Introduction to Radars
Lecture 3: Unmodulated CW Radar

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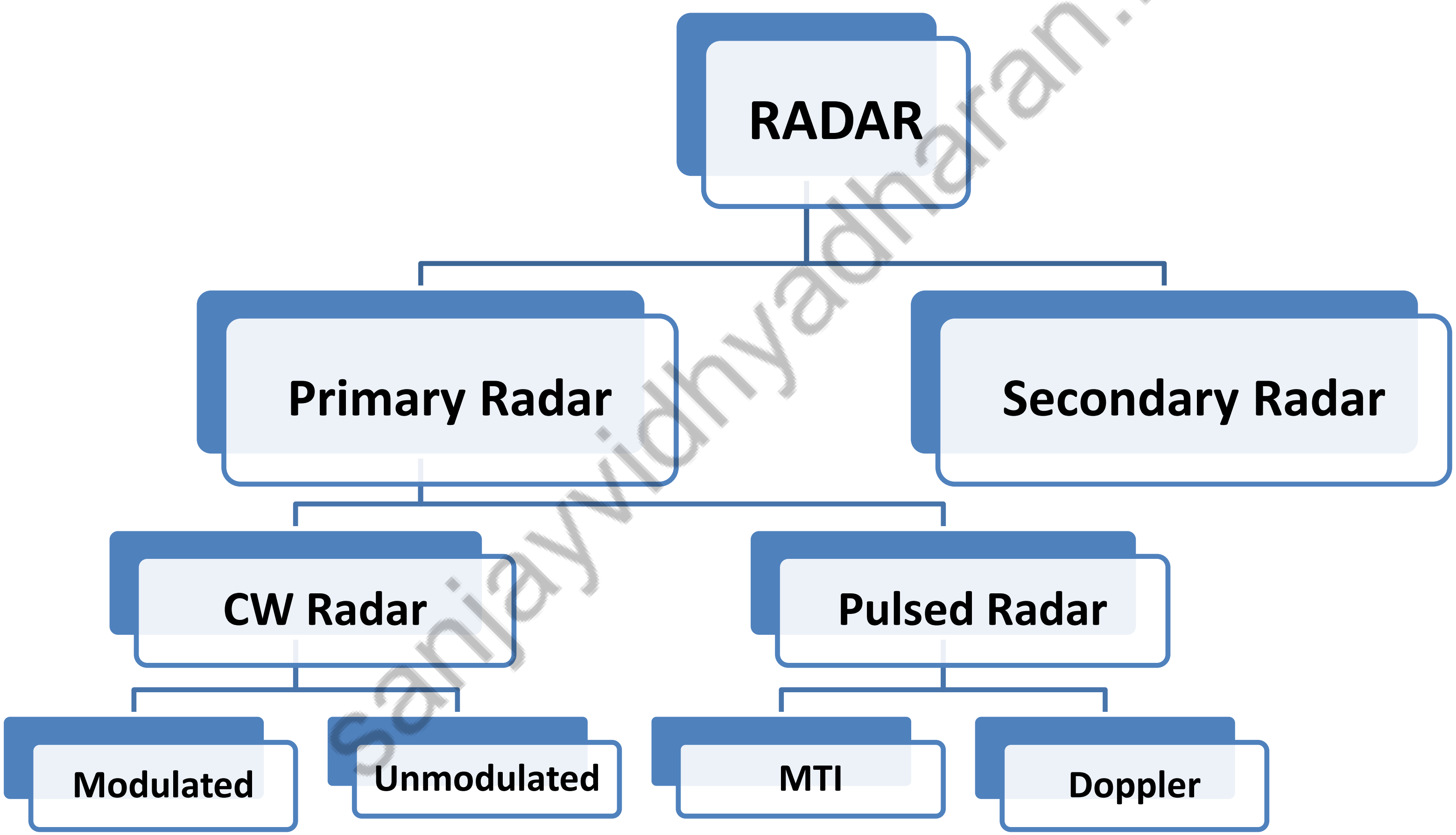
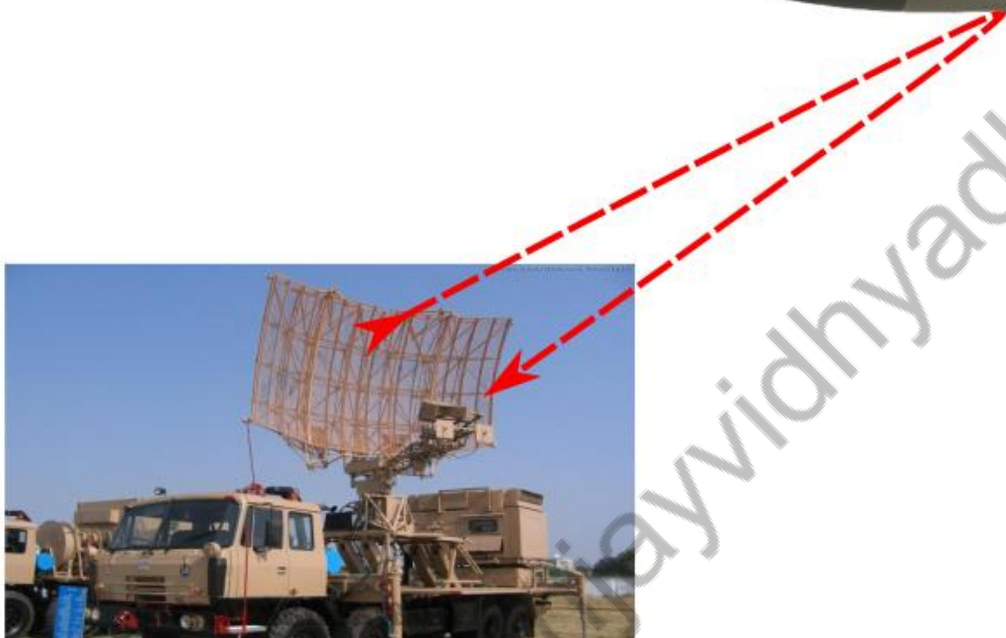
Classification of Radars



