INSTITUTE OF AERONAUTICAL ENGINEERING

(Autonomous)
Dundigal, Hyderabad -500 043

ELECTRONICS AND COMMUNICATIONENGINEERING

TUTORIAL QUESTION BANK

Course Title	**RADAR SYSTEMS**				
Course Code	**AEC521**				
Programme	B.Tech.				
Semester	VI	ECE			
Course Type	Core Elective				
Regulation	**IARE - R16**				
Course Structure	**Theory**			**Practical**	
	Lectures	**Tutorials**	**Credits**	**Laboratory**	**Credits**
	3	-	3	-	0
Chief Coordinator	Dr. M V Krishna Rao, Professor				
Course Faculty	Dr. M V Krishna Rao, Professor				

COURSE OBJECTIVES(COs):

The course should enable the students to:	
I	Understand the basic principle of radar.
II	Analyze and compare different types of radars.
III	Compare the performance of different types of tracking radars in noise environment.
IV	Classify different components of radar receiver and analyze their utilization.

COURSE OUTCOMES (COs)

CO 1	Learning and Understanding of Pulse radar systems
CO 2	Understanding of CW and FMCW radar systems.
CO 3	Exploration of Moving Target Indication and Pulse Doppler Radar systems
CO 4	Analysis of Target detection techniques and Understanding of Tracking Radar
CO 5	Discussion of subsystems of a typical Radar Transmitter and Receiver

COURSE LEARNING OUTCOMES(CLOs)

AAEC521.01	Learning of the operating principles of Pulse & CW radars
AEC521.02	Understanding of various types of radar targets: point and fluctuating
AEC521.03	Appreciate various types of clutters, noises, losses involved in radar systems
AEC521.04	Preliminary System design of Pulse and Pulse Compression radars
AEC521.05	Preliminary System design of CW and FM-CW radars
AEC521.06	Appreciate various interferences encountered in radar target detection
AEC521.07	Understanding of the operating principles of MTI & Pulse Doppler radars
AEC521.08	Preliminary System design of MTI and Pulse Doppler radars
AEC521.09	Understanding of the operating principles of search and tracking radars
AEC521.10	Understanding & Analysis of detection techniques of target echo signal
AEC521.11	Understanding of tracking techniques of target echo signal
AEC521.12	Understanding of different subsystems of a typical Radar transmitter
AEC521.13	Appreciate the concept of Noise Figure and the estimating the performance of radar receivers
AEC521.14	Understanding of different subsystems of a typical Radar Receiver

TUTORIAL QUESTION BANK

MODULE - I FUNDAMENTALS OF RADAR				
PART-A (Short Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Explain the relation between Radar range resolution and the signalBandwidth with relevant equation.	Remember	CO 1	AEC521.01
2	Explain the importance of Radar Pulse in determining the Minimum range of a radar set?	Understand	CO 1	AEC521.01
3	Explain the relation between Pulse Repetition period and Pulse Repetition frequency in a Radar System.	Understand	CO 1	AEC521.01
4	Distinguish between average power and Peak power and express therelation between the two.	Understand	CO 1	AEC521.04
5	Define the duty cycle of a pulse train and state its importance in a pulse radar system.	Remember	CO 1	AEC521.01
6	Define the term radar range resolution and write the equation ?	Understand	CO 1	AEC521.01
7	Explain the usage of a Duplexer in the Radar system.	Understand	CO 1	AEC521.04
8	List out some important applications of radar systems.	Remember	CO 1	AEC521.01
9	Write simple Radar Equation.	Understand	CO 1	AEC521.04
10	Describe the meaning of Antenna effective area	Understand	CO 1	AEC521.04
11	Discuss the importance of the position of a target in a lobe for maximum probable detection of the target?	Understand	CO 1	AEC521.02
12	Describe the relation between peak power of radar and the duty cycleof the pulses.	Understand	CO 1	AEC521.04
13	Define Unambiguous range in a radar system	Understand	CO 1	AEC521.03
14	Explain how the unambiguous range can be selected with proper pulse repetition frequency.	Remember	CO 1	AEC521.03
15	What is the ground clutter in radar systems?	Remember	CO 1	AEC521.03
16	Explain what is meant by false alarm.	Understand	CO 1	AEC521.02
17	What are the point targets in radar terminology?	Understand	CO 1	AEC521.02
18	Write the relation between pulse repetition frequency and pulse repetition period.	Remember	CO 1	AEC521.03
19	What is the weather clutter in radar systems?	Understand	CO 1	AEC521.03

