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Note : Remove "Table of Content" before including in CP Book
Each Course Plan shall be printed and made into a book with cover page
Blooms Level in all sections match with A.2, only if you plan to teach / learn at higher levels the uses

15EC833 RADAR SYSTEMS

A. COURSE INFORMATION

1. Course Overview

Degree:	B.E	Program:	EC
Year / Semester :	4/8	Academic Year:	2018
Course Title:	RADAR SYSTEMS	Course Code:	15EC833
Credit / L-T-P:	3	SEE Duration:	180 Minutes
Total Contact Hours:	50	SEE Marks:	80 Marks
CIA Mark	20	Assignment	1 / Module
Course Plan Author	Mrs.SYEDA N	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	Basics of Radar: Introduction, Maximum Unambiguous Range, Radar Waveforms, Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power. Simple form of the Radar Equation, Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar, The Origins of Radar, Illustrative Problems.	10	Demonstrate the basic principle of RADAR System.	L3
2	The Radar Equation: Prediction of Range Performance, Detection of signal in Noise, Minimum Detectable Signal, Receiver Noise, SNR, Modified Radar Range Equation, Envelope Detector — False Alarm Time and Probability, Probability of Detection, Radar Cross Section of Targets: simple targets – sphere, cone-sphere, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.	10	Solve the RADAR Equation and to calculate Transmitter power.	L4
3	MTI and Pulse Doppler Radar: Introduction, Principle, Doppler Frequency Shift, Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler, MTI Radar with – Power Amplifier Transmitter, Delay Line Cancelers — Frequency Response of Single Delay- Line Canceler, Blind Speeds, Clutter Attenuation, MTI Improvement Factor, N- Pulse Delay-Line Canceler, Digital MTI Processing – Blind phases, I and Q Channels, Digital MTI Doppler signal processor, Moving Target Detector- Original MTD.	10	working principle of CW and Frequency Modulated Radar.	L4
4	Tracking Radar: Tracking with Radar- Types of Tracking Radar Systems, Monopulse TrackingAmplitude Comparison Monopulse (one-and two-coordinates), Phase Comparison Monopulse. Sequential Lobing, Conical Scan Tracking, Block Diagram of Conical Scan L1, L2, L3 156 Tracking Radar, Tracking in Range, Comparison of Trackers.	10	Tracking Radar principle.	L4
5	The Radar Antenna: Functions of The Radar Antenna, Antenna Parameters, Reflector Antennas and Electronically Steered Phased array Antennas. Radar Receiver: The Radar Receiver, Receiver Noise Figure, Super Heterodyne Receiver, Duplexers	10	Noise Figure and Noise Temperature in Radar	L4

	and Receivers Protectors, Radar Displays.		Receivers	

3. Course Material

Books & other material as recommended by university (A, B) and additional resources used by course teacher (C).
1. Understanding: Concept simulation / video ; one per concept ; to understand the concepts ; 15 – 30 minutes
2. Design: Simulation and design tools used – software tools used ; Free / open source
3. Research: Recent developments on the concepts – publications in journals; conferences etc.

Modules	Details	Chapters in book	Availability
A	**Text books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1-3	Introduction to Radar Systems- Merrill I Skolink, 3e, TMH, 2001.	In Lib and dept	In Lib / In Dept
4-5	Radar Principles, Technology, Applications — Byron Edde, Pearson Education, 2004.		
B	**Reference books (Title, Authors, Edition, Publisher, Year.)**	**-**	**-**
1-3	Radar Principles – Peebles. Jr, P.Z. Wiley. New York, 1998.	In dept	In Lib
4-5	Principles of Modem Radar: Basic Principles – Mark A. Rkhards, James A. Scheer, William A. Holm. Yesdee, 2013	In dept	In Lib
C	**Concept Videos or Simulation for Understanding**	**-**	**-**
C1	https://www.tutorialspoint.com/radar_systems/radar_systems_range_equation.htm	1	Internet
C2	https://www.radartutorial.eu/01.basics/Duty%20cycle.en.html	2	Internet
C3	http://www.ee.fju.edu.tw/pages/032_faculty/sclin/lecture/rada_system_design/chapter14.pdf	3	Internet
C4	https://en.wikipedia.org/wiki/Radar_configurations_and_types	4	Internet
C5	https://www.microwaves101.com/encyclopedias/radar-range-equation	5	Internet
D	**Software Tools for Design**		
1	Microwave bench		
2	Antenna		
E	**Recent Developments for Research**	**-**	**-**
1	Military radar		
2	Air, Sea borne radar		
F	**Others (Web, Video, Simulation, Notes etc.)**	**-**	**-**
1	https://www.explainthatstuff.com/radar.html	internet	L1-L3
2	https://www.eeweb.com/profile/ravi-kumar-6/articles/radar-types-its-application	internet	L1-L4

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15EC71	Digital	filters	6	Available	L2

		communication				
2	15EC64	Antenna	1Basic structure of antennas.microwave	7	Available	L2

Note: If prerequisites are not taught earlier, GAP in curriculum needs to be addressed. Include in Remarks and implement in B.5.