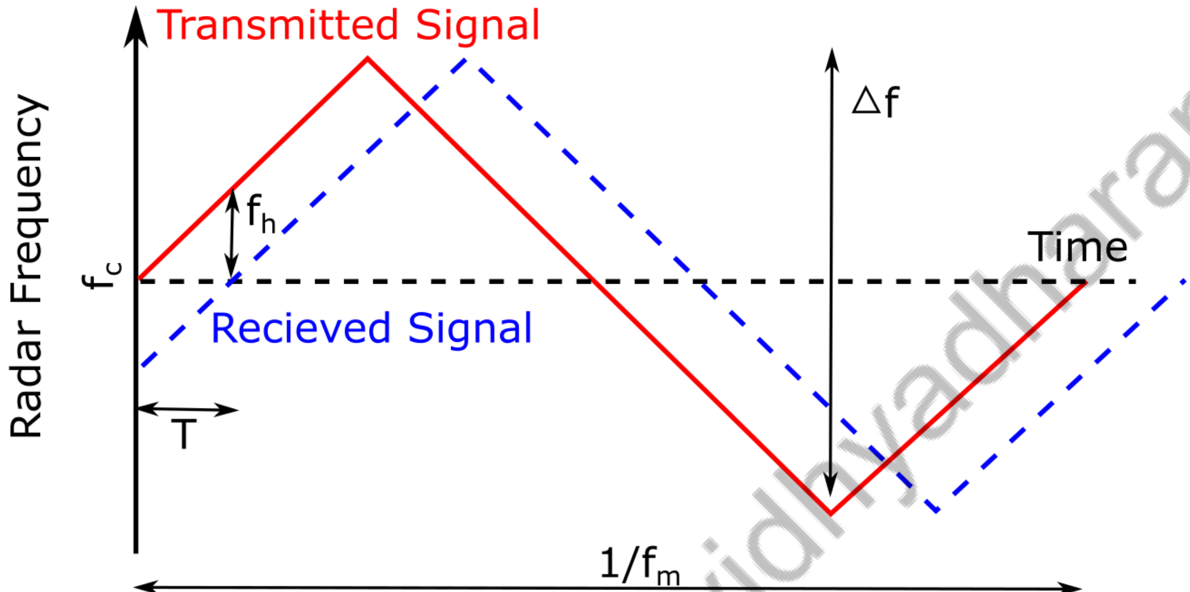
Primary Radars

Primary Pulsed Radars



$$Max\ Radar\ Range\ \ R_{max} = \left[\frac{P_t G \sigma A_e}{(4\pi)^2 F_n k T B_n \left({S_o}/{N_0}\right)_{min}}\right]^{1/4}$$

Modulated CW Radar



$$R = \frac{cT}{2}$$

Radio Altimeters

$$f_c = 4.2 - 4.4 \text{ GHz}$$
$$\Delta f = 100 - 200 \text{ MHz}$$
$$f_m = 50 - 300\ Hz$$
$$Range = 1 - 2\ Kms$$

$$Rate\ of\ Change\ of\ f_c = \frac{\Delta f}{1/2f_m} = 2.\Delta f.f_m$$

$$Change\ in\ f_c\ in\ Time\ T = f_h = 2.\Delta f.f_m.T = \frac{2.\Delta f.f_m\,2R}{c}$$

$$Target\ Range\ R = \frac{cf_h}{4.\Delta f.f_m}$$

Doppler Effect

Aircraft Staionary

Tansmiiting Frequency = Receiving Frequency

E.g. Transmitting at 0,1,2 ,3, ,…ns

If travel time is 1000 ns

Received will be 1000, 1001, 1002, 1003…..

