CBCS SCHEME

USN | | | | | | | | | | |

15EC833

Eighth Semester B.E. Degree Examination, July/August 2021
RADAR Engineering

Time: 3 hrs. Max. Marks: 80

Note: ***Answer any FIVE full questions.***

1 a. Define RADAR. Explain the basic principle of RADAR with block diagram. **(08 Marks)**
b. Briefly describe the major area of radar application. **(08 Marks)**

2 a. With a neat diagram, explain conventional pulse radar with a superheterodyne receiver. **(08 Marks)**
b. Explain the simple form of radar equation. **(08 Marks)**

3 a. Derive the modified RADAR equation in terms of signal to noise ratio. **(08 Marks)**
b. Briefly discuss the following type of signal losses in RADAR.
i) Antenna losses
ii) Losses in Doppler processing radar. **(08 Marks)**

4 a. Explain the concepts of pulse repetition frequency and range ambiguities in case of radar. **(08 Marks)**
b. Making use of portion of radar receiver block diagram, discuss with necessary equation the probability of false alarm and probability of detection. **(08 Marks)**

5 a. Explain the working of digital Moving Target Indicator (MTI) Doppler signal processor with neat diagram. **(08 Marks)**
b. With a neat block diagram, explain how simple pulse radar extracts the Doppler frequency shaft of the echo signal from the moving target. **(08 Marks)**

6 a. Illustrate with neat block diagram, single – delay line canceller. Also derive the expression for frequency response of single-delay line canceller. **(08 Marks)**
b. Write a note on blind speeds. **(08 Marks)**

7 a. Define monopulse tracker. Using block diagram, explain amplitude comparison monopulse tracking radar in one angle co-ordinates. **(08 Marks)**
b. With a neat block diagram, explain conical scan tracking radar. **(08 Marks)**

8 a. Discuss the concept of phase comparison monopulse. **(08 Marks)**
b. Compare monopulse and conical radar tracking system. **(08 Marks)**

9 a. List the different functions served by radar antenna. **(08 Marks)**
b. What is the role of duplexers in radar system? Illustrate the transmit condition and receiver condition in case of balanced duplexer. **(08 Marks)**

10 a. List the advantages and limitations of electronically steered phased array antenna. **(08 Marks)**
b. Explain different types of radar display system. **(08 Marks)**

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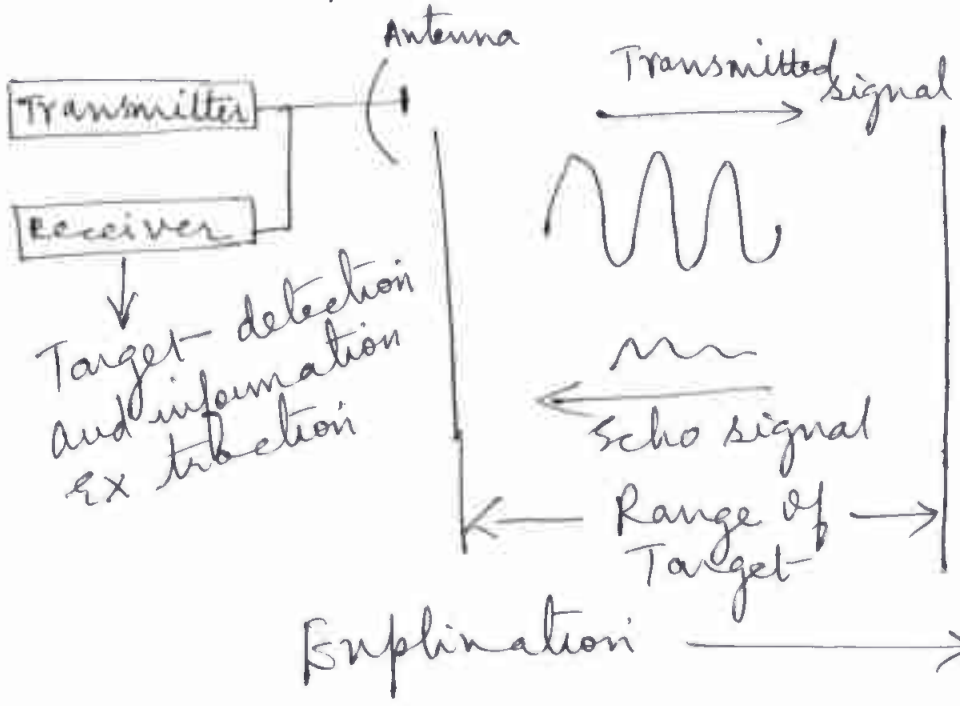
Scheme & Solutions