B. OBE PARAMETERS

1. Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
	Student should be able to	-	-	-	-	-
15EC833.1	Demonstrate the basic principle of RADAR System.	10	Demonstrate the basic principle of RADAR System.	Lecture	Q & A Unit test	L3
15EC833.2	Solve the RADAR Equation and to calculate Transmitter power.	10	Solve the RADAR Equation and to calculate Transmitter power.	Lecture PPT	Q & A Unit test	L4
15EC833.3	Analyze the working principle of CW and Frequency Modulated Radar.	10	working principle of CW and Frequency Modulated Radar.	Lecture	Assignment and Slip Test	L4
15EC833.4	Demonstrate the basic principle of Receiver and also extraction of signal in Noise.		extraction of signal in Noise.	Lecture	Slip test CIA	L4
15EC833.5	Analyze the principle of each and every block of MTI and Pulse Doppler Radar.	10	MTI and Pulse Doppler Radar	Lecture	Slip test CIA	L4
-	**Total**	**50**	-	-	-	-

Note: Identify a max of 2 Concepts per Module. Write 1 CO per concept.

2. Course Applications

SNo	Application Area	CO	Level
1	Wiireless communication equipmentsindustrial controllers and data acquisition systems	CO1	L2
2	Antenna device drivers	CO2	L2
3	Doppler frequency	CO3	L4
4	Applications include Smartphones, Netbooks, eReaders, Digital TV Servers and Networking	CO4	L2

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO1	PO2	PO3	PO4	PO5	PO 6	PO7	PO8	PO 9	PO1 0	PO1 1	PO1 2	Level
15EC833CO 1	Demonstrate the basic principle of RADAR System.	3	1	1										L2
15EC833CO 2	Solve the RADAR Equation and to calculate Transmitter power.	3		2										L4
15EC833CO 3	Analyze the working principle of CW and Frequency Modulated Radar.	3	2	1										L4
15EC833CO 4	Draw the block diagram of FM-CW Radar and also calculate Measurement errors.	3		2										L2
15EC833CO 5	Demonstrate the basic principle of Receiver and also extraction of signal in Noise	2	2	2										L4
Note: Mention the mapping strength as 1, 2, or 3														

4. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					

Note: Write Gap topics from A.4 and add others also.

C. COURSE ASSESSMENT

1. Course Coverage

Module #	Title	Teaching Hours	No. of question in Exam						CO	Levels
			CIA-1	CIA-2	CIA-3	Asg	Extra Asg	SEE		
1	Basics of Radar: Introduction,	10	2	-	-	1	1	2	CO1	L2

	Maximum Unambiguous Range, Radar Waveforms, Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power. Simple form of the Radar Equation, Radar Block Diagram and Operation, Radar Frequencies, Applications of Radar, The Origins of Radar, Illustrative Problems.									
2	The Radar Equation: Prediction of Range Performance, Detection of signal in Noise, Minimum Detectable Signal, Receiver Noise, SNR, Modified Radar Range Equation, Envelope Detector — False Alarm Time and Probability, Probability of Detection, Radar Cross Section of Targets: simple targets – sphere, cone-sphere, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.	10	2	-	-	1	1	2	CO2	L2, L4
3	MTI and Pulse Doppler Radar: Introduction, Principle, Doppler Frequency Shift, Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler, MTI Radar with – Power Amplifier Transmitter, Delay Line Cancelers — Frequency Response of Single Delay- Line Canceler, Blind Speeds, Clutter Attenuation, MTI Improvement Factor, N- Pulse Delay-Line Canceler, Digital MTI Processing – Blind phases, I and Q Channels, Digital MTI Doppler signal processor, Moving Target Detector-Original MTD.	10	-	2	-	1	1	2	CO3	L2, L4
4	Tracking Radar: Tracking with Radar- Types of Tracking Radar Systems, Monopulse TrackingAmplitude Comparison Monopulse (one-and two-coordinates), Phase Comparison Monopulse. Sequential Lobing, Conical Scan Tracking, Block Diagram of Conical Scan L1, L2, L3 156 Tracking Radar, Tracking in Range, Comparison of Trackers.	10	-	2	-	1	1	2	CO4	L2
5	The Radar Antenna: Functions of The Radar Antenna, Antenna Parameters, Reflector Antennas and Electronically Steered Phased array Antennas. Radar Receiver: The Radar Receiver, Receiver Noise Figure, Super Heterodyne Receiver, Duplexers and Receivers Protectors, Radar Displays.	10	-	-	4	1	1	2	CO5	L2, L4