Doppler Effect

$$f_d = \frac{2\,dR}{\lambda dt} = \frac{2v_r}{\lambda}$$

Aircraft Moving In

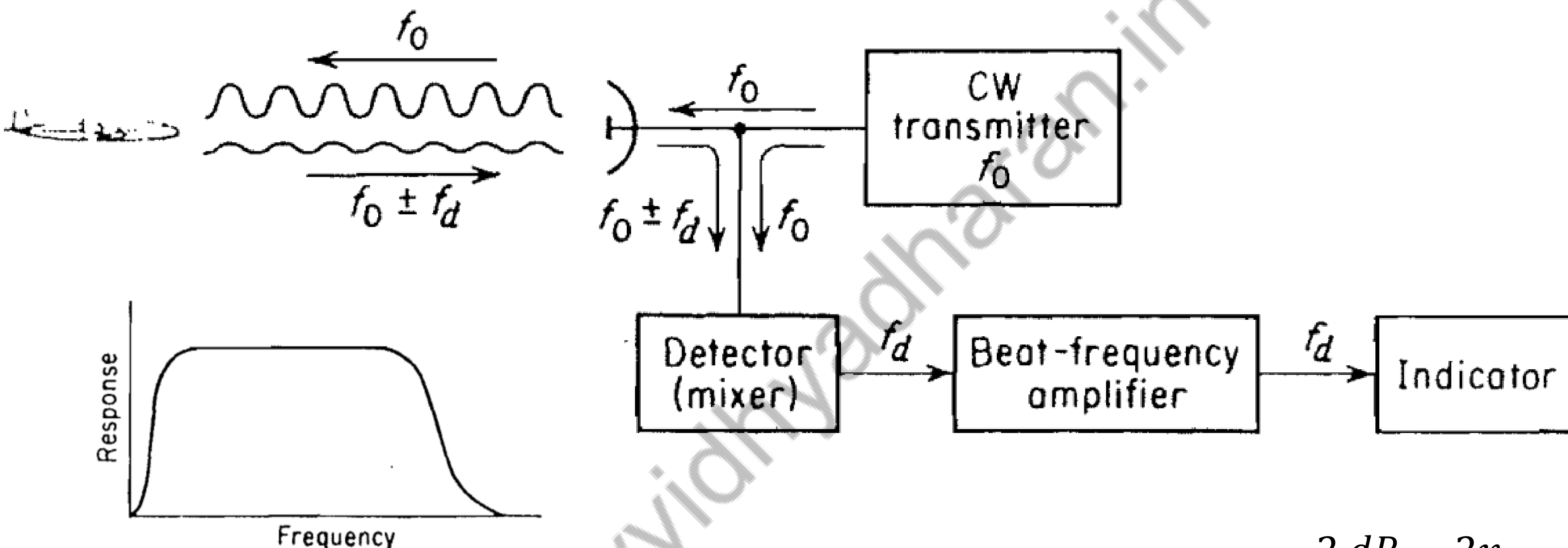
Tansmiiting Frequency = Receiving Frequency

E.g. Transmitting at 0,1,2 ,3, ,...ns

Travel time is 1000 , 999.5, 999, ...ns

Received will be 1000, 1000.5, 1001,..

