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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

15EC71 : MICROWAVE AND ANTENNAS

A. COURSE INFORMATION

1. Course Overview

Degree:	BE	Program:	EC
Year / Semester :	4/7	Academic Year:	2019-20
Course Title:	MICROWAVES AND ANTENNAS	Course Code:	15EC71
Credit / L-T-P:	4-1-0	SEE Duration:	180 Minutes
Total Contact Hours:	50 Hours	SEE Marks:	80 Marks
CIA Marks:	20 Marks	Assignment	1 / Module
Course Plan Author:	N S MYTHREYE	Sign	Dt:
Checked By:		Sign	Dt:

2. Course Content

Module	Module Content	Teaching Hours	Module Concepts	Blooms Level
1	Microwave tubes: Introduction, Reflex Klystron Oscillator, Mechanism of Oscillations, Modes of Oscillations, Mode curve. Microwave transmission lines: Microwave frequencies, devices, systems, Transmission line equation and solution, Reflection and transmission co-efficient, standing wave and standing wave ratio, Smith chart, Single stub matching	12	Klystron oscillator, Microwave transmission lines	L2, L4
2	Microwave network theory: Symmetrical Z and Y parameters for reciprocal networks, S matrix representation of multiport networks. Microwave passive devices: coaxial connectors, adapters, attenuators, phase shifters, waveguides tees, magic tees	7	Multiport networks, Microwave passive devices	L3,L2
3	Striplines: Introduction, Microstriplines, parallel strip lines, shielded striplines. Antenna Basics: Introduction, Basic Antenna Parameters, Patterns, Beam Area, Radiation Intensity, Beam Efficiency, Directivity and Gain, Antenna Apertures,	12	Striplines, Antenna parameters	L3,L3

	Effective Height, Bandwidth, Radio Communication Link, Antenna Field Zones & Polarization.			
4	Point Sources and Arrays: Introduction, Point Sources, Power Patterns, Power Theorem, Radiation Intensity, Field Patterns, Phase Patterns, Arrays of Two Isotropic Point Sources, Pattern Multiplication, Linear Arrays of n Isotropic Point Sources of equal Amplitude and Spacing. Electric Dipoles: Introduction, Short Electric Dipole, Fields of a Short Dipole (General and Far Field Analyses), Radiation Resistance of a Short Dipole, Thin Linear Antenna (Field Analyses), Radiation Resistances of Lambda/2 Antenna.	13	Array of point sources, electric dipole antennas	L3,L4
5	Loop and Horn Antenna: Introduction, Small loop, Comparison of Far fields of Small Loop and Short Dipole, The Loop Antenna General Case, Far field Patterns of Circular Loop Antenna with Uniform Current, Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current, Horn antennas Rectangular Horn Antennas. Antenna Types: Helical Antenna, Helical Geometry, Practical Design Considerations of Helical Antenna, Yagi-Uda array, Parabola General Properties, Log Periodic Antenna.	10	Loop and horn antennas, Other antenna types	L2,L2

3. Course Material

Module	Details	Available
	Text books	
1	Microwave Engineering – Annapurna Das, Sisir K Das TMH Publication, 2nd, 2010.	In Lib/ In dept
1	Microwave Devices and circuits- Liao, Pearson Education.	In Lib/ In dept
2	Microwave Engineering – Annapurna Das, Sisir K Das TMH Publication, 2nd, 2010.	In Lib/ In dept
3	Microwave Devices and circuits- Liao, Pearson Education.	In Lib/ In dept
3	Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4thSpecial Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.	In Lib/ In dept
4	Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4thSpecial Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.	In Lib/ In dept
5	Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4thSpecial Indian Edition , McGraw- Hill Education Pvt. Ltd., 2010.	In Lib/ In dept

2	Reference books	
	Microwave Engineering – David M Pozar, John Wiley India Pvt. Ltd. 3rdEdn, 2008.	In lib
	Microwave Engineering – Sushrut Das, Oxford Higher Education, 2nd Edn, 2015.	Not Available
	Antennas and Wave Propagation- Harish and Sachidananda: Oxford University Press, 2007.	In lib
3	Others (Web, Video, Simulation, Notes etc.)	
		Not Available