-	Total	52	4	4	4	5	5	10	-	-

Note: Distinct assignment for each student. 1 Assignment per chapter per student. 1 seminar per test per student.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	15	CO1, CO2	L2, l4
CIA Exam – 2	15	CO3, CO4 ,	L2, L4
CIA Exam – 3	15	CO5	L4
Assignment - 1	5	CO1, CO2	L2, L4
Assignment - 2	5	CO3, CO4 ,	L2, L4
Assignment - 3	5	CO5	L2
Seminar - 1	0		L2, L4
Seminar - 2	0		L2, L4
Seminar - 3	0		L2
Other Activities – define – Slip test			L2, L3, L4
Final CIA Marks	**20**	**-**	**-**

Note : Blooms Level in last column shall match with A.2 above.

D1. TEACHING PLAN - 1

Module - 1

Title:	Basics of Radar	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Demonstrate the basic principle of RADAR System	CO1	L2
2	Analyze Radar types	CO1	L3
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Basics of Radar: Introduction,	Co1	L2
2	Maximum Unambiguous Range, Radar Waveforms,.	Co1	L2
3	Definitions with respect to pulse waveform - PRF, PRI, Duty Cycle, Peak Transmitter Power, Average transmitter Power.	Co1	L2
4	Simple form of the Radar Equation,	Co1	L2
5	Radar Block Diagram and Operation,	Co1	L2
6	Radar Block Diagram and Operation, Radar Frequencies,	Co1	L2
7	Applications of Radar,	Co1	L2
8	The Origins of Radar, Illustrative Problems	Co1	L2
c	**Application Areas**	**CO**	**Level**
1	Wiireless communication equipments	CO1	L3
2	industrial controllers and data acquisition systems	CO1	L4
d	**Review Questions**	-	-
1	Explain the basic principle of radar operation with a neat block diagram.	CO1	L2

2	Explain various applications of radar	CO1	L2
3	Derive the expression for simple form of radar equation.	CO1	L2
4	Define maximum unambiguous range of radar and mention radar frequencies.	CO1	L3
5	Explain the various receiver signal to noise ratio.	CO1	L2
6	Mention the common parameters of pulse radar.	CO1	L2
7	Explain the various system losses in a radar system.	CO1	L2
8	Define swerling target models..	CO1	L2
e	**Experiences**	-	-
1			
2			
3			
4			
5			

Module – 2

Title:	The Radar Equation	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Solve the RADAR Equation and to calculate Transmitter power.	CO2	L2
2	Apply Transmitter power for antennas	CO2	L4
b	***Course Schedule***	-	-
Class No	**Module Content Covered**	**CO**	**Level**
8	The Radar Equation: Prediction of Range Performance	CO2	L4
9	Detection of signal in Noise, Minimum Detectable Signal,	CO2	L4
10	Receiver Noise, SNR, Modified Radar Range Equation	CO2	L4
11	Envelope Detector — False Alarm Time and Probability,	CO2	L4
12	Probability of Detection, Radar Cross Section of Targets: simple targets – sphere	CO2	L4
13	cone-sphere, Transmitter Power, PRF and Range Ambiguities, System Losses (qualitative treatment), Illustrative Problems.Logical Instructions	CO2	L4
c	**Application Areas**	**CO**	**Level**
1	Solve the RADAR Equation and to calculate Transmitter power.	CO2	L4
2	Apply Transmitter power for antennas	CO2	L4
d	**Review Questions**	-	-
1	Explain the various receiver signal to noise ratio.	CO2	L2
2	Mention the common parameters of pulse radar.	CO2	L4
3	Explain the various system losses in a radar system.	CO2	L4
4	Define swerling target models..	CO2	L2
5	Mention the common parameters of pulse radar.	CO2	L4
6	Explain the various system losses in a radar system.	CO2	L4
7	Define swerling target models..	CO2	L2
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E1. CIA EXAM – 1

a. Model Question Paper – 1

CIA -#Dept:	1-EC	Sem / Div:	IV/A	Course:	Radar Engineering	Elective:	Y
Date:	8/2/2019	Time:	9.30-10.45	C Code:	15EC833	Max Marks:	30

Note: Answer all full questions. All questions carry 15 marks.