CW Radar



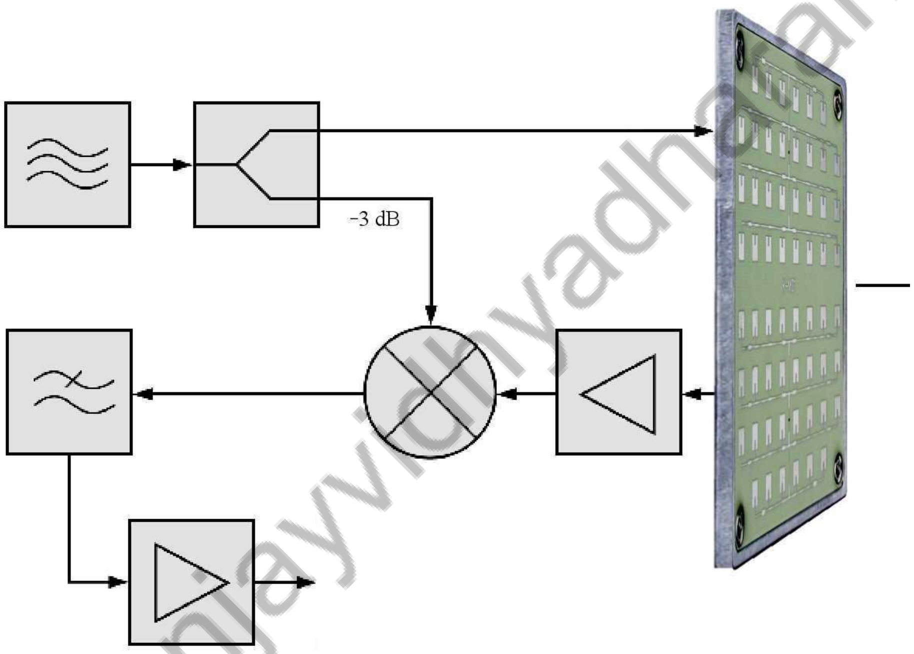
$$f_d = \frac{2\,dR}{\lambda dt} = \frac{2v_r}{\lambda}$$

The sign of f_d is lost in this process

The purpose of the doppler amplifier is to eliminate echoes from stationary targets and to amplify the doppler echo signal to a level where it can indicate a moving object.

The low-frequency cutoff must be high enough to reject d-c component caused by stationary targets, but it should be low enough to pass the smallest doppler frequency expected