Signature of Scrutinizer

Subject Title : Radar Engineering **Subject Code :** 15EC833

Question Number	Solution	Marks Allocated
1. a	Module 1 Radar is an Electromagnetic System for the detection and location of reflecting object such as aircraft, Ships, space craft Vehicals people and the natural Environment Basic principle of radar  Explination	1 MARK 2M 5M 8M
b.	Explain any 8 Application of radar (OR)	8 M
2 a.	Block diagram of Conventional pulse radar with a superheterodyne receiver — Explination Block diagram —	6M

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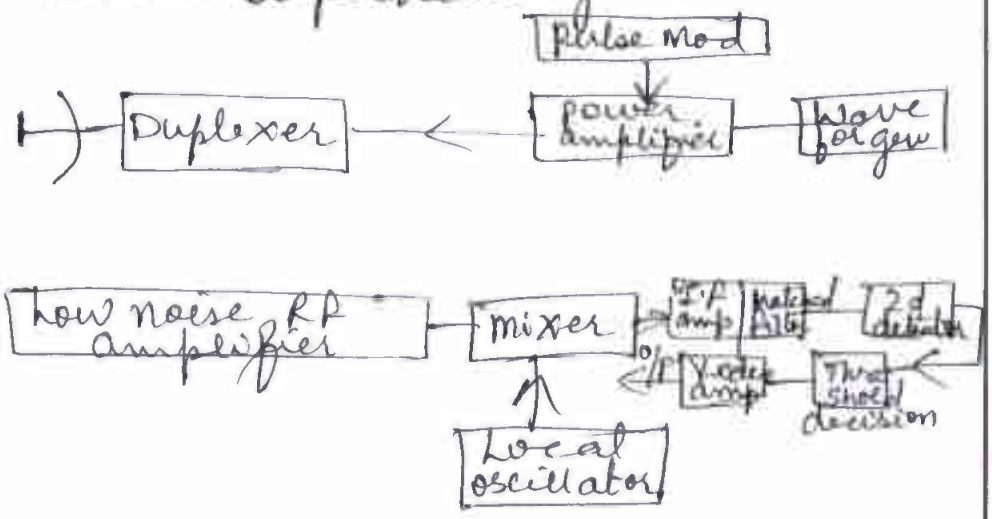
Question Number	Solution	Marks Allocated

Block diagram of Conventional pulse Radar Superheterodyne receiver



2 Mark

6+2=8 Mark

2 b. Simple form of radar Equation

i) Isotopic antenna = $\frac{P_t}{4\pi R^2}$

ii) Power density is measured in units of Watts per square meter 1 mark

iii) $\lambda = c/f$, R_{max} $\left[\frac{P_t G^2 \lambda^2 \sigma}{(4\pi)^2 S_{min}}\right.$ 2 mark

