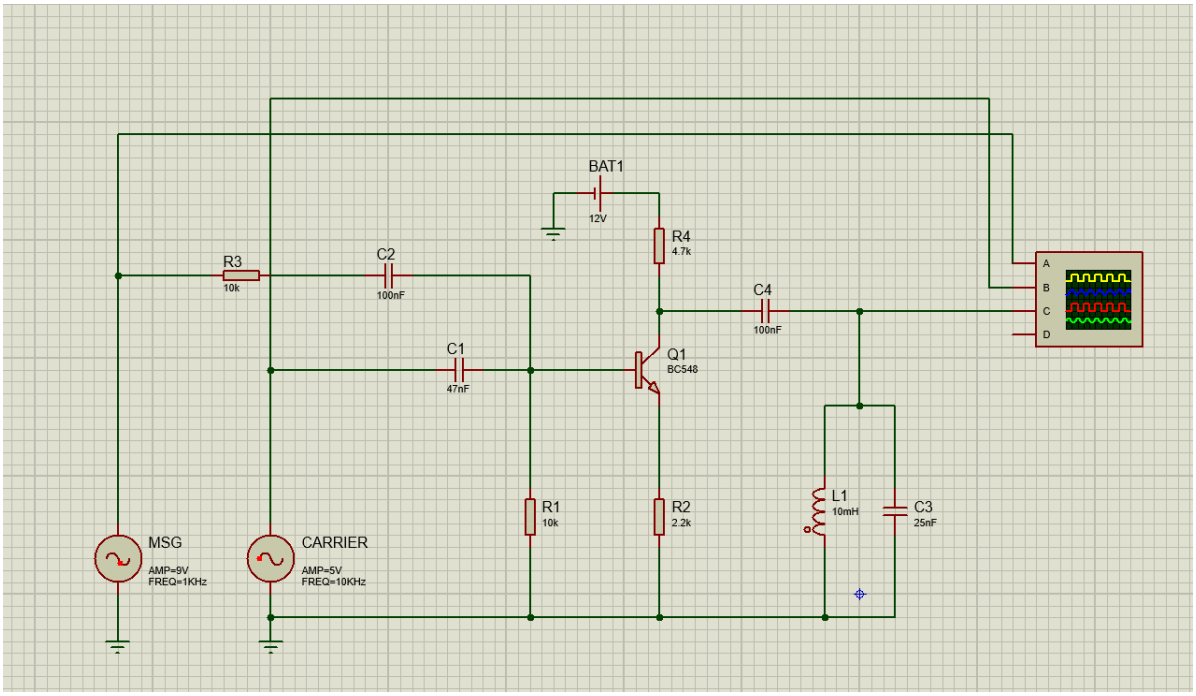
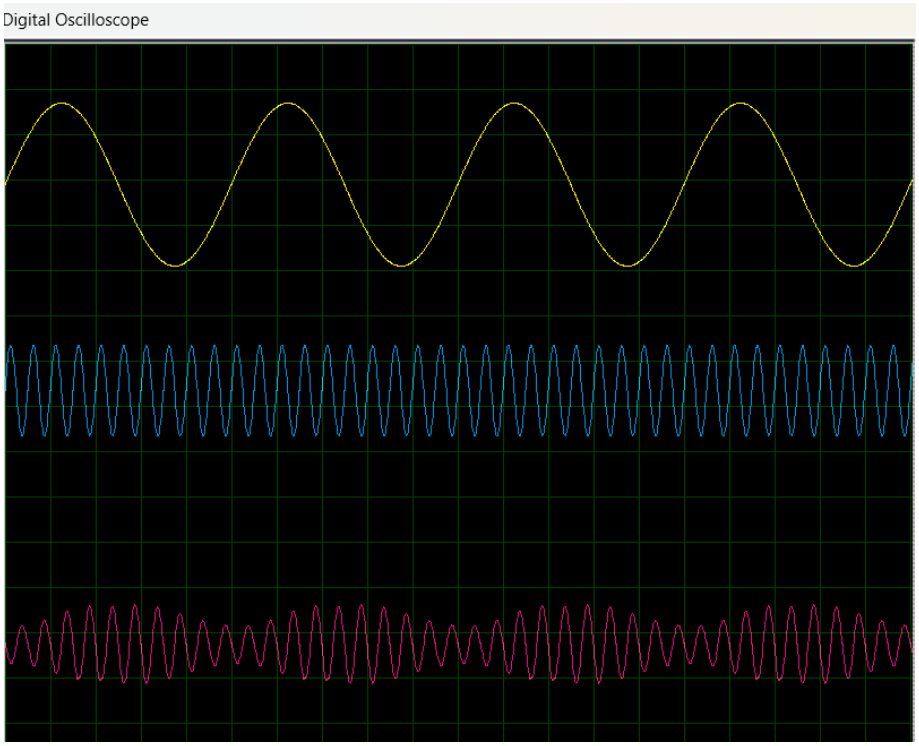
Analog Signal and Digital Signal