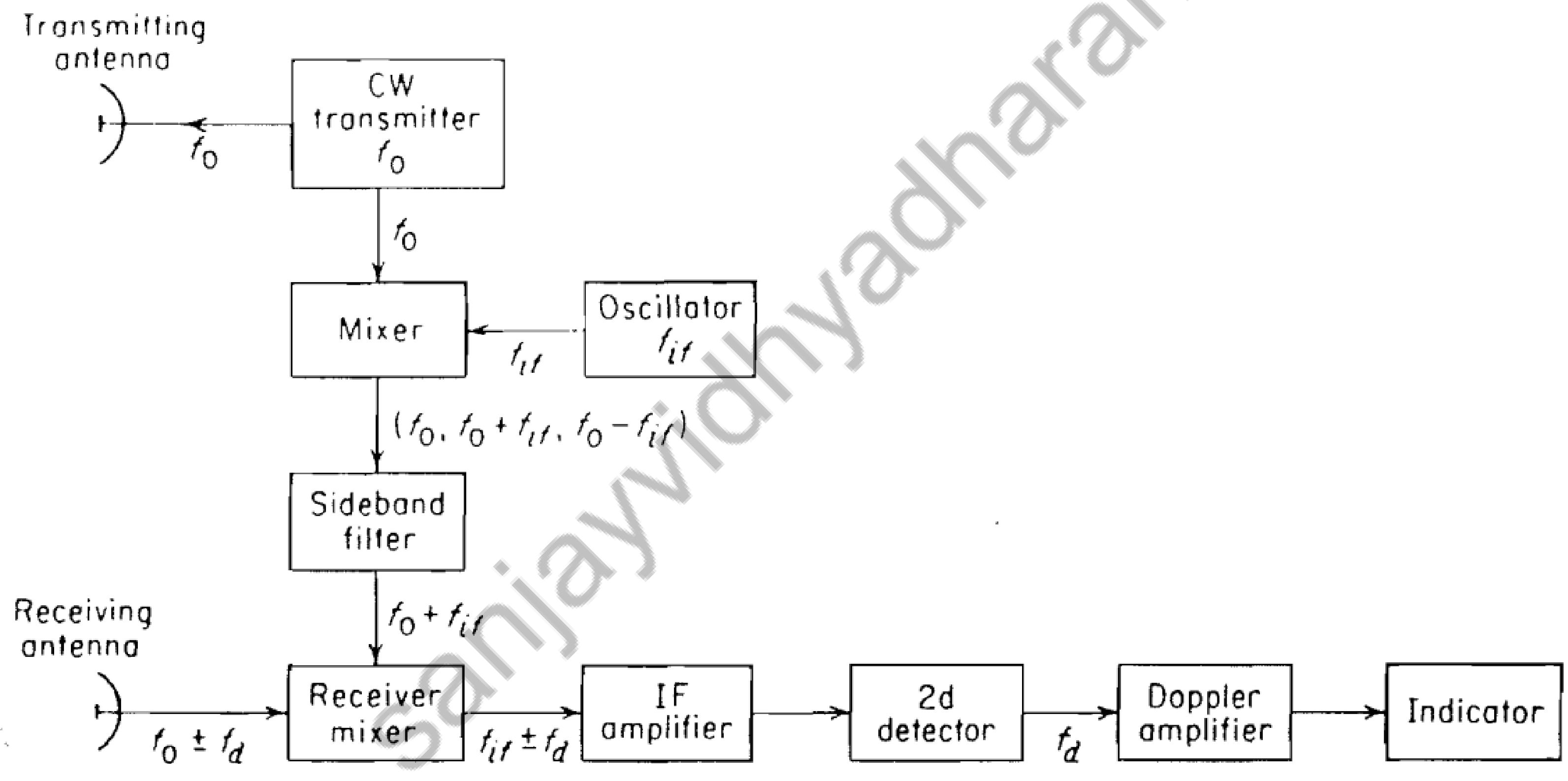
CW Radar



https://www.radartutorial.eu/02.basics/Continuous%20Wave%20Radar.en.html

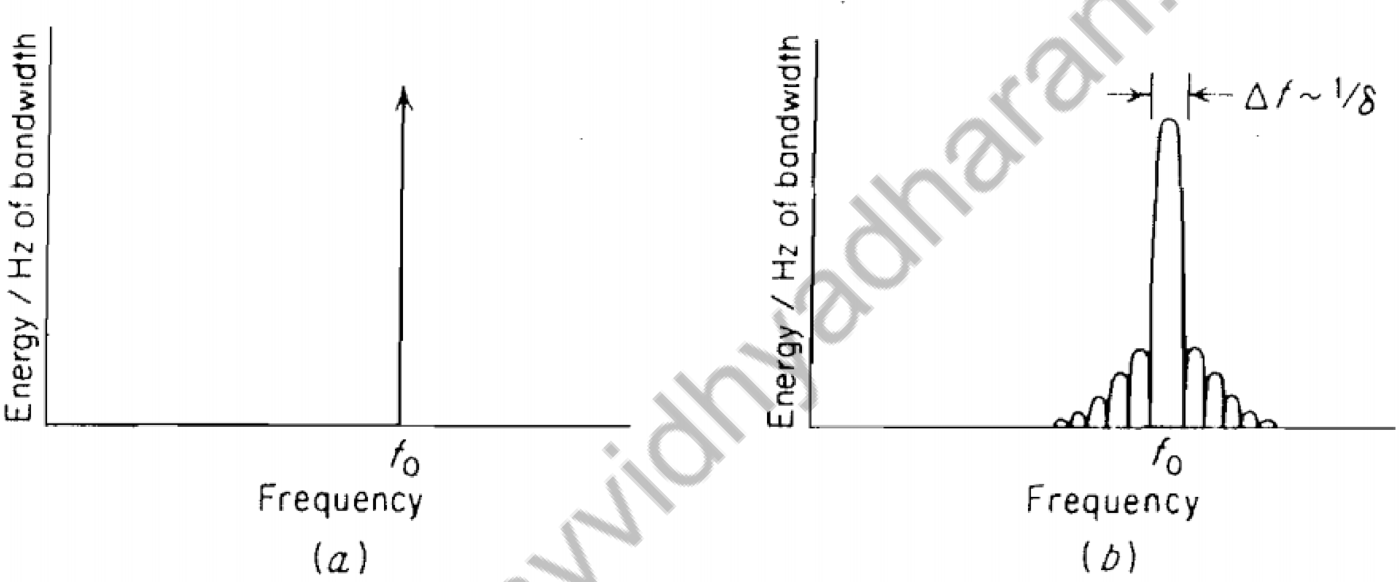
CW Radar

Superheterodyne CW doppler radar



CW Radar

Frequency spectrum of CW received signal



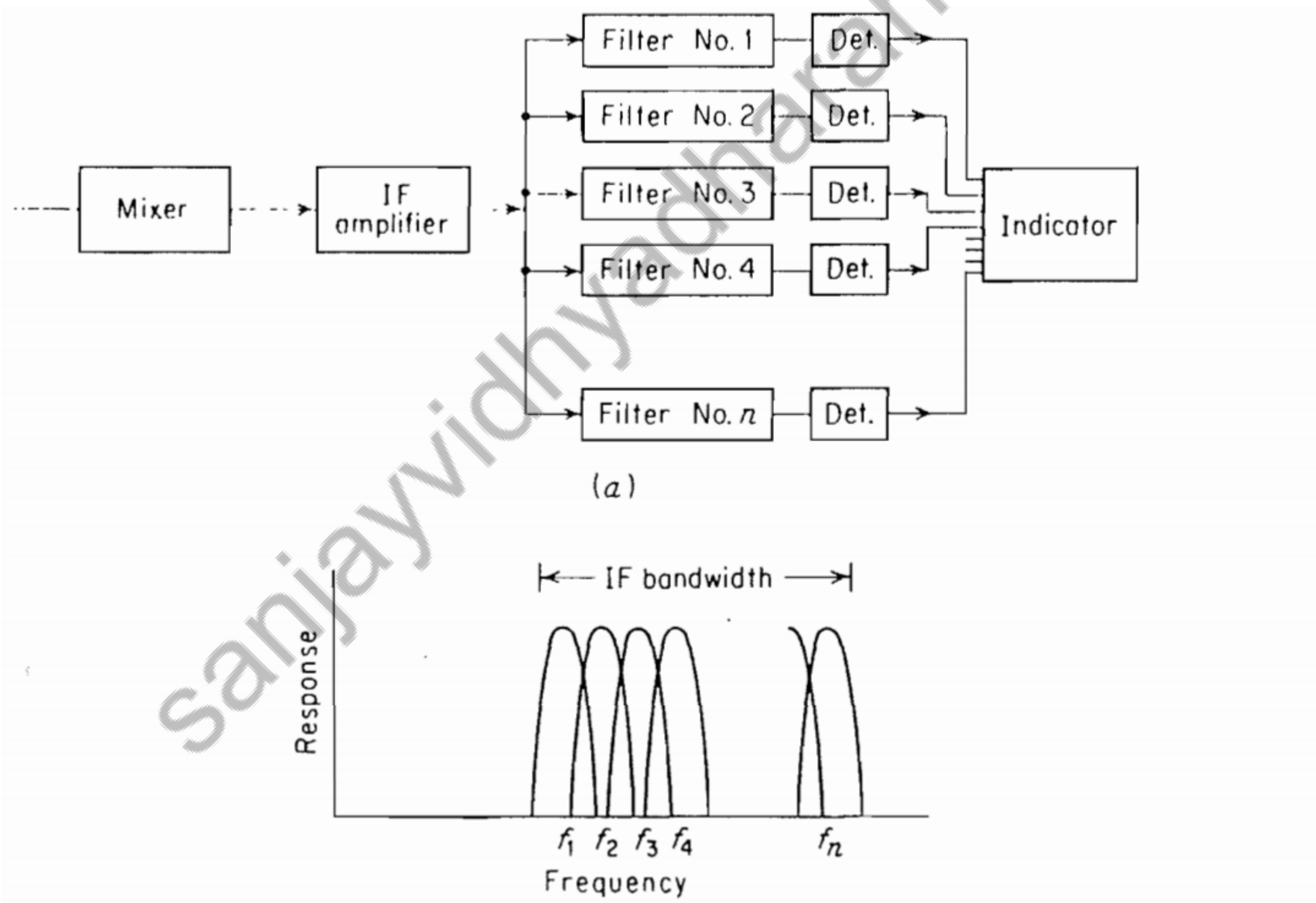
Frequency spectrum (a) infinite duration and (b) finite duration

The aircraft cross section can change by 15 dB for a change in target aspect of as little as $1/3^0$

The echo signal from a propeller-driven aircraft can also contain modulation components at a frequency proportional to the propeller rotation