iv) $R_{max} = \frac{P_t A_e^2 \sigma}{4\pi \lambda^2 S_{min}}$ 2 mark

v) $G = \frac{4\pi A_e}{\lambda^2} = \frac{4\pi P_a A}{\lambda^2}$ 2 mark

1 mark / 8 mark

Module 2

3 a. RADAR Equation in terms of signal to noise ratio

Available thermal noise power = KTB_n ①

K Boltzmann's Constant = 1.38×10^{-23} J/deg

In eq ① the B_n is called the noise band

1 Mark

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Question Number	Solution	Marks Allocated
	width, defined as $B_n = \int_0^\infty \lvert H(f)\rvert^2 df$ — (2) 1 mark $H(f)$ = frequency response function of IF amplifier & f_0 = frequency response of the maximum f_n = Noise out of practical Receiver / Noise out of ideal Receiver = $\frac{N_{out}}{KT_0BG_a}$ 1 mark — (3) where N_{out} = Noise out of the receiver & G_a = available gain Eq (3) can be written as $f_n = \frac{S_{in}/N_{in}}{S_{out}/N_{out}}$ — (4) 1 mark Rearranging eq (4) the I/p signal is $S_{in} = \frac{KT_0BF_n S_{out}}{N_{out}}$ — (5) 1 Mark If the minimum detectable signal S_{min} is the value of S_{in} which corresponds to the minimum detectable signal to noise ratio at the output of the IF $(S_{out}/N_{out})_{min}$ $S_{min} = KT_0BF_n \left(\frac{S_{out}}{N_{out}}\right)_{min}$ — (6) The form of radar equation $R^4_{max} = \frac{P_t G A_e \sigma}{(4\pi)^2 KT_0 BF_n (S/N)_{min}}$ — (7) 1 mark Explination – 2 marks.	1+7=8 marks
3. b.	i) Antenna losses - Explination - 4 mark ii) Losses in Doppler processing radar. Explination – 4 mark	8 Marks

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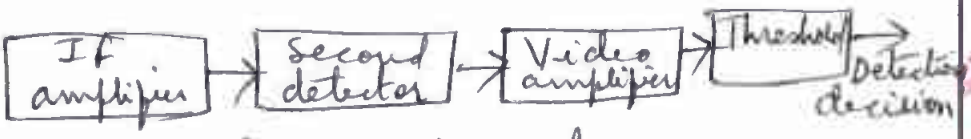
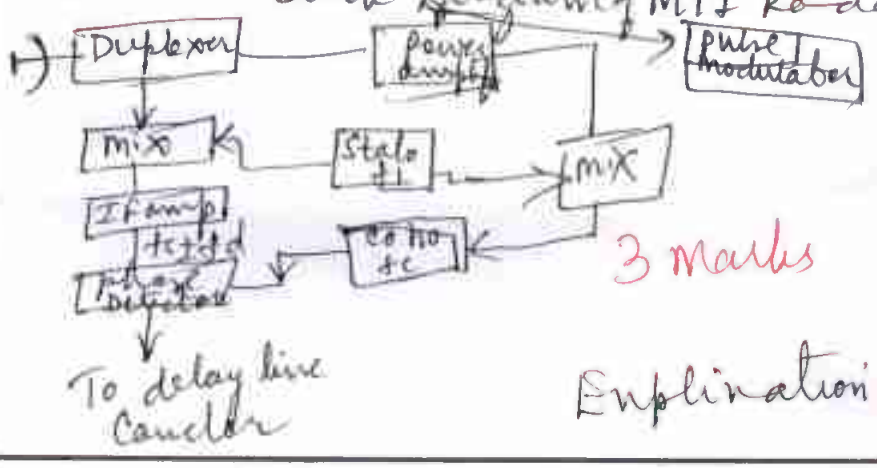
Question Number	Solution	Marks Allocated
4 a.	Concepts of pulse repetition frequency & range ambiguities in radar Explination (OR)	8 Marks
4. b.	Radar receiver block diagram  2m	
	probability of false alarm. $P(V) = \frac{1}{\sqrt{2\pi\psi_0}} \exp\left(-\frac{V^2}{2\psi_0}\right)$ — (1)	
	Rayleigh $p(R) = \frac{R}{\psi_0} \exp\left(-\frac{R^2}{2\psi_0}\right)$ — (2)	
	$P(R)$ evaluated from V_T to ∞ or probability $(V_T < R < \infty) = \int_{V_T}^{\infty} \frac{R}{\psi_0} \exp\left(-\frac{R^2}{2\psi_0}\right) dR = \exp\left(-\frac{V_T^2}{2\psi_0}\right)$ — (3)	4m
	$P_{fa} = \exp\left(-\frac{V_T^2}{2\psi_0}\right)$ — (4)	8 Marks
Module 3	Explination — 2 m	
5 a.	Block Diagram of MTI Radar  3 Marks	8 Marks
	Explination 5 Marks	

