EXPERIMENT NUMBER : 2

EXPERIMENT NAME : FREQUENCY MODULATION

DATE : 17/10/2022, MONDAY

* **AIM :**

To perform frequency modulation for free-running oscillator and using a carrier signal, verify the same using digital oscilloscope.

* **COMPONENTS REQUIRED :**

1. Digital oscilloscope (DSO)
2. Function Generator
3. Capacitor (1 nF), (1 μF)
4. Resistor
5. PLL - IC 565
6. Breadboard
7. Probes - 3
8. Connecting wires, as required

* **THEORY :**

Frequency modulation is a form of modulation in which amplitude of message is varied by changing frequency of carrier. The amplitude and phase of carrier remains constant.

Instantaneous frequency f_i in FM modulation is -

$f_i + f_c + k_f m(t)$, where k_f is frequency sensitivity

Angle, $\theta_i(f) = 2\pi f_c t + 2\pi k_f \int m(t)\, dt$,

where f_c is frequency of carrier

$m(t)$ is message signal

The equation of FM modulated signal is -

$$u(t) = A_c \cos\left[2\pi f_c t + 2\pi k_f \int m(t)\, dt\right]$$

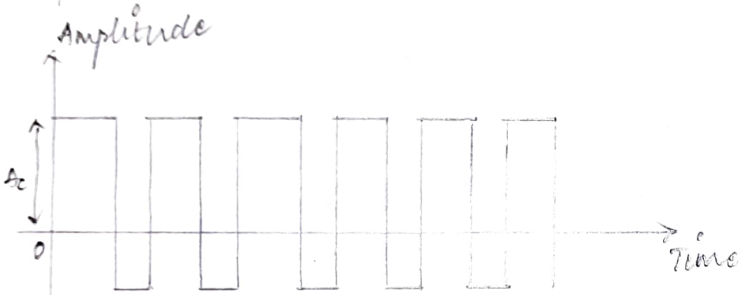
PTO

The modulation index $\beta = \frac{\Delta f}{f_m} = \frac{k_f A_m}{f_m}$, where -

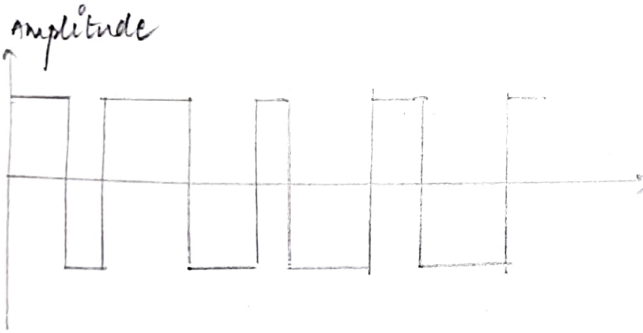
Δf is the frequency deviation
A_m is amplitude of message signal

* MODEL GRAPHS:

Message signal (Baseband)



carrier signal



Frequency Modulated Wave

The frequency of modulated wave increases, when amplitude of modulating signal increases, similarly it decreases, when the amplitude of message signal decreases.

→ PHASE LOCKED LOOPS (PLL) :-

A PLL is an electronic circuit with a voltage-driven oscillator that constantly adjusts to match the frequency of an input signal. These are used for modulation and demodulation.

A PLL reduces phase errors between output and input frequencies. When the phase difference between these signals is low, the system is said to be locked. This locking action depends on PLL's ability to provide negative feedback. PLL helps to establish input-output relationship to generate appropriate control voltage. It helps achieve frequency lock in circuit.

→ Components of PLL:-

① Phase detector - Phase comparator or mixer, compares phase of two signals and generates voltage according to phase difference. It multiplies the reference input and VCO output.

② VCO - Generates a sinusoidal signal, whose frequency closely matches the center frequency provided by low-pass filter.

③ Low-pass filter - A loop filter that attenuates high frequency alternating current (AC) component of input signal and flattens the signal.

→ PLL IC 565 :-

It is usable over the frequency range 0.1 Hz to 500 kHz. It has highly stable center frequency and is able to achieve a very linear FM detection. The output of VCO is capable of producing TTL compatible square. The dual supply is in the range of ±6V to ±12 V.