QNo		Questions	CO	Level	Marks	Module
1	a	Explain the basic principle of radar operation with a neat block diagram.	CO1	L2	8	1
	b	Explain various applications of radar	CO1	L2	7	1
		OR				
2	a	Derive the expression for simple form of radar equation.	CO1	L2	8	1
	b	Define maximum unambiguous range of radar and mention radar frequencies.	CO1	L3	7	1
3	a	Explain the various receiver signal to noise ratio.	CO2	L2	8	2
	b	Mention the common parameters of pulse radar.	CO2	L2	7	2
		OR				
4	a	Explain the various system losses in a radar system.	CO2	L2	8	2
	b	Define swerling target models..	CO2	L2	7	2

b. Assignment -1

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EC833	Sem:	8	Marks:	5 / 10	Time:	90 – 120 minutes
Course:	RADAR SYSTEMS						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EC003	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
2	1KT16EC005	Explain various applications of radar	5	CO1	L2
3	1KT16EC008	Derive the expression for simple form of radar equation.	5	CO1	L2
4	1KT16EC011	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
5	1KT16EC012	Explain the various receiver signal to noise ratio.	5	CO2	L4
6	1KT16EC015	Mention the common parameters of pulse radar.	5	CO2	L2
7	1KT16EC016	Explain the various system losses in a radar system.	5	CO2	L4
8	1KT16EC018	Define swerling target models..	5	CO2	L4
9	1KT16EC020	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
10	1KT16EC022	Explain various applications of radar	5	CO1	L2
11	1KT16EC023	Derive the expression for simple form of radar equation.	5	CO1	L2
12	1KT16EC024	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4

13	1KT16EC025	Explain the various receiver signal to noise ratio.	5	CO2	L4
14	1KT16EC026	Mention the common parameters of pulse radar.	5	CO2	L2
15	1KT16EC027	Explain the various system losses in a radar system.	5	CO2	L4
16	1KT16EC028	Define swerling target models..	5	CO2	L4
17	1KT16EC029	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
18	1KT16EC032	Explain various applications of radar	5	CO1	L2
19	1KT16EC033	Derive the expression for simple form of radar equation.	5	CO1	L2
20	1KT16EC035	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
21	1KT16EC410	Explain the various receiver signal to noise ratio.	5	CO2	L4
22	1KT16EC417	Mention the common parameters of pulse radar.	5	CO2	L2
23	1KT15EC016	Explain the various system losses in a radar system.	5	CO2	L4
24	1KT15EC027	Define swerling target models..	5	CO2	L4
25	1KT16EC041	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
26	1KT16EC042	Explain various applications of radar	5	CO1	L2
27	1KT16EC043	Derive the expression for simple form of radar equation.	5	CO1	L2
28	1KT16EC044	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
29	1KT16EC045	Explain the various receiver signal to noise ratio.	5	CO2	L4
30	1KT16EC047	Mention the common parameters of pulse radar.	5	CO2	L2
31	1KT16EC048	Explain the various system losses in a radar system.	5	CO2	L4
32	1KT16EC049	Define swerling target models..	5	CO2	L4
33	1KT16EC050	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
34	1KT16EC051	Explain various applications of radar	5	CO1	L2
35	1KT16EC052	Derive the expression for simple form of radar equation.	5	CO1	L2
36	1KT16EC053	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
37	1KT16EC057	Explain the various receiver signal to noise ratio.	5	CO2	L4
38	1KT16EC058	Mention the common parameters of pulse radar.	5	CO2	L2
39	1KT16EC059	Explain the various system losses in a radar system.	5	CO2	L4
40	1KT16EC061	Define swerling target models..	5	CO2	L4
41	1KT16EC063	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
42	1KT16EC064	Explain various applications of radar	5	CO1	L2
43	1KT16EC066	Derive the expression for simple form of radar equation.	5	CO1	L2
44	1KT16EC067	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4

45	1KT16EC068	Explain the various receiver signal to noise ratio.	5	CO2	L4
46	1KT16EC069	Mention the common parameters of pulse radar.	5	CO2	L2
47	1KT16EC070	Explain the various system losses in a radar system.	5	CO2	L4
48	1KT16EC073	Define swerling target models..	5	CO2	L4
49	1KT16EC074	Explain the basic principle of radar operation with a neat block diagram.	5	CO1	L2
50	1KT16EC077	Explain various applications of radar	5	CO1	L2
51	1KT16EC078	Derive the expression for simple form of radar equation.	5	CO1	L2
52	1KT17EC402	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
53	1KT17EC403	Explain the various receiver signal to noise ratio.	5	CO2	L4
54	1KT17EC406	Mention the common parameters of pulse radar.	5	CO2	L2
55	1KT17EC408	Explain the various system losses in a radar system.	5	CO2	L4
56	1KT16EC079	Define swerling target models..	5	CO2	L4
57	1KT16EC080	Define maximum unambiguous range of radar and mention radar frequencies.	5	CO1	L4
58	1KT16EC425	Explain the various receiver signal to noise ratio.	5	CO2	L4