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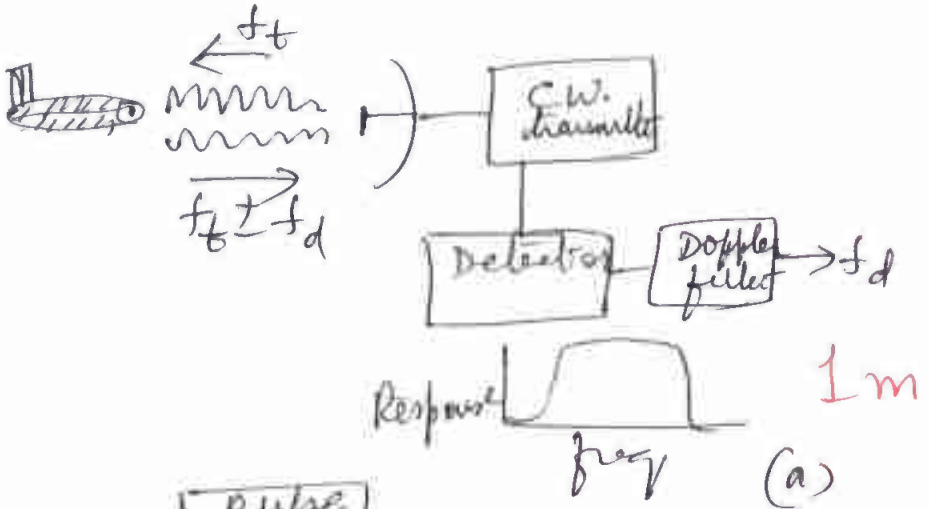
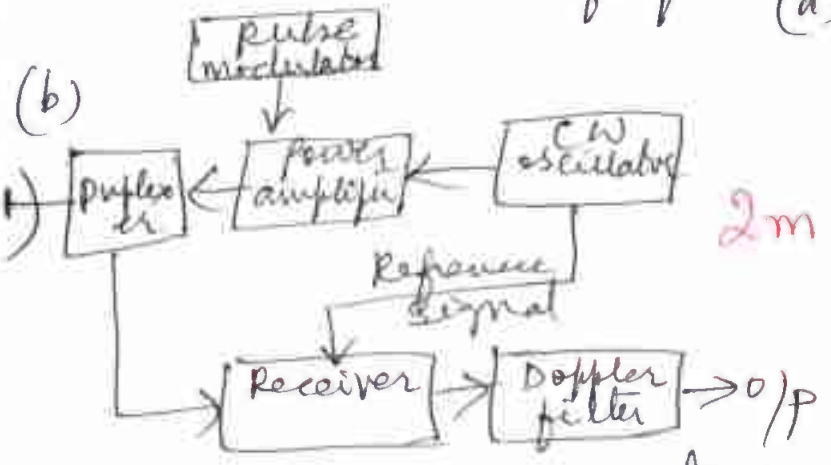
Question Number	Solution	Marks Allocated
5 b.	Simple CW Radar block diagram that Extracts the doppler frequency Shift from a moving target & rejects Stationary Clutter Echoes.	