4. Course Prerequisites

SNo	Course Code	Course Name	Module / Topic / Description	Sem	Remarks	Blooms Level
1	15MAT 31	Mathematics-III	5/ Vector integration/Knowledge of vector analysis	3		L2
2	15IT35	Electronics Instrumentation	3/Oscilloscopes/ Knowledge of oscillators	3		L2
3	15EC36	Engineering ELectromagnetics	3/ Steady Magnetic Fields/ Knowledge of fields	3		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
15EC71.1	Comprehend the working of Klystron oscillator	5	Klystron oscillator	Lecture	Slip Test	L2
15EC71.2	Examine the transmission lines using graphical methods	7	Microwave transmission lines	Lecture/ Tutorial	Assignment	L4
15EC71.3	Implement the Z, Y and S parameters to Multiport networks	5	Multiport networks	Lecture	Assignment	L3

15EC71.4	Understand the working of microwave passive devices	2	Microwave passive devices	Lecture	Slip Test	L2
15EC71.5	Have knowledge of micro, parallel and shielded striplines	3	Striplines	Lecture	Slip test	L3
15EC71.6	Compute the antenna design characteristics using the parameters	9	Antenna parameters	Lecture/ Tutorial	Assignment	L3
15EC71.7	Extend the antenna parameters to the array of point sources	9	Array of point sources	Lecture/ Tutorial	Assignment	L3
15EC71.8	Examine the field parameters of electric dipole antennas	4	Electric dipole antennas	Lecture/ Tutorial	Assignment	L4
15EC71.9	Explain the working of horn and loop antennas	5	Loop and horn antennas	Lecture	Assignment	L2
15EC71.10	Compare the working of helical, parabola, Yagi-Uda and log-periodic antennas	5	Helical, Parabola, Yagi-Uda and Log-periodic antennas	Lecture	Assignment	L2
-	**Total**	**62**	-	-	-	-

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

2. Course Applications

SNo	Application Area	CO	Level
1	Local oscillators in radar receivers and modulators in microwave transmitters	CO1	L2
2	Propagation and transmission of high microwave frequency signals	CO2	L4
3	Conventional Radio Resources for phase control	CO3	L3
4	Services medical, security, home, entertainment, and communication industries	CO4	L2
5	Printed circuit boards of radio receivers, mother boards	CO5	L2
6	Transmission and reception of signals of any frequency	CO6	L3
7	Mathematical modeling of light, electromagnetic radiation, sound, heat, fluid pollution	CO7	L3
8	A driven element used in feeding the elaborate directional antennas like horn, yagi-uda antennas	CO8	L4
9	Horn-Transmission in wider bandwidth, increasing the directivity and reduces the spurious responses of the parabolic reflector, short range radar system(speed enforcement cameras), Loop- Finding directions in radars, aircraft and radio receivers	CO9	L2
10	Helical-Circularly polarized radio waves for satellite communication, Parabolic-	CO10	L2

	direct the radio waves in radio telescopes, Yagi-Uda-high directivity for log distance communication, Log-Periodic-Wide bandwidth UHF terrestrial TV		

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO 1	PO2	PO 3	PO 4	PO 5	PO6	PO 7	PO 8	PO9	PO 10	PO 11	PO 12	Level
15EC71.1	Comprehend the working of Klystron oscillator	3	3	-	-	-	-	-	-	-	-	-	-	L2
15EC71.2	Examine the transmission lines using graphical methods	3	3	2	2	1	-	-	-	-	-	-	-	L4
15EC71.3	Implement the Z, Y and S parameters to Multiport networks	3	3	-	-	-	-	-	-	-	-	-	-	L3
15EC71.4	Understand the working of microwave passive devices	3	2	-	-	-	-	-	-	-	-	-	-	L2
15EC71.5	Have knowledge of micro, parallel and shielded striplines	3	2	-	-	-	-	-	-	-	-	-	-	L3
15EC71.6	Compute the antenna design characteristics using the parameters	3	3	2	1	-	-	-	-	-	-	-	-	L3
15EC71.7	Extend the antenna parameters to the array of point sources	3	3	2	1	-	-	-	-	-	-	-	-	L3
15EC71.8	Examine the field parameters of electric dipole antennas	3	3	2	1	-	-	-	-	-	-	-	-	L4
15EC71.9	Explain the working of horn and loop antennas	3	2	-	-	-	-	-	-	-	-	-	-	L2
15EC71.10	Compare the working of helical, parabola, Yagi-Uda and log-periodic antennas	**3**	**2**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	L2
Note: Mention the mapping strength as 1, 2, or 3														