D2. TEACHING PLAN - 2

Module – 3

Title:	MTI and Pulse Doppler Radar	Appr Time:	16 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	working principle of CW and Frequency Modulated Radar.	CO3	L2
2	extraction of signal in Noise.	CO3	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction, Principle, Doppler Frequency Shift,	CO3	L2
2	Simple CW Radar, Sweep to Sweep subtraction and Delay Line Canceler,	CO3	L2
3	MTI Radar with – Power Amplifier Transmitter,	CO3	L2
4	Delay Line Cancelers — Frequency Response of Single Delay- Line Canceler,	CO3	L2
5	Blind Speeds, Clutter Attenuation,	CO3	L2
6	MTI Improvement Factor, N- Pulse Delay-Line Canceler,	CO3	L2
7	Digital MTI Processing – Blind phases, I and Q Channels, Digital MTI Doppler signal processor, Moving Target Detector-Original MTD	CO3	L2

8	Digital MTI Processing – Blind phases,	CO3	L4
9	I and Q Channels, Digital MTI Doppler signal processor, Moving Target Detector- Original MTD	CO3	L2
c	**Application Areas**	**CO**	**Level**
1	Antenna device drivers	CO3	L4
2	Analyze the working principle of CW and Frequency Modulated Radar l	CO3	L4
d	**Review Questions**	-	-
1	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	CO3	L2
2	Differentiate between MTI and pulse Doppler Radar	CO3	L2
3	Explain the principle of double line canceller with necessary equation and waveform.	CO3	L2
4	Describe the parameters and limitations of MTI radar.	CO3	L4
5	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	CO3	L2
6	Differentiate between MTI and pulse Doppler Radar	CO3	L2
7	Explain the principle of double line canceller with necessary equation and waveform.	CO3	L2
8	Describe the parameters and limitations of MTI radar.	CO3	L2
e	**Experiences**	-	-
1			
2			
3			
4			
5			

Module – 4

Title:	Tracking Radar	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Analyze the principle of each and every block of MTI and Pulse Doppler Radar.	CO4	L4
2	Understand radar in Doppler frequencies	CO4	L4
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Tracking with Radar- Types of Tracking Radar Systems,	CO4	L2
2	Monopulse TrackingAmplitude Comparison Monopulse (one- and two-coordinates),	CO4	L2
3	Phase Comparison Monopulse. Sequential Lobing,	CO4	L2
4	Conical Scan Tracking,	CO4	L2
5	Block Diagram of Conical Scan L1, L2, L3 156 Tracking Radar,	CO4	L2
6	Tracking in Range	CO4	L2
7	Comparison of Trackers.	CO4	L2
c	**Application Areas**	**CO**	**Level**
1	Analyze the principle of each and every block of MTI and Pulse Doppler Radar.	CO4	L4
2	Understand radar in Doppler frequencies	CO4	L2

d	Review Questions		-
1	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	CO4	L2
2	Mention the types of tracking radar systems.	CO4	L2
3	Explain the principle of a conical scan radar system.	CO4	L2
4	Define sequential lobe and its applications.	CO4	L4
5	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	CO4	L2
6	Mention the types of tracking radar systems.	CO4	L2
7	Explain the principle of a conical scan radar system.	CO4	L2
8	Define sequential lobe and its applications.	CO4	L2
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E2. CIA EXAM – 2

a. Model Question Paper – 2

CIA - #Dept:	2-EC	Sem / Div:	VIII/A	Course:	Radar Engineering	Elective:	Y
Date:	23/4/2019	Time:	9.30-10.45	C Code:	15EC833	Max Marks:	30

Note: Answer all full questions. All questions carry 15 marks.

QNo		Questions	CO	Level	Marks	Module
1	a	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	CO5	L2	8	3
	b	Differentiate between MTI and pulse Doppler Radar	CO5	L2	7	3
		OR				
2	a	Explain the principle of double line canceller with necessary equation and waveform.	CO6	L2	8	3
	b	Describe the parameters and limitations of MTI radar.	CO6	L3	7	3
3	a	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	CO7	L2	8	4
	b	Mention the types of tracking radar systems.	CO7	L2	7	4
		OR				
4	a	Explain the principle of a conical scan radar system.	CO8	L2	8	4
	b	Define sequential lobe and its applications.	CO8	L2	7	4

b. Assignment – 2

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions							
Crs Code:	15EC833	Sem:	8	Marks:	10 / 10	Time:	90 – 120 minutes
Course:	RADAR SYSTEMS						

Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EC003	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO3	L4
2	1KT16EC005	Differentiate between MTI and pulse Doppler Radar	5	CO3	L2
3	1KT16EC008	Explain the principle of double line canceller with necessary	5	CO3	L2

		equation and waveform.			
4	1KT16EC011	Describe the parameters and limitations of MTI radar.	5	CO3	L2
5	1KT16EC012	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO3	L2
6	1KT16EC015	Mention the types of tracking radar systems.	5	CO3	L2
7	1KT16EC016	Explain the principle of a conical scan radar system.	5	CO3	L2
8	1KT16EC018	Define sequential lobe and its applications.	5	CO3	L4
9	1KT16EC020	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO3	L2
10	1KT16EC022	Differentiate between MTI and pulse Doppler Radar	5	CO3	L2
11	1KT16EC023	Explain the principle of double line canceller with necessary equation and waveform.	5	CO3	L2
12	1KT16EC024	Describe the parameters and limitations of MTI radar.	5	CO3	L2
13	1KT16EC025	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO3	L2
14	1KT16EC026	Mention the types of tracking radar systems.	5	CO3	L2
15	1KT16EC027	Explain the principle of a conical scan radar system.	5	CO3	L2
16	1KT16EC028	Define sequential lobe and its applications.	5	CO3	L2
17	1KT16EC029	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO4	L2
18	1KT16EC032	Differentiate between MTI and pulse Doppler Radar	5	CO4	L4
19	1KT16EC033	Explain the principle of double line canceller with necessary equation and waveform.	5	CO4	L2
20	1KT16EC035	Describe the parameters and limitations of MTI radar.	5	CO4	L2
21	1KT16EC410	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO4	L2
22	1KT16EC417	Mention the types of tracking radar systems.	5	CO4	L2
23	1KT15EC016	Explain the principle of a conical scan radar system.	5	CO4	L2
24	1KT15EC027	Define sequential lobe and its applications.	5	CO4	L4
25	1KT16EC041	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO4	L2
26	1KT16EC042	Differentiate between MTI and pulse Doppler Radar	5	CO4	L2
27	1KT16EC043	Explain the principle of double line canceller with necessary equation and waveform.	5	CO4	L2
28	1KT16EC044	Describe the parameters and limitations of MTI radar.	5	CO4	L2
29	1KT16EC045	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO3	L4
30	1KT16EC047	Mention the types of tracking radar systems.	5	CO3	L2
31	1KT16EC048	Explain the principle of a conical scan radar system.	5	CO3	L2
32	1KT16EC049	Define sequential lobe and its applications.	5	CO3	L2
33	1KT16EC050	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO3	L2
34	1KT16EC051	Differentiate between MTI and pulse Doppler Radar	5	CO3	L2
35	1KT16EC052	Explain the principle of double line canceller with necessary equation and waveform.	5	CO3	L2
36	1KT16EC053	Describe the parameters and limitations of MTI radar.	5	CO3	L4
37	1KT16EC057	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO3	L2

38	1KT16EC058	Mention the types of tracking radar systems.	5	CO3	L2
39	1KT16EC059	Explain the principle of a conical scan radar system.	5	CO3	L2
40	1KT16EC061	Define sequential lobe and its applications.	5	CO3	L2
41	1KT16EC063	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO3	L2
42	1KT16EC064	Differentiate between MTI and pulse Doppler Radar	5	CO3	L2
43	1KT16EC066	Explain the principle of double line canceller with necessary equation and waveform.	5	CO4	L2
44	1KT16EC067	Describe the parameters and limitations of MTI radar.	5	CO4	L2
45	1KT16EC068	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO4	L2
46	1KT16EC069	Mention the types of tracking radar systems.	5	CO4	L2
47	1KT16EC070	Explain the principle of a conical scan radar system.	5	CO3	L2
48	1KT16EC073	Define sequential lobe and its applications.	5	CO3	L2
49	1KT16EC074	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	5	CO4	L2
50	1KT16EC077	Differentiate between MTI and pulse Doppler Radar	5	CO4	L2
51	1KT16EC078	Explain the principle of double line canceller with necessary equation and waveform.	5	CO4	L2
52	1KT17EC402	Describe the parameters and limitations of MTI radar.	5	CO4	L2
53	1KT17EC403	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	5	CO3	L2
54	1KT17EC406	Mention the types of tracking radar systems.	5	CO3	L2
55	1KT17EC408	Explain the principle of a conical scan radar system.	5	CO4	L2
56	1KT16EC079	Define sequential lobe and its applications.	5	CO4	L2
57	1KT16EC080	Mention the types of tracking radar systems.	5	CO4	L2
58	1KT16EC425	Mention the types of tracking radar systems.	5	CO4	L2

D3. TEACHING PLAN - 3

Module – 5

Title:	The Radar Antenna	Appr Time:	10 Hrs
a	***Course Outcomes***	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Demonstrate the basic principle of Receiver and also extraction of signal in Noise.	CO5	L2
2	Different types of radar architecture	CO5	L2
b	***Course Schedule***		
Class No	**Module Content Covered**	**CO**	**Level**
1	Functions of The Radar Antenna,	CO5	L2
2	Antenna Parameters,	CO5	L2
3	Reflector Antennas and Electronically Steered Phased array Antennas.	CO5	L2
4	Radar Receiver: The Radar Receiver	CO5	L2
5	Receiver Noise Figure,	CO5	L2
6	Super Heterodyne Receiver	CO5	L2
7	Duplexers and Receivers Protectors,	CO5	L2