PART-B (Long Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Discuss the parameters on which maximum detectable range of a radar system depends.	Remember	CO 1	AEC521.04
2	What are the specific bands assigned by the ITU for the radar? Whatthe corresponding frequencies?	Understand	CO 1	AEC521.04
3	What are the different range frequencies that radar can operate and give their applications?	Understand	CO 1	AEC521.01
4	What are the basic functions of radar? In indicating the position of atarget, what is the difference between azimuth and elevation?	Understand	CO 1	AEC521.01
5	Derive fundamental radar range equation governed by minimum receivable echo power S_{min}.	Remember	CO 1	AEC521.01
6	Draw the functional block diagram of simple pulse radar and explainthe purpose and functioning of each block in it.	Remember	CO 1	AEC521.04
7	List major applications of radar in civil and military systems.	Remember	CO 1	AEC521.01
8	With the help of a suitable block diagram explain the operation of a pulse radar.	Understand	CO 1	AEC521.01
9	Explain how the Radar is used to measure the range of a point target?	Understand	CO 1	AEC521.02
10	Write the simplifier version of radar range equation and explain howthis equation does not adequately describe the performance of practical radar?	Remember	CO 1	AEC521.02
11	Describe how threshold level for detection is decided in the presenceof receiver noise for a specified probability of occurrence of false alarms.	Understand	CO 1	AEC521.01
12	Describe the e effect of pulse repetition frequency on the estimatedunambiguous range of radar.	Understand	CO 1	AEC521.01
13	Obtain the SNR at the output of IF amplifier of radar receiver for a specified probability of detection without exceeding a specified probability of false alarm.	Remember	CO 1	AEC521.02
14	Explain system losses will effect on the radar range.	Remember	CO 1	AEC521.03
15	Discuss about the factors that influence the prediction of radar range.	Remember	CO 1	AEC521.03
16	What are multiple-time-around echoes? Explain the relation between un-ambiguous range estimation and multiple-time-around echoes.	Understand	CO 1	AEC521.03
17	Estimate the radar cross-section of a spherical target if the wavelength of transmitting signal with reference to the target size is in Rayleighregion.	Remember	CO 1	AEC521.02
18	List any five losses in a radar system and discuss the possible causes of each of them.	Understand	CO 1	AEC521.03
	PART-C (Analytical Questions)			
S. No	**Questions**	**BloomsTaxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Justify the requirement of integration of radar pulses to improve targetdetection process	Understand	CO 1	AEC521.01
2	Find the distance to the target if the time TR taken by the pulse to travel to the target and return is 0.2 microseconds. (Assume that electromagnetic energy travels at the speed of light). If the Time TR is doubled, what would be the distance R to thetarget?	Understand	CO 1	AEC521.01
3	Describe the effect of (in terms of wavelength of operation) size of aspherical target on determination of radar cross section of the sphere.	Understand	CO 1	AEC521.01