4. Mapping Justification

Mapping		Justification	Mapping Level
CO	**PO**	**-**	**-**
CO1	PO1	Knowledge of klystron oscillator is required in building complex systems like satellite communication and space ships...	
CO1	PO2	Analysing problem in microwave systems require knowledge of	

		klystron oscillator	
CO2	PO1	The transmission line concept is necessary in the encrypted data transmission technology at high frequencies	
CO2	PO2	Needed in formulating the transmission line problems	
CO2	PO3	Design and development of data transmission systems at high frequencies need the knowledge of transmission lines	
CO2	PO4	Experimenting the concept for complex problems using graphical methods	
CO2	PO5	A graphical method is used. Can be implemented in Smith chart software	
CO3	PO1	The solution of Z, Y and S parameters are used in multichannel data transmission	
CO3	PO2	Used in identification of ports and its characteristics in Z, Y and S parameters	
CO4	PO1	Necessary in building complex microwave systems	
CO4	PO2	Analysis of devices and its measurements	
CO5	PO1	Used in PCB's, microwave boards, and digital systems	
CO5	PO2	Formulating the connections in the circuit boards	
CO6	PO1	Knowledge of antenna parameters are required for building complicated antenna systems.	
CO6	PO2	Analyzing problems on antenna and its parameters	
CO6	PO3	The knowledge is required to find solutions for the antenna parameters of all antennas.	
CO6	PO4	Research based knowledge on the parameters are necessary for the design of antenna and its arrays	
CO7	PO1	Knowing about the antenna arrays would help the design of antennas for RADAR applications	
CO7	PO2	Analyzing the antenna arrays in broadside and endfire directions	
CO7	PO3	Design and development of solutions for antenna arrays as point sources in broadside and endfire directions of space.	
CO7	PO4	Valid conclusions are provided for the both the broadside and endfire directions of radiation of the antenna arrays	
CO8	PO1	Used in building highly directive and secured communication systems	
CO8	PO2	Analysis of short dipole and thin linear dipole antenna characteristics	
CO8	PO3	Design and development of solutions of the dipole antennas in short range and as a thin linear array.	
CO8	PO4	The knowledge of dipole antennas helps in resolving the dipole antenna complexities	
CO9	PO1	Knowledge of these antennas are used in applications like Radio	

		broadcast, Navigation systems, Radio transmission and reception, GPS, Satellite communication, Radio frequency identification	
CO9	PO2	Analyzing the horn and loop antennas and its characteristics	
CO10	PO1	Knowledge of these antennas are used in applications like Radio broadcast, Navigation systems,Radio transmission and reception, GPS Satellite communication, Radio frequency identification	
CO10	PO2	Analyzing the parabolic, helical, log periodic, yagi uda antennas and its characteristics	

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	NOT APPLICABLE				
2					
3					
4					
5					

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

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	HFSS Tool	Presentation/ Mini Project		Self	
2	Antenna Fabrication process	Presentaion		Self	
3					
4					
5					
6					
7					
8					
9					
10					

Note: Anything not covered above is included here.

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	Microwave Tubes And Microwave Transmission Lines	12	5	-	-	1	1	2	CO1, CO2	L2, L4
2	Microwave Network Theory and Microwave Passive Devices	7	3	-	-	1	1	2	CO3, CO4	L3,L2
3	Striplines And Antenna Basics	12	-	3	-	1	1	2	CO5, CO6	L3,L3
4	Point Sources and Arrays and Electric Dipoles	13	-	6	-	1	1	2	CO7, C08	L3,L4
5	Loop and Horn Antenna And Antenna Types	10	-	-		1	1	2	CO9, CO10	L2,L2
-	**Total**	**54**				**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, CO3,Co4	L2,L4,L3,L2
CIA Exam – 2	15	CO5, CO6, CO7, C08	L2,L3,L3,L4
CIA Exam – 3	15	CO9, CO10	L2,L2
Assignment - 1	05	CO1, CO2, CO3,Co4	L2,L4,L3,L2
Assignment - 2	05	CO5, CO6, CO7, C08	L2,L3,L3,L4
Assignment - 3	05	CO9, CO10	L2,L2
Seminar - 1			
Seminar - 2			
Seminar - 3			
Other Activities – Mini	-	CO9, CO10	L2,L2