8	Radar Displays.	CO5	L2
c	**Application Areas**	**CO**	**Level**
1	Radar antennas	CO5	l4
2	Manufacturing of different radar recievers	CO5	l4
d	**Review Questions**		
1	Describe the functions of radar antenna.	CO5	L2
2	Explain reflector antenna.	CO5	L2
3	Explain the antenna parameters.	CO5	L2
4	Explain super heterodyne receiver.	CO5	L2
5	Explain types of display presentations.	CO5	L4
6	Explain steering of a linear array with variable phase shifters.	CO5	L2
7	Explain noise figure and noise temperature of a receiver system.	CO5	L4
8	Explain principle behind the operation of duplexers and receiver protectors.	CO5	L4
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E3. CIA EXAM – 3

a. Model Question Paper – 3

CIA #Dept:	3-EC	Sem / Div:	VIII/A	Course:	Radar Engineering	Elective:	Y
Date:	17/5/2019	Time:	9.30-10.45	C Code:	15EC833	Max Marks:	30

Note: Answer all full questions. All questions carry 15 marks.

QNo		Questions	CO	Level	Marks	Module
1	a	Describe the functions of radar antenna.	CO5	L2	8	5
	b	Explain reflector antenna.	CO5	L2	7	5
		OR				
2	a	Explain the antenna parameters.	CO5	L2	8	5
	b	Explain super heterodyne receiver.	CO5	L3	7	5
3	a	Explain types of display presentations.	CO5	L2	8	5
	b	Explain steering of a linear array with variable phase shifters.	CO5	L2	7	5
		OR				
4	a	Explain noise figure and noise temperature of a receiver system.	CO5	L2	8	5
	b	Explain principle behind the operation of duplexers and receiver protectors.	CO5	L2	7	5

b. Assignment – 3

Note: A distinct assignment to be assigned to each student.

Model Assignment Questions

Crs Code:	18EC833	Sem:	8	Marks:	10 / 10	Time:	90 – 120 minutes
Course:	RADAR SYSTEMS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT16EC003	Describe the functions of radar antenna.	5	CO5	L2
2	1KT16EC005	Explain reflector antenna.	5	CO5	L2
3	1KT16EC008	Explain the antenna parameters.	5	CO5	L2
4	1KT16EC011	Explain super heterodyne receiver.	5	CO5	L2
5	1KT16EC012	Explain types of display presentations.	5	CO5	L2
6	1KT16EC015	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
7	1KT16EC016	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
8	1KT16EC018	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
9	1KT16EC020	Describe the functions of radar antenna.	5	CO5	L2
10	1KT16EC022	Explain reflector antenna.	5	CO5	L2
11	1KT16EC023	Explain the antenna parameters.	5	CO5	L2
12	1KT16EC024	Explain super heterodyne receiver.	5	CO5	L2
13	1KT16EC025	Explain types of display presentations.	5	CO5	L2
14	1KT16EC026	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
15	1KT16EC027	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
16	1KT16EC028	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
17	1KT16EC029	Describe the functions of radar antenna.	5	CO5	L2
18	1KT16EC032	Explain reflector antenna.	5	CO5	L2
19	1KT16EC033	Explain the antenna parameters.	5	CO5	L2
20	1KT16EC035	Explain super heterodyne receiver.	5	CO5	L2
21	1KT16EC410	Explain types of display presentations.	5	CO5	L2
22	1KT16EC417	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
23	1KT15EC016	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
24	1KT15EC027	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
25	1KT16EC041	Describe the functions of radar antenna.	5	CO5	L2
26	1KT16EC042	Explain reflector antenna.	5	CO5	L2
27	1KT16EC043	Explain the antenna parameters.	5	CO5	L2
28	1KT16EC044	Explain super heterodyne receiver.	5	CO5	L2
29	1KT16EC045	Explain types of display presentations.	5	CO5	L2
30	1KT16EC047	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
31	1KT16EC048	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
32	1KT16EC049	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4