4	Compute the maximum detectable range of a radar system specified below: Operating wavelength = 3.2 cm, Peak pulse transmitted power = 500 kW, Minimum detectable power = 0.1pW, Capture area of the antenna = $5m^2$ and a Radar cross-sectional area of the target $5m^2$.G=1000;	Remember	CO 1	AEC521.04
5	For the specifications of a radar listed below, compute the power received at 50 Km distance from the radar antenna. Operating wavelength = 3.0 cm Peak pulse transmitted power = 320 kW Transmitting gain, G of the antenna = 9.6 ×104 Effective aperture area of receiving antenna = 5 sq.m Radar cross-sectional area of the target, _ = 12 sq.m.	Remember	CO 1	AEC521.04
6	Use the radar range equation to determine the required transmit power for a pulse radar given that S_{min} =10^{-13} Watts, G=2000 $\lambda = 0.23m$, PRF=524Hz σ=2.0m^2 for a target range of 70Km.	Remember	CO 1	AEC521.04
UNIT – II CW AND FREQUENCY MODULATED RADAR				
PART-A (Short Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Describe the Doppler effect?	Understand	CO 2	AEC521.05
2	Explain how the Doppler effect is used to determine velocity of targets in Radar systems?	Understand	CO 2	AEC521.05
3	If the transmitting source is fixed and the radar target is approaching the source, what type of change the received frequency will undergo?	Remember	CO 2	AEC521.05
4	If the target and the Frequency source are moving close to each other,with constant velocity, explain the change in the frequency?	Remember	CO 2	AEC521.05
5	What is Doppler frequency shift?	Understand	CO 2	AEC521.05
6	Explain how the multipath signals produce error in FM altimeter?	Remember	CO 2	AEC521.06
7	How to find the target speed from Doppler frequency?	Remember	CO 2	AEC521.05
8	Establish a relation between Doppler frequency shift and radial velocity of a moving target.	Understand	CO 2	AEC521.05
9	What factor determines the difference between the transmitted frequency and the received frequency in an FM transmitter?	Remember	CO 2	AEC521.05
10	Stationary objects can be detected by an FM radar? Explain in detail?	Understand	CO 2	AEC521.05
11	With necessary mathematical expressions, describe range and Doppler measurement if the transmitted signal of a CW radar is frequencymodulated?	Understand	CO 2	AEC521.05
12	What are interferences that effect the velocity measurements in CW or FMCW radars?	Remember	CO 2	AEC521.06
PART-B (Long Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	With the help of a suitable block diagram, explain the operation ofCW Doppler radar in a sideband super heterodynereceiver.	Understand	CO 2	AEC521.05
2	List the limitations of CW radar and explain.	Remember	CO 2	AEC521.05
3	What is Doppler frequency shift? Establish a relation between Doppler frequency shift and radial velocity of a moving target.	Remember	CO 2	AEC521.05
4	Explain how isolation between transmitter and receiver of a radar system can be achieved if single antenna is used for transmission andreception.	Understand	CO 2	AEC521.05
5	What is Doppler frequency shift? Discuss the effect of receiver bandwidth on the efficiency of detection and performance of a CWDoppler radar.	Understand	CO 2	AEC521.05

