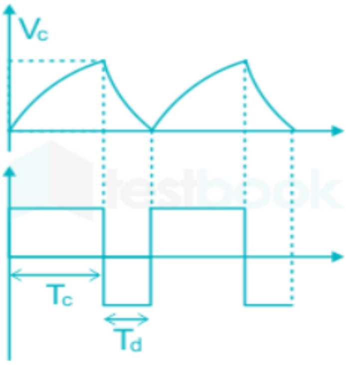
2) For an Astable multivibrator using 5555 Timer if C= 0.01µF, R_1 = 10kΩ, R_2 = 50kΩ, find the frequency and the duty cycle.

Solution:

555 timer Astable Multivibrator pin diagram is shown below:



The waveform for the charging and discharging is as shown:



Where $T_C = (R_1 + R_2)C \ln 2$

$T_C = 0.693\ (R_1 + R_2)C$

& $T_d = 0.692\ R_2C$

$T = t_c + t_d$

$T = 0.693\ (R_1 + 2R_2)C$

Frequency of oscillation will be:

$$f = \frac{1}{T} = \frac{1}{0.693(R_1+2R_2)C}$$

Duty cycle is defined as the ratio of charging time to the discharging time, i.e.

$$D = \frac{T_C}{T_C+T_d}$$

$$D = \frac{0.693(R_1+R_2)C}{0.693\ (R_1+2R_2)C}$$

$$D = \frac{R_1+R_2}{R_1+2R_2}$$

Calculation:

Given C = 0.01 μF, R_1 = 10 kΩ, and R_2 = 50 kΩ

The frequency will be:

$$f = \frac{1}{0.693(10k+2(50k))\times 0.01\times 10^{-6}}$$

f = 1.31 kHz

Now, the Duty cycle will be:

$$D = \frac{10k+50k}{10k+2\times 50k}$$

D = 54.54 %

3) An **Astable 555 Oscillator** is constructed using the following components, R1 = 1kΩ, R2 = 2kΩ and capacitor C = 10uF. Calculate the output frequency from the 555 oscillator and the duty cycle of the output waveform.

Solution

t_1 – capacitor charge “ON” time is calculated as:

$$\begin{aligned} t_1 &= 0.693(R_1 + R_2).C \\ &= 0.693(1000 + 2000) \times 10 \times 10^{-6} \\ &= 0.021s = 21ms \end{aligned}$$

t_2 – capacitor discharge “OFF” time is calculated as:

$$\begin{aligned} t_2 &= 0.693\,R_2.C \\ &= 0.693 \times 2000 \times 10 \times 10^{-6} \\ &= 0.014s = 14ms \end{aligned}$$

Total periodic time (T) is therefore calculated as:

$$T = t_1 + t_2 = 21ms + 14ms = 35ms$$

The output frequency, *ƒ* is therefore given as:

$$f = \frac{1}{T} = \frac{1}{35ms} = 28.6Hz$$

Giving a duty cycle value of:

$$\text{Duty Cycle} = \frac{R_1 + R_2}{(R_1 + 2R_2)} = \frac{1000 + 2000}{(1000 + 2 \times 2000)} = 0.6 \text{ or } 60\%$$

As the timing capacitor, C charges through resistors R1 and R2 but only discharges through resistor R2 the output duty cycle can be varied between 50 and 100% by changing the value of resistor R2.

By decreasing the value of R2 the duty cycle increases towards 100% and by increasing R2 the duty cycle reduces towards 50%. If resistor, R2 is very large relative to resistor R1 the output frequency of the 555 astable circuit will determined by R2 x C only.

The problem with this basic astable 555 oscillator configuration is that the duty cycle, the “mark to-space” ratio will never go below 50% as the presence of resistor R2 prevents this. In other words we cannot make the outputs “ON” time shorter than the “OFF” time, as (R1 + R2)C will always be greater than the value of R1 x C. One way to overcome this problem is to connect a signal bypassing diode in parallel with resistor R2 as shown below.