① It is a 14-pin IC operated from dual power supply; +V (pin # 10) and −V (pin # 1).
② Pin # 4 has VCO output.
③ Pin # 7 has FM output.
④ Pin # 8 and #9 has external R and C, for VCO which determines the free running frequency of VCO.

Experiment 2
Frequency Modulation

SANTOSH
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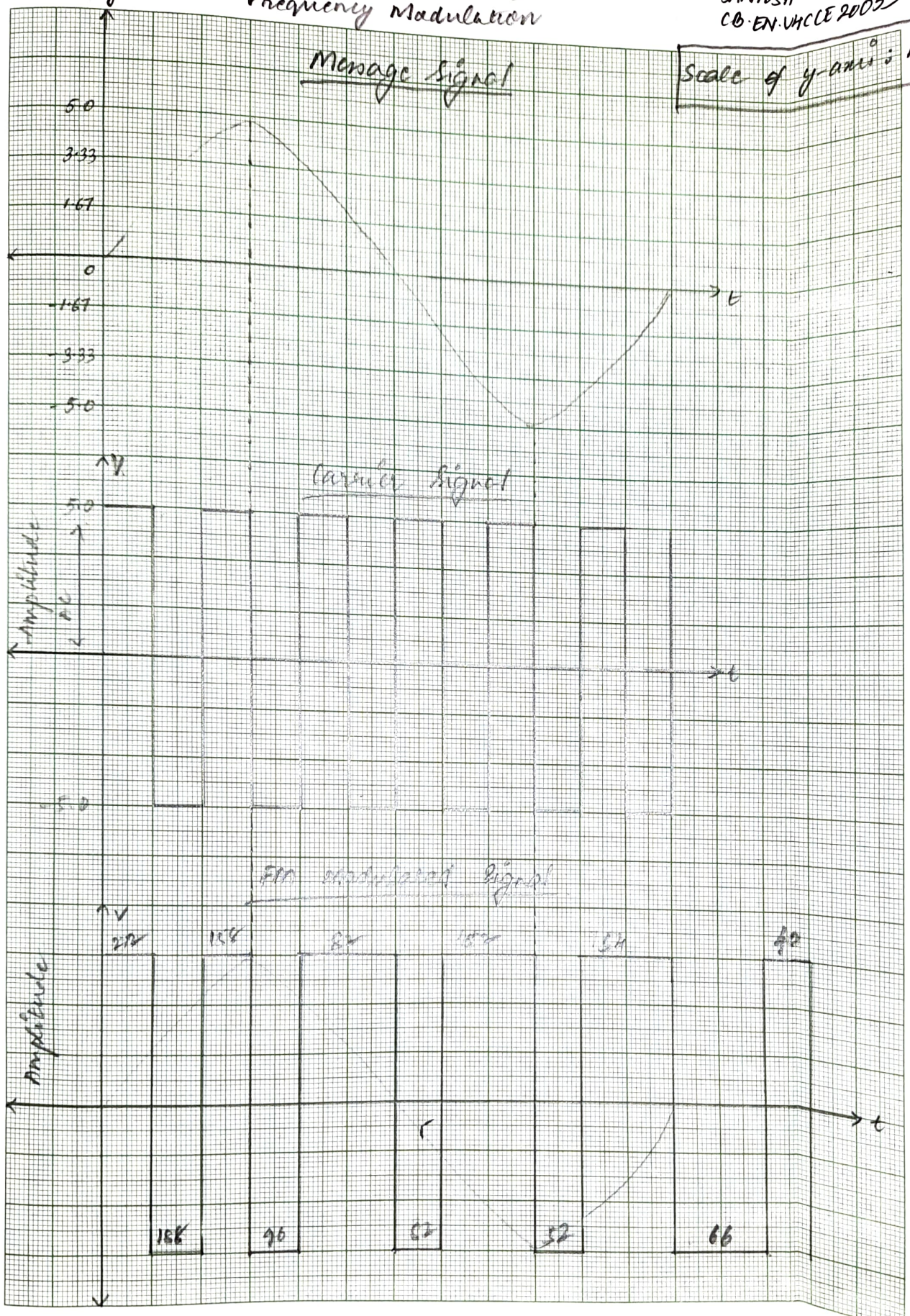
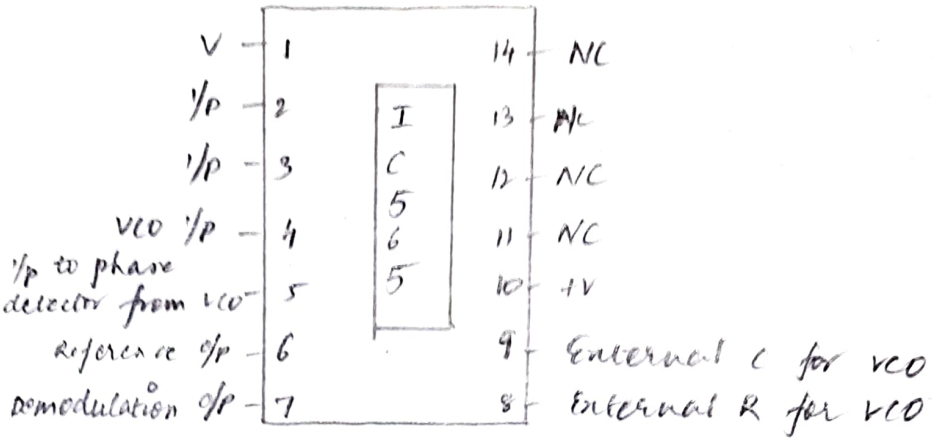
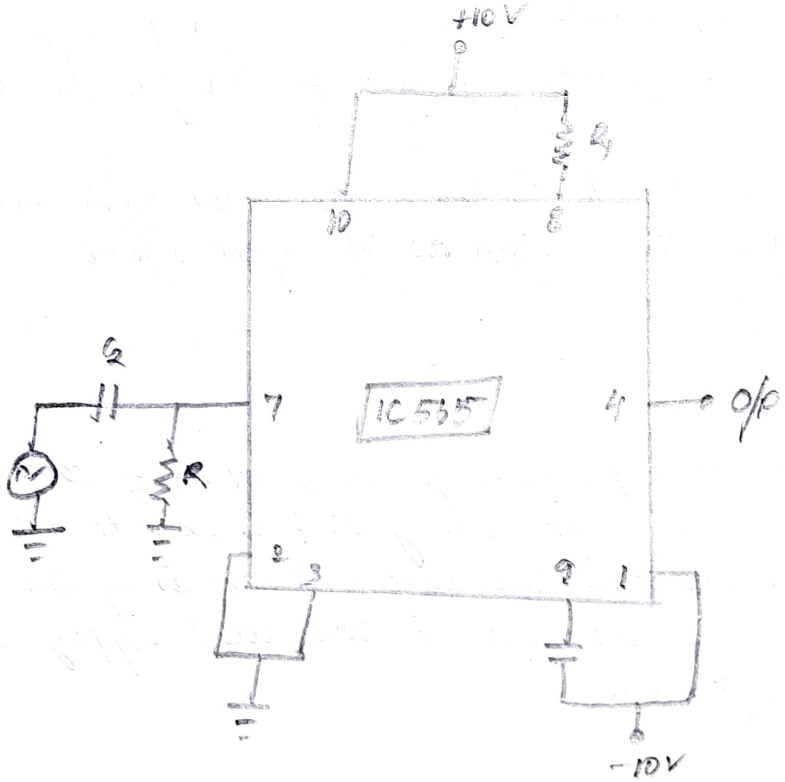


Pin Diagram of PLL IC 565



Circuit Diagram of FM modulation



$$f_c = \frac{0.3}{R_1 C_1} = 7000\ Hz$$

$$R_1 = \frac{0.3}{7000 \times 10^{-9}} = 42\ K\Omega$$

Center frequency is given by -

$$f_c = \frac{0.3}{R_f C}, \quad \text{where } C = 1nF, \quad R_f = 50K\Omega$$

$$= 7KHz$$

RESULT:

S.No.	x_1	x_2	Δx	f
1.	720	932	212	4.7×10^{-3}
2.	532	720	188	5.3×10^{-3}
3.	374	532	158	6.3×10^{-3}
4.	278	374	96	0.0169
5.	194	278	82	0.0121
6.	112	194	82	0.0121
7.	56	46	52	0.0192
8.	58	6	52	0.0182
9.	112	58	54	0.0189

FM modulation using free running oscillator designed at $f_c = 7KHz$ and 10V.

obtained frequency = 6.75 kHz

voltage = 10.07 V.