6	With the help of a suitable block diagram, explain the operation of aCW tracking illuminator application of a CW radar.	Understand	CO 2	AEC521.05
7	With the help of a suitable block diagram, explain the operation of aCW radar with non- zero IF in the receiver.	Understand	CO 2	AEC521.05
8	What are the factors that limit the amount of isolation between Transmitter and Receiver of CW Radar?	Remember	CO 2	AEC521.05
9	What are various applications of CW Radar?	Remember	CO 2	AEC521.05
10	List out the possible errors for measurement of altitudes accuratelyusing a FM-CW altimeter and explain.	Remember	CO 2	AEC521.05
11	Discuss the results of multiple frequency usage for operating FM-CW radar while mentioning the limitations of multiple frequency usage in CW radars.	Remember	CO 2	AEC521.05
12	Describe Range and Doppler measurement of a target using a FMCW radar.	Understand	CO 2	AEC521.05
13	Why the step error and quantization errors which occur in cycle counter are used for frequency measurement in FMCW Radar?	Understand	CO 2	AEC521.05
14	How to select the difference between two transmitted signals of CWradar?	Remember	CO 2	AEC521.05
15	What are the various unwanted signals which cause errors in FM altimeter?	Understand	CO 2	AEC521.06
PART-C (Analytical Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**		**Course Learning Outcome**
1.	Find out the Doppler frequency shift caused by a space borne target approaching with a relative velocity of 100 m/s with respect to a CW Radar operating at a carrier frequency of 6.0 GHz. (Velocity ofelectromagnetic wave can be assumed as 3 x 10^8 m/s)	Understand	CO 2	AEC521.05
2.	For an ambiguous range of 81 nautical miles (1nmi=1852 meters) in atwo frequency CW Radar. Determine f_2 and Δf when f_1 =4.2 kHz.	Remember	CO 2	AEC521.05
3.	Determine the acceleration of a target if the received signal bandwidthis 40Hz and the operating wavelength is 9 cm	Understand	CO 2	AEC521.05
4.	Determine the operating wavelength if the target is moving with acceleration as same as acceleration of gravity and the received signal bandwidth is 50 Hz.	Understand	CO 2	AEC521.05
5.	With a transmit (CW) frequency of 5GHz, calculate the Doppler frequency seen by stationary Radar when the target radial velocity is100km/hr.	Understand	CO 2	AEC521.05
6.	A radar system operates at 3 cm with a peak pulse power of500kw. Its minimum receivable power is 10 -3 w, the capture area ofthe antenna Is 5 m^2 and the radar cross-sectional area of the target is 20m^2. Findthe maximum range of the radar	Remember	CO 2	AEC521.05
7.	The minimum receivable signal in a radar receiver who's IF bandwidth is1.5 MHz and which has a noise figure 9 dB will be?	Understand	CO 2	AEC521.05
8.	A target is moving with a velocity of 360km/hour radically towardsthe transmitting frequency generator of 3 GHz will be?	Remember	CO 2	AEC521.05
9.	The beat frequency in a swept-frequency transmitter providesrangeInformation. Explain.	Understand	CO 2	AEC521.05
10	With the help of suitable block diagram, explain the operation of aFM- CW altimeter.	Understand	CO 2	AEC521.05
11	What is the purpose of two carrier frequencies in a CW Radar? Explain in detail.	Remember	CO 2	AEC521.05

UNIT-III MOVING TARGET INDICATION AND PULSE DOPPLER RADAR				
PART-A (Short Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Define MTI radars	Remember	CO 3	AEC521.07
2	What is a delay line canceller?	Understand	CO 3	AEC521.07
3	What are blind speeds?	Remember	CO 3	AEC521.07
4	How does MTI radar differ from CW radar?	Understand	CO 3	AEC521.07
5	Write about Doppler Effect.	Understand	CO 3	AEC521.07
6	List out the limitations of CW Radar.	Remember	CO 3	AEC521.07
7	What is AMTI?	Remember	CO 3	AEC521.07
8	Define Clutter visibility factor.	Remember	CO 3	AEC521.07
9	Define MTI improvement factor.	Remember	CO 3	AEC521.07
CIE-2				
10	What is cancellation ratio in a pulse doppler/MTI radar?	Remember	CO 3	AEC521.07
11	Define Clutter visibility factor.	Understand	CO 3	AEC521.07
12	How an MTI delay line canceller can be treated as a transversal filter?	Understand	CO 3	AEC521.08
13	What is the distinctive feature that makes the MTI radar and pulse Doppler radar differ?	Understand	CO 3	AEC521.07
14	What is the purpose of limiter in the receiver of an MTI radar?	Remember	CO 3	AEC521.07
15	Define pulse doppler radar.	Remember	CO 3	AEC521.07
16	List out the advantages of Non coherent MTI radar.	Understand	CO 3	AEC521.07
17	What is the adverse effect using a limiter in an MTI radar receiver?	Remember	CO 3	AEC521.07
PART-B (Long Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	CO 3	**Course Learning Outcome**
1	What is a delay line canceller? Illustrate the concept of blind speeds based on the frequency response of a single delay linecanceller.	Understand	CO 3	AEC521.07
2	Discuss the factors limiting the performance of an MTI system.	Remember	CO 3	AEC521.07
3	What are blind speeds? Suggest a method to reduce the effect of blind speeds for unambiguous detection of a moving target.	Understand	CO 3	AEC521.07
4	Explore the possibility of broadening the clutter rejection null using a second delay line canceller in the MTI radar system.	Remember	CO 3	AEC521.07
5	Describe automatic tracking of a target through range gating technique for unambiguous detection of a moving target.	Understand	CO 3	AEC521.07
6	With the help of necessary block diagram explain the operation of an MTI radar system with a power oscillator in the transmitter.	Understand	CO 3	AEC521.08
7	Enumerate the advantage of the delay line canceller as compared to conventional frequency domain filter.	Understand	CO 3	AEC521.07
8	Describe the usage of filter banks in an MTI radar that gives range information also.	Understand	CO 3	AEC521.07
9	Compare and contrast the situations with a power amplifier and a power oscillator in the transmitter of an MTI system.	Remember	CO 3	AEC521.07
CIE-2				
10	Describe the method of staggering pulse repetition frequency to reduce the effect of blind speeds in an MTI system.	Understand	CO 3	AEC521.08
11	Discuss the limitations of non-coherent MTI Radar systems	Remember	CO 3	AEC521.07
12	Write the description of Range gate Doppler filters.	Remember	CO 3	AEC521.08

