

CHUKA



UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF
SCIENCE IN ENGINEERING

EENG 586: NAVIGATION AND SURVEILLANCE SYSTEMS

STREAMS: BSc. EENG

TIME: 2 HOURS

DAY/DATE: MONDAY 14/04/2025

8.30 A.M. – 10.30 A.M.

INSTRUCTIONS

- This paper consists of **four** questions
- Question **one** is compulsory
- Attempt Question **one** and any other **two**

QUESTION ONE (30 MARKS)

- (a) (i) Outline any Two reasons why communications, navigation and surveillance technology has grown rapidly in the modern world
- (ii) Explain any Two applications of a radar system **(6 marks)**
- (b) A radar amplifier has a gain of 6dB calculate the output of the amplifier if the input is:
- (i) -3dB
- (ii) 0.5mW **(5 marks)**
- (c) (i) A radar has the following parameters:
- peak power transmitted by the radar = 250kW
 - gain of transmitting antenna = 4,000
 - effective aperture of the receiving antenna = 4m^2
 - radar cross section of the target = 25m^2
 - power of minimum detectable signal = 10^{-12} W .

Calculate the maximum range of the radar

(ii) Explain the difference between receiver noise and signal to noise ratio and state how they affect radar performance **(8 marks)**

(d) (i) The intensity of a transmitted electromagnetic wave at a range of 500m from the radar is 0.04W/m^2 . Calculate its intensity at 2km.
 (ii) A radar has a pulse repetition interval of 0.25milliseconds calculate the maximum unambiguous Doppler shift that it can measure **(6 marks)**

(e) (i) State any Two factors that affect the radar performance
 (ii) Determine the range resolution of a pulse radar system with the characteristics shown in table Q.1(e) **(5 marks)**

	Pulse duration	frequency
(a)	$1.0 \mu\text{s}$	9.4 GHz
(b)	$1.0 \mu\text{s}$	34.4 GHz
(c)	$0.1 \mu\text{s}$	9.4 GHz
(d)	$0.01 \mu\text{s}$	9.4 GHz

Q.1 (e)

QUESTION TWO (20 MARKS)

(a) (i) Explain the most common used radar frequency band
 (ii) Fig.Q2(a) shows a block diagram of the basic radar system state the functions of each block **(10 marks)**

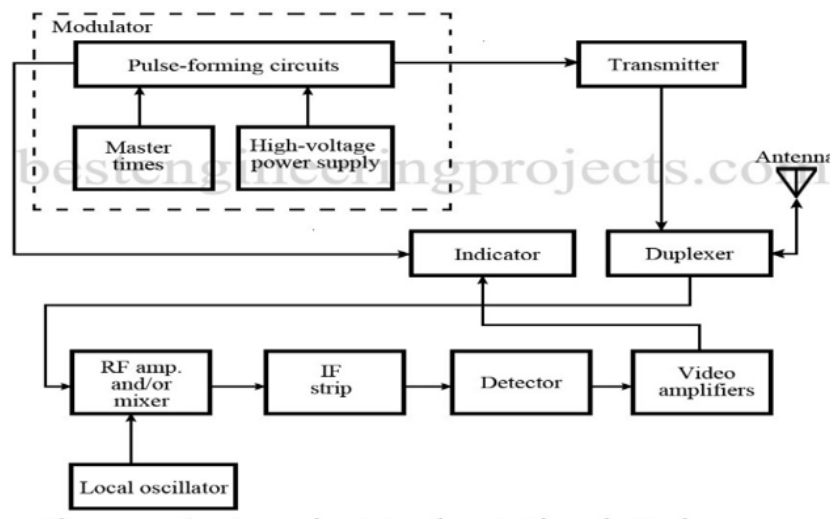


Fig.2(a)

(b) (i) Derive the simplest form of a radar equation from the basic principles

(ii) Calculate the maximum range of a radar system which operates at 3cm with a peak power 500kW. If the maximum receivable power is 10^{-13} W, the capture area of its antenna is 6m^2 and the radar cross section area of the target is 20m^2 **(10 marks)**

QUESTION THREE (20 MARKS)

(a) (i) Given that the Beat frequency $f_b(\text{up}) = 15\text{KHz}$ and $f_b(\text{down}) = 25\text{KHz}$, modulating frequency: 1MHz and $\Delta f: 1\text{KHz}$ and Operating frequency: 3Ghz . Determine the Range and Doppler velocity of an approaching target using a triangular modulation FM CW Radar

(ii) Fig Q3(a) shows a block diagram of a Moving Target Indicator with power amplifier transmitter explain the functions of each block **(10 marks)**