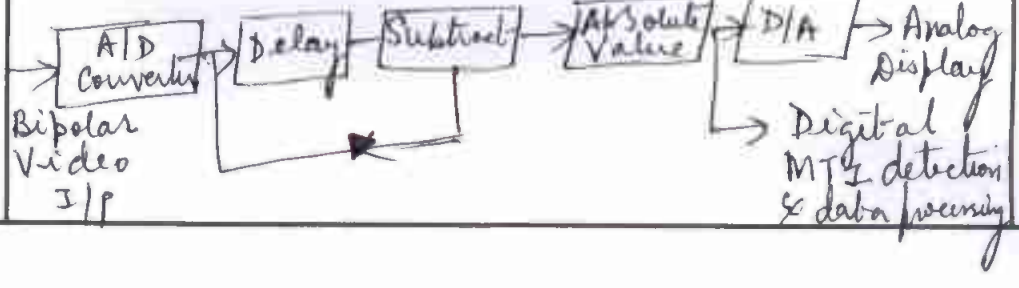


Explination — 5m

8 Marks.

OR

6 a.	Block diagram of a single delay line Canceler	



1m

Q.No. Subject Title:- Radar Engg Subject Code 15EC833

Marks allocated

Solution.

a) Representation of the echo pulse train

1m

b) Video pulse train after phase detector

1m

c) Have an exaggerated width Compared to the period of the doppler frequency

1m

7 Marks

Frequency response to a single Delay line Canceler

$V_1 = K \sin(2\pi f_0 t_d - \phi_0)$ — ① ½ m

$V_2 = K \sin[2\pi f_d (t - T_p) - \phi_0]$ — ② ½ m

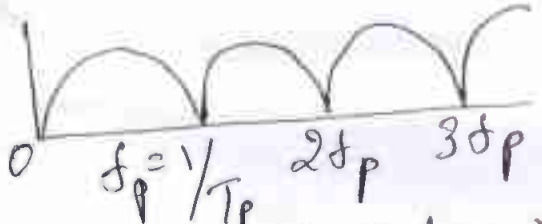
$V = V_1 - V_2 = 2K \sin(\pi f_d T_p) \cos\left(2\pi f_d \left(t - \frac{T_p}{2}\right) - \phi_0\right)$ — ③ ½ m

$H(f) = 2\sin(\pi f_d T_p)$ ½ m

Explination — 2 m

1+7=8 M

6b. Blind speed



1m.

Explination - 7m

8 Marks

Magnitude of freq response

Module 4

7a. A monopulse tracker is defined as one in which information Concerning the angular

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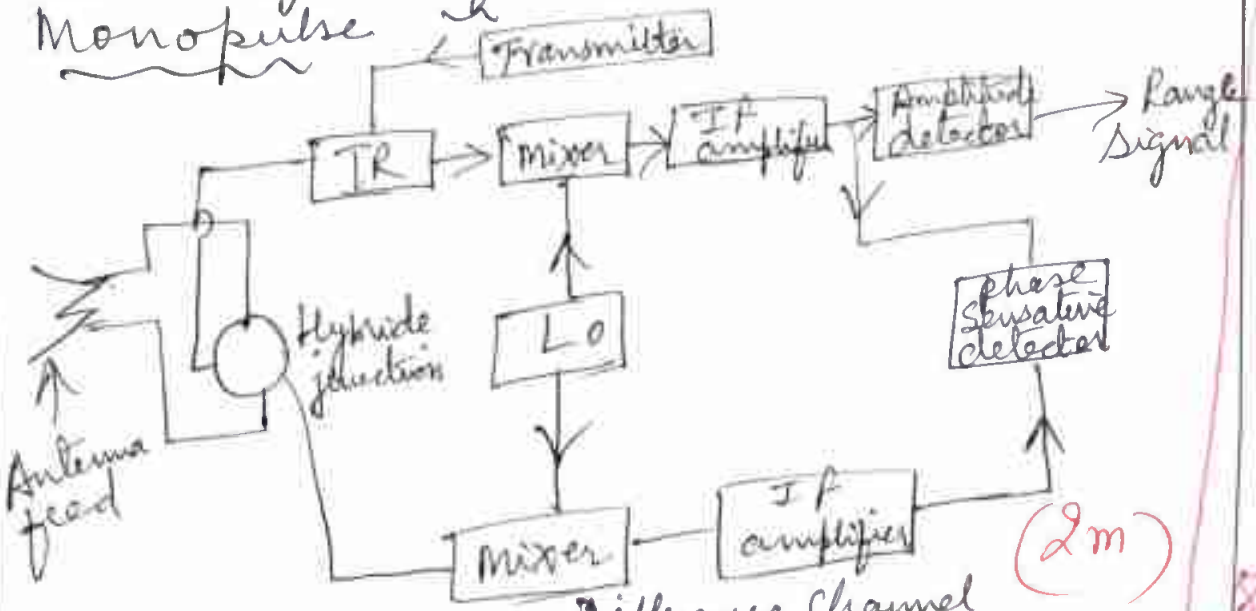
Marks allocated