13	Explain the operation of MTI radar with 2 pulse repetition frequencies	Understand	CO 3	AEC521.07
14	What are the Equipment instabilities of an MTI radar system?	Remember	CO 3	AEC521.07
15	What is the Scanning modulation of an MTI radar?	Remember	CO 3	AEC521.07
16	Explain in detail about Internal fluctuation of clutter of an MTI Radar.	Remember	CO 3	AEC521.07
PART-C (Analytical Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Derive an expression for blind speed of an MTI radars.	Understand	CO 3	AEC521.07
2	Discuss the frequency response characteristics of an MTI radar using range gates and filters.	Understand	CO 3	AEC521.08
3	How an MTI delay line canceller can be treated as a transversal filter?	Understand	CO 3	AEC521.08
4	Describe in brief automatic tracking of a target through range gating technique for unambiguous detection of a moving target.	Understand	CO 3	AEC521.08
	CIE-2			
5	A s-band air surveillance radar utilizes a staggered waveform with four different PRFs which are 1222,1031,1138,1000 Hz. What is the first blind speed if a constant PRF is used which corresponds to the pulse repetition period equal to the average of the four pulse repetition periods.	Understand	CO 3	AEC521.08
6	A s-band radar utilizes a staggered waveform with four different PRFs which are 1222,1031,1138,1000 Hz. What is first blind speed of the staggered PRF wave form? Note the ni for these four frequencies are : 27,32,29,33 respectively	Understand	CO 3	AEC521.08
7	Explain very briefly the following limitations of MTI radar. (a) Equipmentinstabilities. (b) Scanning modulation. (d). Internal fluctuation ofclutter.	Understand	CO 3	AEC521.07
8	What is the target glint? Compute the improvement in tracking accuracythat is possible when a tracking radar uses pulse-to-pulse frequency agility. It is given that the agility bandwidth is 200MHz, target depth is 7m, glint bandwidth is 5000Hz and the pulse repetition frequency is 30KHz.	Understand	CO 3	AEC521.08
9	Discuss about the internal Fluctuation of clutter which limits the performance of MTI radar.	Understand	CO 3	AEC521.07
UNIT-IV TRACKING RADAR AND RADAR DETECTION THEORY				
PART-A (Short Answer Questions)				
S. No	**Questi ons**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	What is glint?	Remember	CO 4	AEC521.09
2	Describe the single lobe scanning?	Understand	CO 4	AEC521.09
3	The reflected signals decrease in strength. Discuss the significance of this Statement with reference to target motion off the lobe axis?	Remember	CO 4	AEC521.09
4	List out and describe the basic methods of scanning?	Understand	CO 4	AEC521.09
5	Define scan and its importance in a Radar system.	Remember	CO 4	AEC521.09
6	Explain Split-range-gate tracking.	Remember	CO 4	AEC521.09
7	Limitation of automatic detection and tracking.	Remember	CO 4	AEC521.10
8	Discuss in detail about the Echo pulse with respect to Tracking in range.	Remember	CO 4	AEC521.10
9	Describe the Early-late range gates with respect to Tracking in range.	Understand	CO 4	AEC521.10