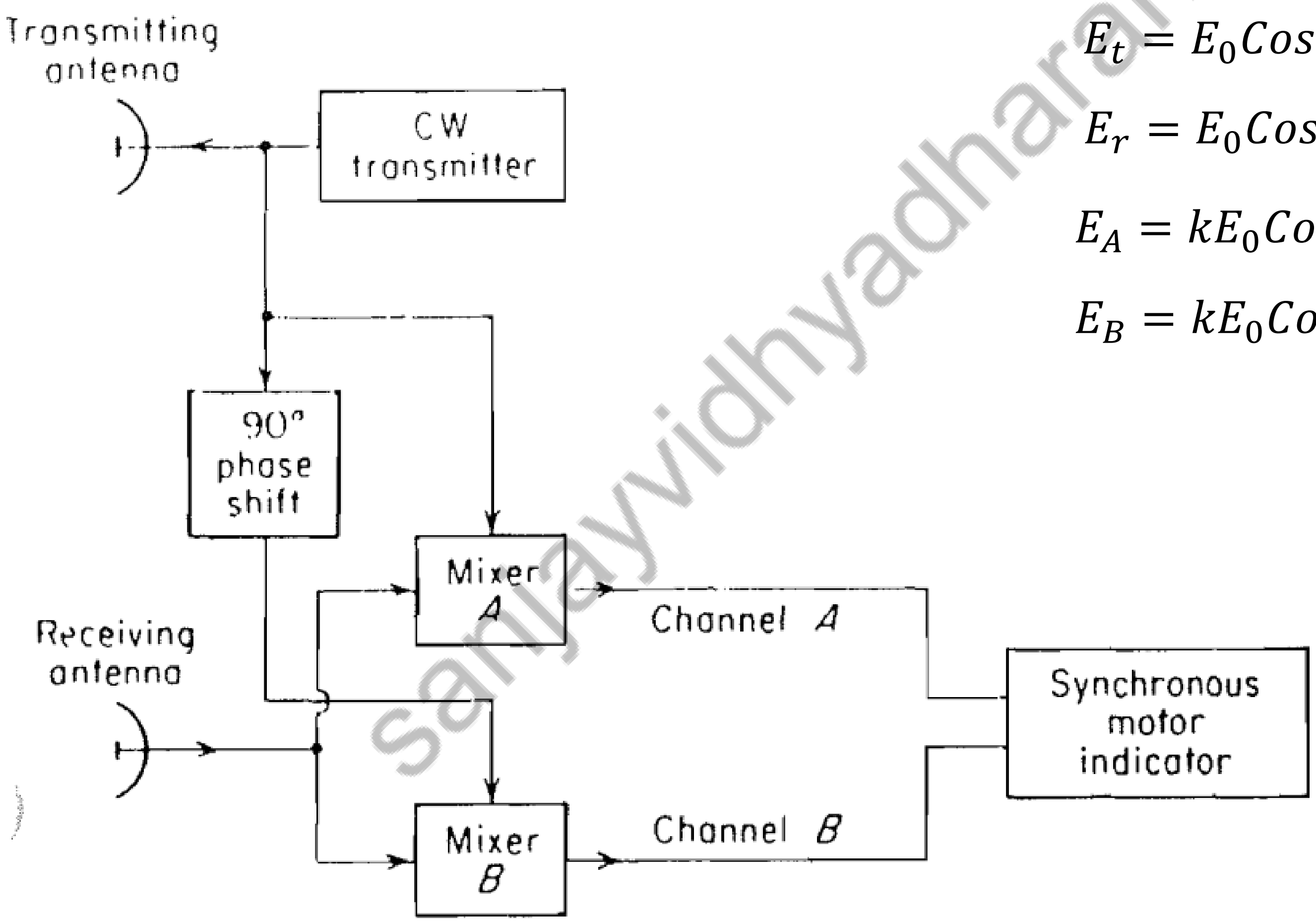
CW Radar

Block diagram of IF doppler filter bank



CW Radar

Measurement of doppler direction using synchronous, two-phase motor



$$E_t = E_0 Cos\omega_0 t$$

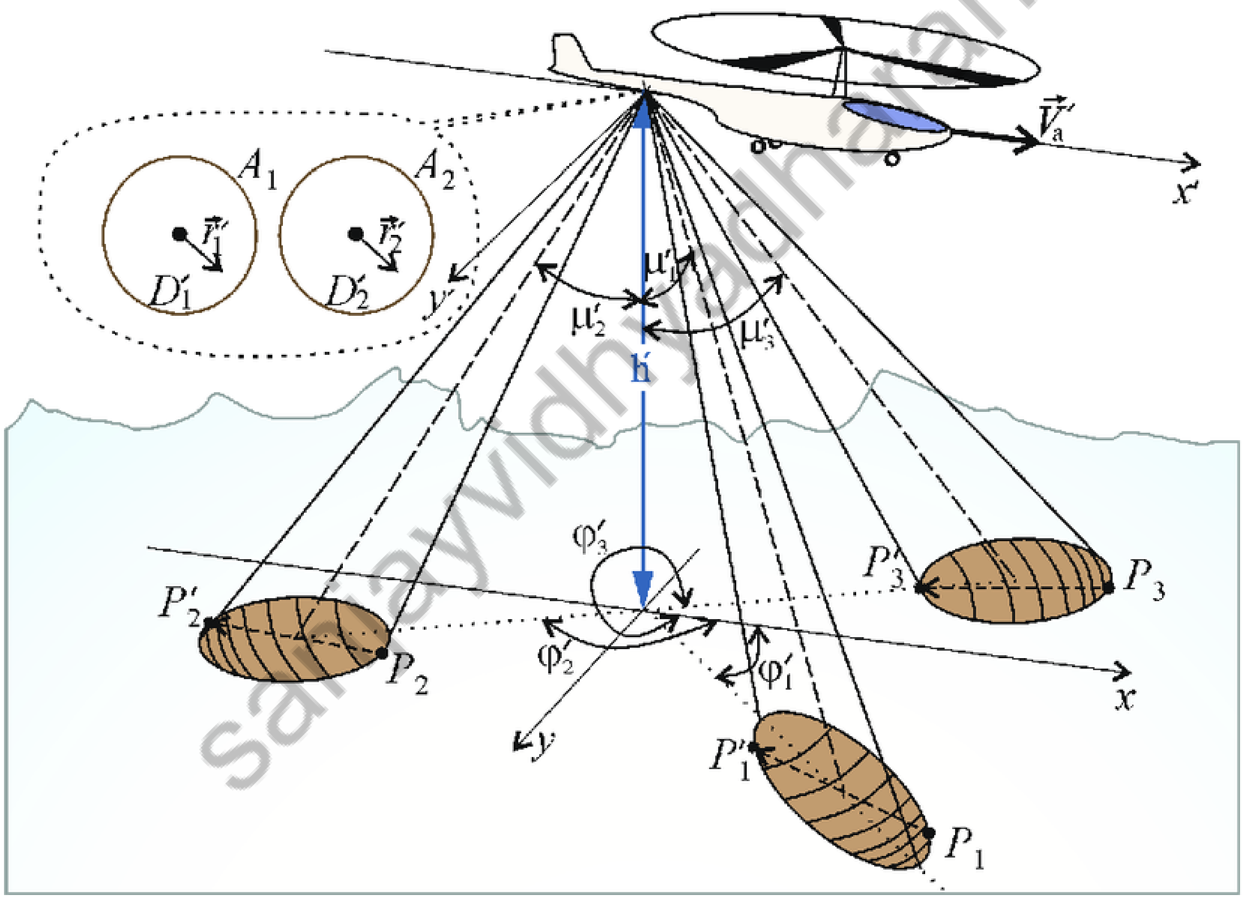
$$E_r = E_0 Cos[(\omega_0 \pm \omega_d)t + \phi]$$