33	1KT16EC050	Describe the functions of radar antenna.	5	CO5	L2
34	1KT16EC051	Explain reflector antenna.	5	CO5	L2
35	1KT16EC052	Explain the antenna parameters.	5	CO5	L2
36	1KT16EC053	Explain super heterodyne receiver.	5	CO5	L2
37	1KT16EC057	Explain types of display presentations.	5	CO5	L2
38	1KT16EC058	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
39	1KT16EC059	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
40	1KT16EC061	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
41	1KT16EC063	Describe the functions of radar antenna.	5	CO5	L2
42	1KT16EC064	Explain reflector antenna.	5	CO5	L2
43	1KT16EC066	Explain the antenna parameters.	5	CO5	L2
44	1KT16EC067	Explain super heterodyne receiver.	5	CO5	L2
45	1KT16EC068	Explain types of display presentations.	5	CO5	L2
46	1KT16EC069	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
47	1KT16EC070	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
48	1KT16EC073	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
49	1KT16EC074	Describe the functions of radar antenna.	5	CO5	L2
50	1KT16EC077	Explain reflector antenna.	5	CO5	L2
51	1KT16EC078	Explain the antenna parameters.	5	CO5	L2
52	1KT17EC402	Explain super heterodyne receiver.	5	CO5	L2
53	1KT17EC403	Explain types of display presentations.	5	CO5	L2
54	1KT17EC406	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
55	1KT17EC408	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2
56	1KT16EC079	Explain principle behind the operation of duplexers and receiver protectors.	5	CO5	L4
57	1KT16EC080	Explain steering of a linear array with variable phase shifters.	5	CO5	L2
58	1KT16EC425	Explain noise figure and noise temperature of a receiver system.	5	CO5	L2

F. EXAM PREPARATION

1. University Model Question Paper

Course:	RADAR SYSTEMS					Month / Year	/2018	
Crs Code:	15EC833	Sem:	8	Marks:	100	Time:	180 minutes	
-	**Note**	Answer all FIVE full questions. All questions carry equal marks.				**Marks**	**CO**	**Level**
		MODULE 1						
1	a	Explain the basic principle of radar operation with a neat block diagram.				8	CO1	L2
	b	Explain various applications of radar				8	CO1	L2
		OR						
2	a	Derive the expression for simple form of radar equation.				8	CO1	L2

	b	Define maximum unambiguous range of radar and mention radar frequencies.	8	CO1	L3
		MODULE 2			
3	a	Explain the various receiver signal to noise ratio.	8	CO2	L2
	b	Mention the common parameters of pulse radar.	8	CO2	L2
		OR			
4	a	Explain the various system losses in a radar system.	8	CO2	L2
	b	Define swerling target models..	8	CO2	L2
		MODULE 3			
5	a	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.	8	CO3	L4
	b	Differentiate between MTI and pulse Doppler Radar	8	CO3	L2
		OR			
6	a	Explain the principle of double line canceller with necessary equation and waveform.	8	CO3	L2
	b	Describe the parameters and limitations of MTI radar.	8	CO3	L2
		MODULE 4			
7	a	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	8	CO4	L2
	b	Mention the types of tracking radar systems.	8	CO4	L4
		OR			
8	a	Explain the principle of a conical scan radar system.	8	CO4	L2
	b	Define sequential lobe and its applications.	8	CO4	L2
		MODULE 5			
9	a	Describe the functions of radar antenna.	8	CO5	L2
-	b	Explain reflector antenna.	8	CO5	L2
		OR			
10	a	Explain the antenna parameters.	8	CO5	L2
	b	Explain super heterodyne receiver.	8	CO5	L2

2. SEE Important Questions

Course:	RADAR SYSTEMS					Month / Year	/2018	
Crs Code:	15EC833	Sem:	8	Marks:	100	Time:	180 minutes	
-	**Note**	Answer all FIVE full questions. All questions carry equal marks.				**Marks**	**CO**	**Level**
		MODULE 1						
1	a	Explain the basic principle of radar operation with a neat block diagram.				8	CO1	L2
	b	Explain various applications of radar				8	CO1	L2
		OR						
2	a	Derive the expression for simple form of radar equation.				8	CO1	L2
	b	Define maximum unambiguous range of radar and mention radar frequencies.				8	CO1	L3
		MODULE 2						
3	a	Explain the various receiver signal to noise ratio.				8	CO2	L2
	b	Mention the common parameters of pulse radar.				8	CO2	L2
		OR						
4	a	Explain the various system losses in a radar system.				8	CO2	L2
	b	Define swerling target models..				8	CO2	L2
		MODULE 3						
5	a	Draw the block diagram of MTI Radar with power amplifier transmitter and explain its operations.				8	CO3	L4

	b	Differentiate between MTI and pulse Doppler Radar	8	CO3	L2
		OR			
6	a	Explain the principle of double line canceller with necessary equation and waveform.	8	CO3	L2
	b	Describe the parameters and limitations of MTI radar.	8	CO3	L2
		MODULE 4			
7	a	Explain the principle of amplitude comparison mono pulse tracking radar with a diagram	8	CO4	L2
	b	Mention the types of tracking radar systems.	8	CO4	L4
		OR			
8	a	Explain the principle of a conical scan radar system.	8	CO4	L2
	b	Define sequential lobe and its applications.	8	CO4	L2
		MODULE 5			
9	a	Describe the functions of radar antenna.	8	CO5	L2
-	b	Explain reflector antenna.	8	CO5	L2
		OR			
10	a	Explain the antenna parameters.	8	CO5	L2
	b	Explain super heterodyne receiver.	8	CO5	L2