10	Explain the Difference signal between early and late range gates.	Remember	CO 4	AEC521.11
11	Why is amplitude comparison mono pulse more likely to be preferred over the phase comparison mono pulse and conical scan tracker oversequential lobbing, or lobe switching, tracker?	Understand	CO 4	AEC521.11
PART-B (Long Answer Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	Discuss the effect of surface quality and reaction characteristics of a target on the angular tracking accuracy of tracking radar.	Remember	CO 4	AEC521.11
2	Describe the phase comparison mono pulse tracking technique in a radar system with the help of necessary block diagram.	Understand	CO 4	AEC521.11
3	With the help of a suitable block diagram, discuss the Sequential lobbing type of tracking technique in a tracking radar system.	Remember	CO 4	AEC521.09
4	Compare and contrast conical scan and sequential lobbing type tracking techniques.	Remember	CO 4	AEC521.09
5	Describe the process of acquiring a moving target prior to tracking it along with the patterns used for acquisition.	Understand	CO 4	AEC521.09
6	Describe automatic tracking of a target through range gating technique	Understand	CO 4	AEC521.09
7	Describe sequential lobbing type of error signal generation to track atarget automatically.	Understand	CO 4	AEC521.09
8	List the merits and demerits of Monopulse tracker over conical scantype tracker.	Remember	CO 4	AEC521.09
9	Draw the block diagram of an amplitude comparison mono pulse tracking radar in azimuth and elevation directions.Explain the functioning of this two dimensional trackingradar.	Understand	CO 4	AEC521.10
10	Why does tracking radar have poor accuracy at low elevation angles?	Remember	CO 4	AEC521.10
11	Explain with diagrams explain Split-range-gate tracking.	Understand	CO 4	AEC521.10
12	Limitation of automatic detection and tracking radar.	Remember	CO 4	AEC521.10
13	Explain the block diagram of amplitude comparison mono pulse forextracting error signals in both elevation and azimuth.	Understand	CO 4	AEC521.10
14	Explain the Early-late gate range tracking with neat sketches.	Remember	CO 4	AEC521.11
15	Draw and explain block diagram of Conical-scan tracking radar.	Understand	CO 4	AEC521.11
PART-C (Analytical Questions)				
S. No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	For ground-based search radar with a beam width of 1.5 deg, the pulse repetition frequency is 300 Hz, and the antenna scan rate is 5 rpm (30deg /sec). Find the number of pulses returned from apoint target as the radar scans through the beam width.	Understand	CO 4	AEC521.09
2	If the one way antenna power pattern of a conical scan tracking antenna is described by the Gaussian function, what is the loss I received signal when the target is directly at the beam cross over? Theantenna half power beam width is 2 deg and the squint angle is 0.75 digress?	Remember	CO 4	AEC521.10
3	Why does tracking radar have poor accuracy at low elevation angles? Summarize the two methods that may be worth considering when it is necessary to avoid poor tracking of target at low altitudes?	Understand	CO 4	AEC521.11
4	Describe sequential lobbing type of error signal generation to track a radar target automatically.	Understand	CO 4	AEC521.11
5	Derive an expression for the detection statistic in a likelihood ratio receiver for a pulse radar.	Understand	CO 4	AEC521.10

6	Derive the impulse response of a matched filter that is commonly used in a radar system.	Remember	CO 4	AEC521.10
7	Explain the differences between matched filter and non-matched filter.	Remember	CO 4	AEC521.10
8	Discuss the matched filters useful in nongaussian noise.	Remember	CO 4	AEC521.10
9	Discuss the relation between the matched filter characteristics and correlation detection.	Remember	CO 4	AEC521.10
10	Discuss in detail about Matched-filter Receiver with necessary expressions.	Remember	CO 4	AEC521.10
11	What is the difference between matched filter and non-matched filter?	Understand	CO 4	AEC521.10
12	Derive the impulse response of a matched filter that is commonly used in a radar receiver.	Remember	CO 4	AEC521.10