$$E_A = kE_0 Cos(\pm\omega_d t + \phi)$$

$$E_B = kE_0 Cos(\pm\omega_d t + \phi + \frac{\pi}{2})$$

Applications CW Radar

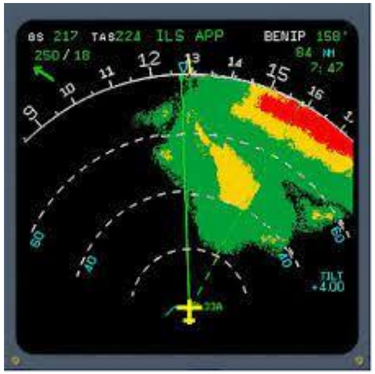
Doppler Navigation System



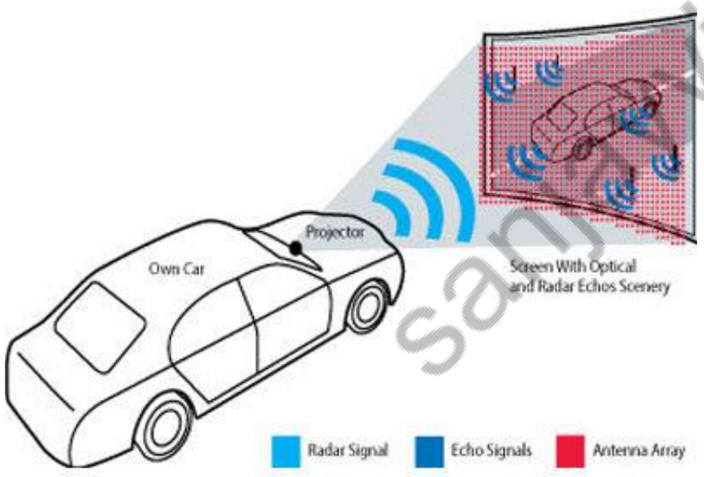
Applications CW Radar

Speed Guns

Weather Radars



Autonomous Vehicles



Thankyou