Aim: To design two circuits for Analog Signal and Digital Signal

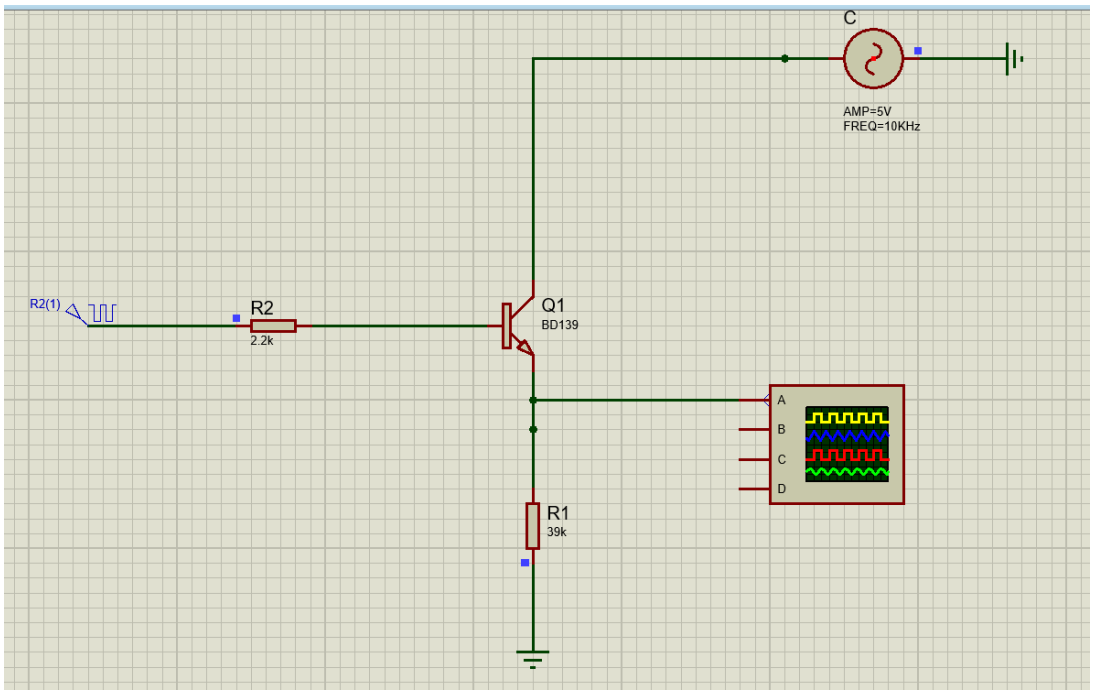
Circuit Diagram for Analog Signal: Amplitude Modulation