UNIT-V
RADAR RECEIVERS

PART-A (Short Answer Questions)

S. No	Questions	Blooms Taxonomy Level	Course Outcome	Course Learning Outcome
1	What are different types of duplexers used in radar receivers?	Understand	CO 5	AEC521.14
2	Define noise figure and equivalent noise temperature of a radar receiver.	Remember	CO 5	AEC521.13
3	Explain how a threshold level is selected in threshold detection?	Understand	CO 5	AEC521.14
4	Distinguish the difference between a mono static and bi static radarsystems	Remember	CO 5	AEC521.12
5	Describe the function of an Envelop detector in Radar receivers.	Understand	CO 5	AEC521.14
6	List out and explain the three fundamental quantities involved in radardisplays?	Understand	CO 5	AEC521.14
7	Explain a typical Radar display system.	Understand	CO 5	AEC521.14
8	How the target is presented on a PPI scope?	Remember	CO 5	AEC521.14

PART-B(Long Answer Questions)

S. No	Questions	Blooms Taxonomy Level	Course Outcome	Course Learning Outcome
1	Explain the principle behind the operation of duplexers and receiver protectors	Understand	CO 5	AEC521.14
2	Explain how a circulator can be utilized for a radar receiver protection	Understand	CO 5	AEC521.14
3	Define noise figure and noise temperature of in a radar receiver	Remember	CO 5	AEC521.13
4	Describe the principle behind the operation of a phased array antenna in a radar system.	Understand	CO 5	AEC521.12
5	Describe the operation of branch and balanced type duplexers with necessary diagrams.	Understand	CO 5	AEC521.14
6	Describe any of two types duplexers used in radar receivers.	Understand	CO 5	AEC521.14
7	Define noise figure and equivalent noise temperature of a radar receiver.	Remember	CO 5	AEC521.13
8	What is low noise front end of a radar receiver? Explain in detail.	Understand	CO 5	AEC521.14
9	Explain how a threshold level is selected in threshold detection?	Remember	CO 5	AEC521.13
10	How to find the number of pulses that returned from a point target asthe radar antenna scans through its beam width?	Understand	CO 5	AEC521.13
11	Define noise figure and noise temperature of a receiver system.	Understand	CO 5	AEC521.13
12	Derive the expression for the noise figure of two networks that are incascade.	Remember	CO 5	AEC521.13

C (Analytical Questions)				
S.No	**Questions**	**Blooms Taxonomy Level**	**Course Outcome**	**Course Learning Outcome**
1	What is relation between the radiation pattern and current feed pattern in a phased array radar?	Remember	CO 5	AEC521.12
2	Describe briefly various visual displays to view radar echo signals in radar systems.	Understand	CO 5	AEC521.14
3	If the target's relative velocity is not constant, a further widening of the received signal spectrum can occur. If ar is the acceleration of the target with respect to the radar, the signal will occupy a bandwidth. If it is the twice the acceleration due to gravity, what should be the receiver bandwidth when the radar wavelength is 10 cm?	Understand	CO 5	AEC521.14
4	Estimate the system noise figure if the antenna is at 300deg Kelvin andthe transmission line loss is 1.5 dB and the receiver noise figure is 2.6dB ?	Remember	CO 5	AEC521.13
5	A receiver with a mixer front end has noise figure of 6.6dB. An LNA witha noise figure of 1.2dB and gain of 10 dB is inserted ahead of mixer toreduce the overall receiver noise figure. A) How much of the new noisefigure is due to mixer noise, and by how much has the dynamic range ofthe receiver been reduced? B) If the gain of LNA were increased to 20 dB,what would be the receiver noise figure and the decrease in dynamicrange?	Remember	CO 5	AEC521.13
6	Discuss about the grating lobes in the phased array antennas used in radar systems	Understand	CO 5	AEC521.12
7	Explain in detail the parameters of radiated energy that need to be altered to achieve electronic scanning in radar antennas?	Remember	CO 5	AEC521.12

Prepared by:
Dr M V Krishna Rao, Professor **HOD, ECE**