Solution

location of a target is obtained by Comparison of singnals received in two or more simultaneous beams (1m)

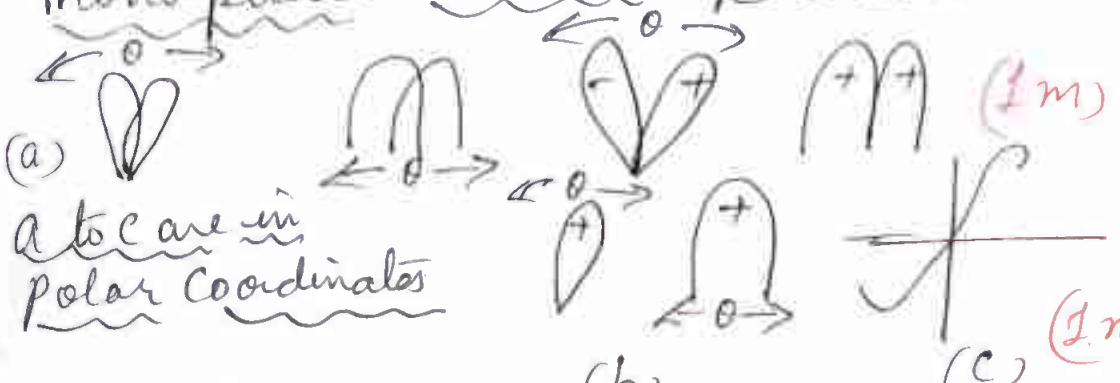
Block diagram of amplitude Comparison Monopulse



Difference Channel (2m)

8 Marks

Monopulse antenna patterns



(1m)

a to c are in Polar Coordinates

(1m)

Explination — 3m

7.b Conical Scan tracking Radar

Explination (5m)