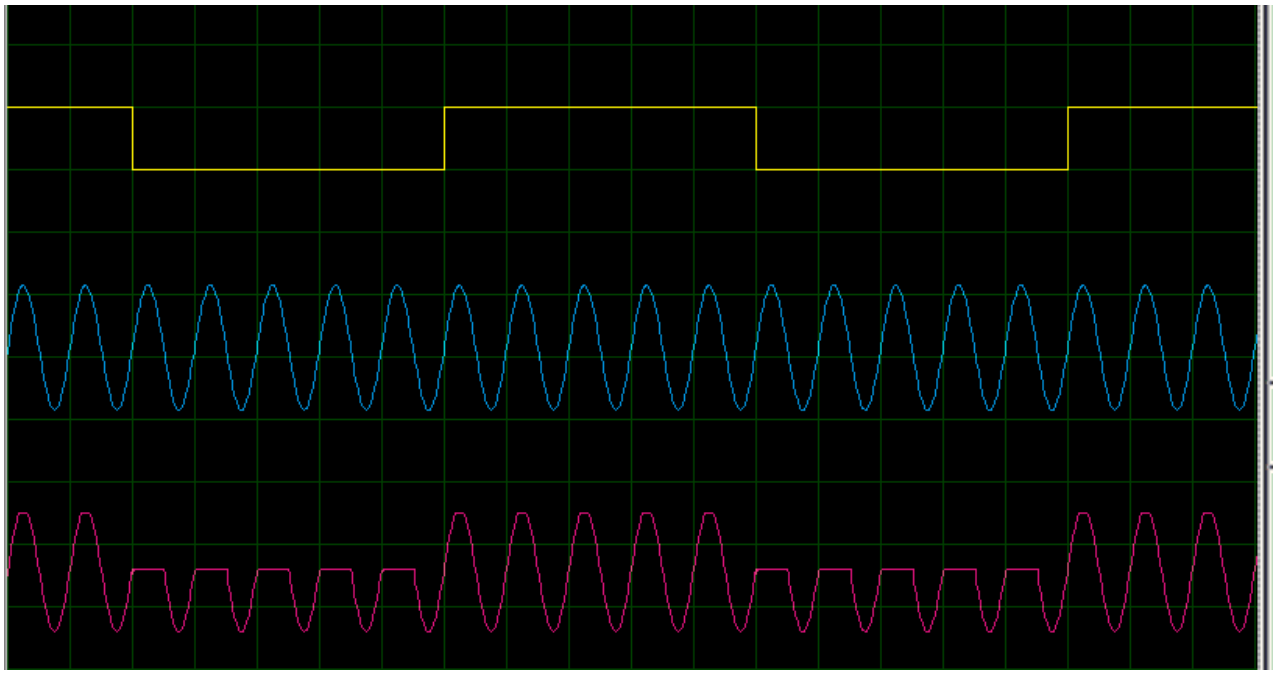
Output:



Circuit Diagram for Digital Signal: Amplitude Shift keying



Output:



Theory:

Amplitude modulation :-

BC548 transistor is class C amplifier configuration
- → high efficiency
- → suitable for LC tank

carrier → 10KHZ, 5V
msg → 1KHZ, 9V

BC548 amplifies and modulates the carrier by varying its amplitude according to the message signal.

L1-C3 tank circuit → acts as filter + frequency selector for carrier frequency

output at collector

$R_1 \rightarrow 10K\Omega$ → Biase bias resistor
$R_2 \rightarrow 2.2K\Omega$ → emitter resistor → negative feedback
$R_3 \rightarrow 10K\Omega$ → Limit current of modulating (msg) signal
$R_4 \rightarrow 4.7K\Omega$ → collector load resistor

$$\text{Gain} \approx \frac{R_C}{R_E} = \frac{R_4}{R_2} = \frac{4.7K\Omega}{2.2K\Omega} \approx 2.13$$ → sufficient for low power AM.

R_4 → if too large → output clipped
R_4 → if too small → weak signal

$4.7K\Omega$ is optimum

Resonate frequency of tank circuit

$$f = \frac{1}{2\pi\sqrt{LC}} = 1 \Big/ 2\pi\sqrt{(10mH)(25nF)} \approx 10KHZ$$

ASK

Ask is a modulation technique where the amplitude of a carrier wave is varied according to a digital input signal (0 or 1)

$R_2 = 2.2K\Omega$

→ controls base current to switch Q1 fully ON without damaging it.

→ $I_B = \frac{I_C}{\beta}$ * β is current gain.

β for BD139, typically 40-100

$V_{in} = 5V$, $\beta = 50$

$V_{BE} \approx 0.7V$,

Desired $I_C = 10mA$

R1 is pull down resistor

$I_B = \frac{10mA}{50} = 0.2mA$

BD139 is very high frequency Transistor

$R_2 = \frac{V_{in} - V_{BE}}{I_B} = \frac{5V - 0.7V}{0.2mA} \approx 21.5K\Omega$

But 2.2KΩ is used for safety

overdrives the base to ensure saturation under any condition.

R_2 ensures the reliable switching and protect the base

the mathematical representation of ASK is

$$s(t) = [m(t) \cdot A_c] \cos(2\pi f_c t)$$