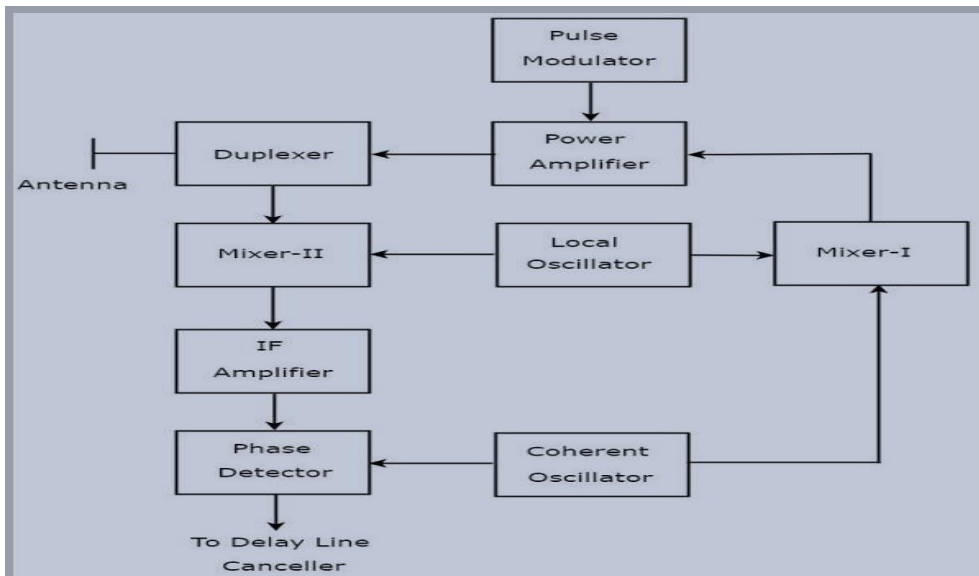


Fig Q3(a)

(b) (i) The received echo of a single Delay line canceller after the Doppler effect is given as $V_1 = A \sin(2\pi f_d t - \phi_0)$ where, A = Amplitude of the echo signal, f_d = Doppler frequency and ϕ_0 = phase shift. Derive the output of the subtractor which will be the input to the full wave rectifier

(ii) A Moving Target Indicator Radar operates at a frequency of 6GHz with a pulse repetition frequency of 1kHz . Find the first, second- and third-blind speeds of the radar **(10 marks)**

QUESTION FOUR (20 MARKS)

(a) (i) If the Radar operates at a frequency of 5GHZ then find the Doppler frequency of an aircraft moving with a speed of 100Km/h

(ii) Figs Q4(a) and (b) show the two techniques used in angular tracking, analyze each method stating ONE application of each **(10 marks)**

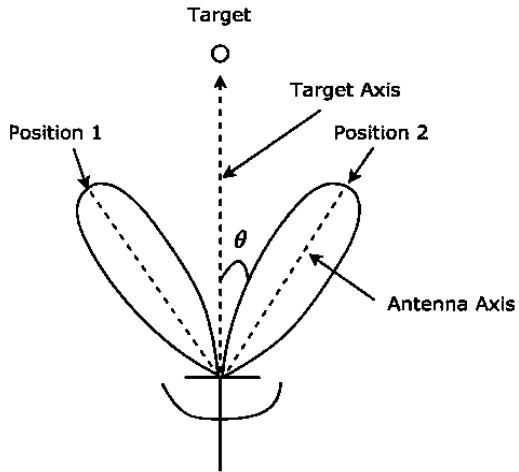
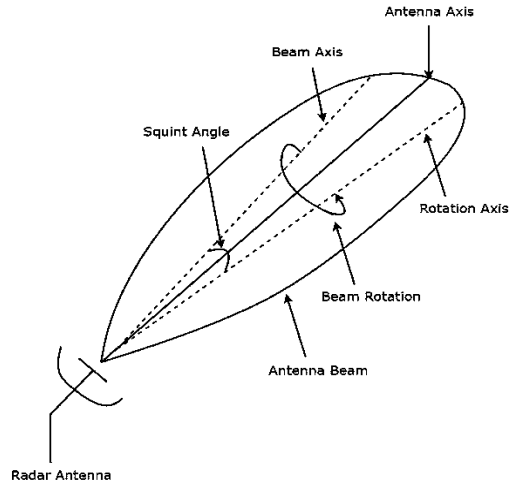


Fig Q4 (a) Sequential Lobing



(b) Conical Scanning

(b) (i) Fig.Q4(b) shows a block diagram of a single Delay line canceller derive its subtractor output and draw the frequency response curve

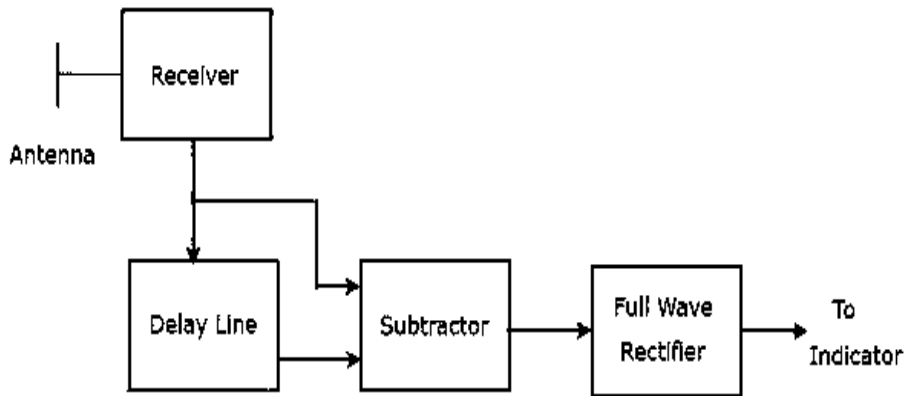


Fig.Q4(b)

(ii) Explain the effect of diffraction and scattering parameters on radar wave propagation process **(10 marks)**