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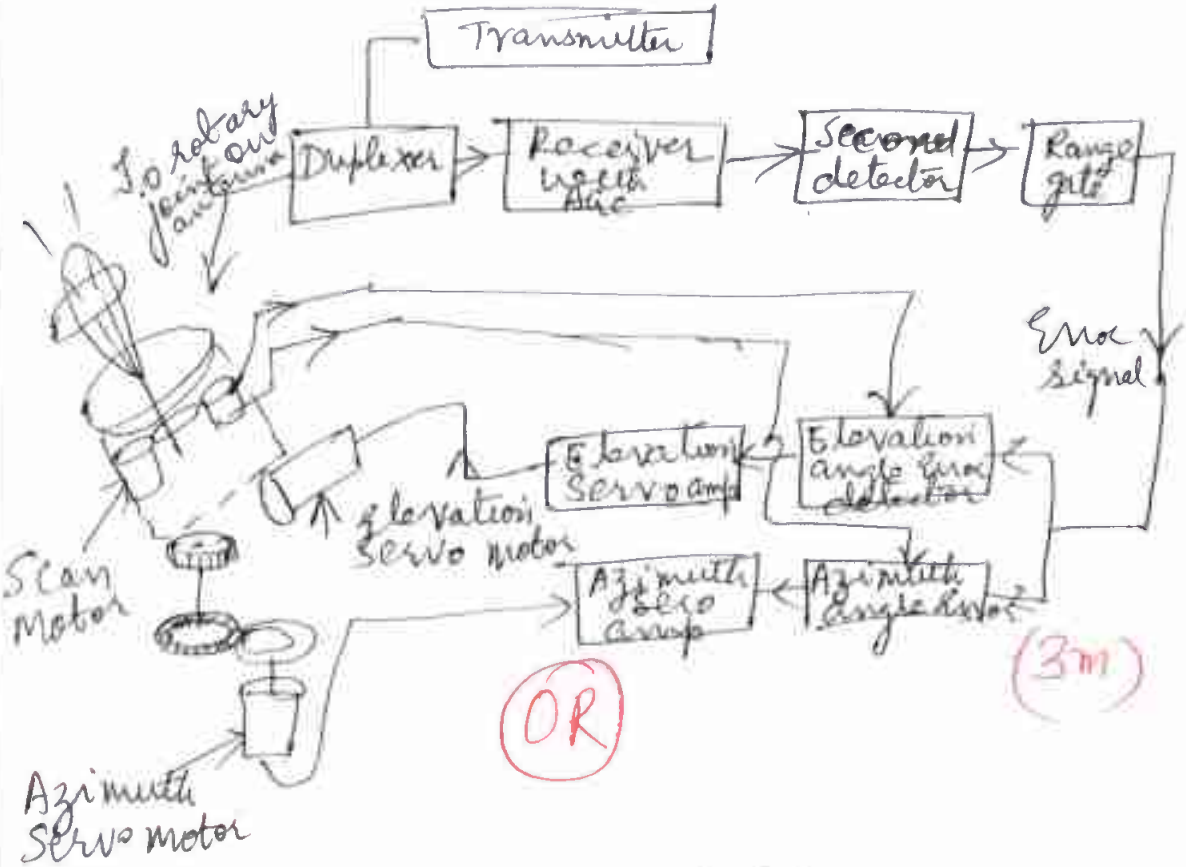
Marks allocated

Solution

Block diagram of Conical scan tracking radar

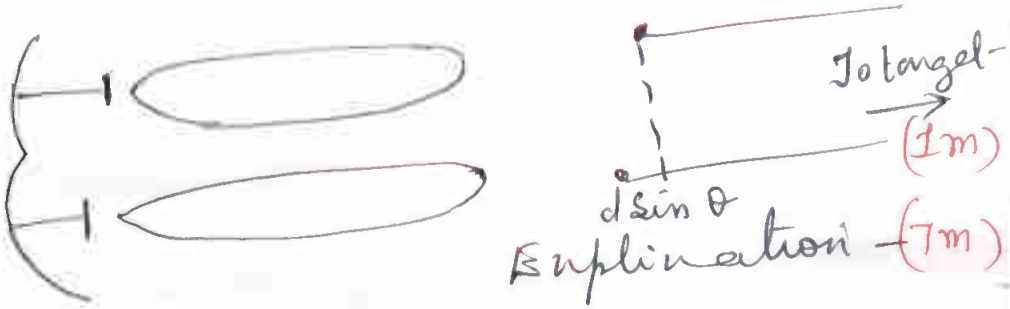


5+3=8m

(3m)

8 a. phase Comparison Monopulse

a) Two antenna radiating identical beams in same direction



8 Marks

b. Monopulse & Conical radar tracking system any 8 differences ——— (8m)

8 Marks

Module 5

9 a. List any 8 functions served by radar

8 Marks

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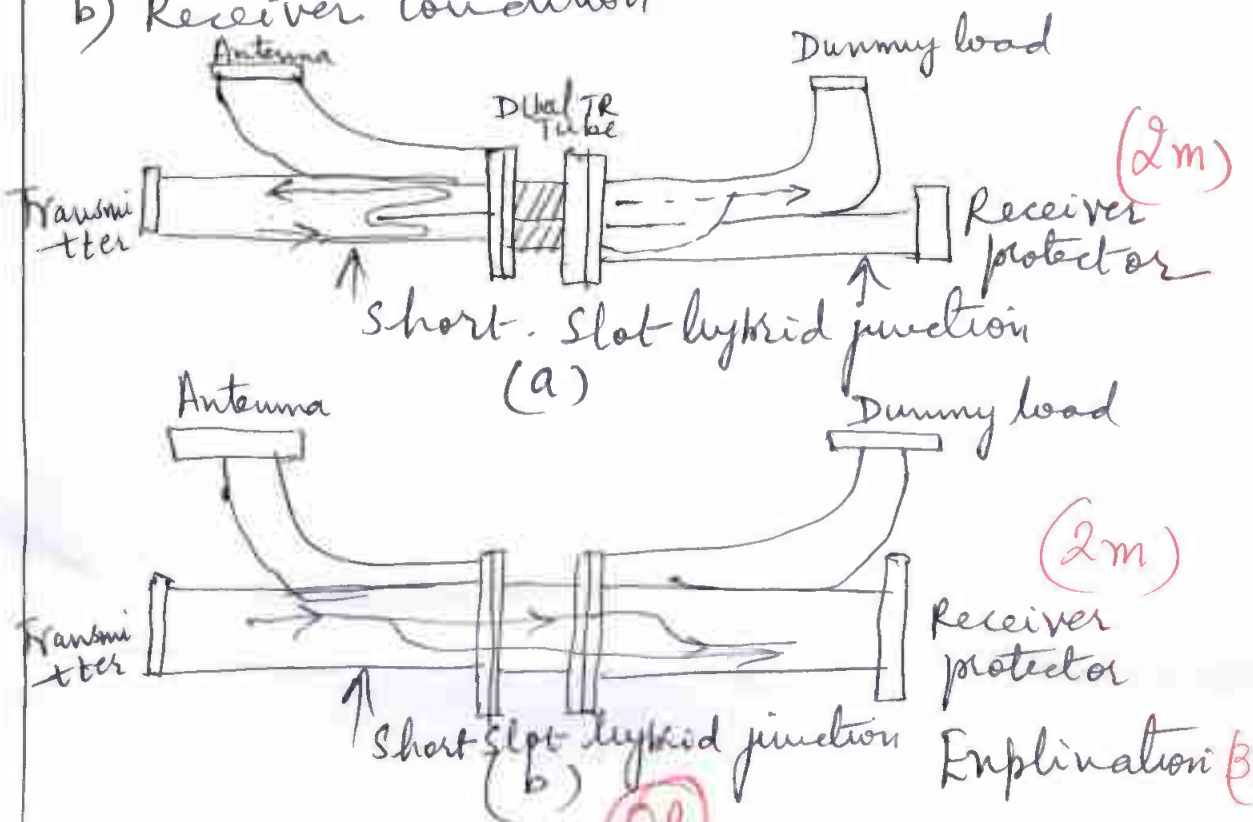
Marks allocated

Solution

9b. Role of Duplexers. A pulse radar can time share a single antenna between the transmitter and receiver by employing a fast acting switching device called a Duplexer. The duplexer cannot always do the entire job of protecting the receiver in addition to the gaseous TR switch a receiver might require diode or ferrite limiters to limit the amount of leakage that gets by the TR switch

Balance Duplexer using dual TR Tubes and 2 short slot hybrid junctions a) Transmit Condition b) Receiver Condition



Explination (3M)

8 Marks

(OR)

10a. List advantages & limitation of electronically steered phased array antenna any Eight 8 Marks

10b. Explain different types of radar display system 8 Marks