Project			
Final CIA Marks	**20**	**-**	**-**

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

D1. TEACHING PLAN - 1

Module - 1

Title:	Microwave Tubes And Microwave Transmission Lines	Appr Time:	12 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Comprehend the working of Klystron oscillator	CO1	L2
2	Examine the transmission lines using graphical methods	CO2	L4
b	*Course Schedule*	-	-
Class No	**Module Content Covered**	**CO**	**Level**
1	Introduction to microwave, Construction of Klystron Oscillators	CO1	L2
2	Mechanism of Oscillations,, Modes Of Oscillations, Mode Curve	CO1	L2
3	Introduction to Transmission lines, Microwave Frequencies, devices and systems	CO1	L2
4	Transmission Line Equations, Transmission Line Solutions	CO1	L2
5	Reflection Co-efficient, Transmission Co-efficient	CO1	L2
6	Standing Wave And Standing Wave Ratio	CO2	L2
7	Introduction to Smith chart, Construction of smith chart	CO2	L2
8	Numericals in Smith chart	CO2	L4
9	Single Stub Matching using Smith chart	CO2	L4
10	Numericals in Single Stub Matching using Smith chart	CO2	L4
11	Numericals in Transmission Lines	CO2	L3
12	Numericals in Transmission Lines	CO2	L3
c	**Application Areas**	**CO**	**Level**
1	Local oscillators in radar receivers and modulators in microwave transmitters	CO1	L2
2	Propagation and transmission of high microwave frequency signals	CO2	L4
d	**Review Questions**	-	-
1	Define microwave tube.	CO1	L2
2	Explain the construction of Reflex Klystron oscillator?	CO1	L2
3	Explain the mechanism of oscillations in Klystron oscillator?	CO1	L2
4	What is a transmission line?	CO2	L2
5	Derive the transmission line equation in voltage and current forms?	CO2	L2

6	Derive the solutions for transmission line equations?	CO2	L2
7	Define reflection co-efficient and derive an expression for the same?	CO2	L2
8	Define transmission co-efficient and derive an expression for the same?	CO2	L2
9	Explain how the standing waves are generated?	CO2	L2
10	Derive an expression for standing wave ratio?	CO2	L2
11	Explain line impedance and admittance?	CO2	L2
12	Explain the construction of smith chart using suitable expression?	CO2	L3
13	Analyze the single stub matched transmission line using smith chart?	CO2	L4
e	**Experiances**	-	-
1			
2			
3			
4			
5			

Module – 2

Title:	Microwave network theory and Microwave passive devices	Appr Time:	7 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Implement the Z, Y and S parameters to Multiport networks	CO3	L3
2	Understand the working of microwave passive devices	CO4	L2
b	*Course Schedule*	-	-
Class No	**Module Content Covered**	**CO**	**Level**
13	Introduction to microwave network theory, Symmetrical Z parameters for Reciprocal Networks	CO3	L2
14	Symmetrical Y parameters for Reciprocal Networks, S-matrix representation of multi-port networks	CO3	L2
15	Numericals in multiport networks	CO3	L3
16	Numericals in multiport networks	CO3	L3
17	Co-axial connectors and adapters	CO3	L2
18	Attenuators and phase shifters	CO4	L2
19	Waveguide tees and magic tees	CO4	L2
c	**Application Areas**	**CO**	**Level**
1	Conventional Radio Resources for phase control	CO3	L3

2	Services medical, security, home, entertainment, and communication industries	CO4	L2
d	**Review Questions**	-	-
14	Represent the reciprocal networks using symmetrical Z parameters?	CO3	L2
15	Describe the reciprocal networks using symmetrical Y parameters?	CO3	L2
16	Implement the multiport networks using S-matrix?	CO3	L2
17	Explain the working co-axial connectors, adapters, attenuators, phase shifters and waveguide tees?	CO4	L2
e	**Experiences**	-	-
1			
2			
3			
4			
5			

E1. CIA EXAM – 1

a. Model Question Paper - 1

Crs Code:	15EC71	Sem:	VII	Marks:	30	Time:	75 minutes
Course:	Microwave and Antennas						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	Explain the working of Klystron oscillator and its modes of oscillations?	5	CO1	L2
	b	Derive an expression for transmission line in voltage and current forms?	10	CO2	L2
2	a	Explain reflection and transmission co-efficients with suitable equations?	5	CO2	L2
	b	Given dVmin=18cm, l=52cm, λ/2 distance between adjacent sources, Vmin=20cm, VSWR=2.5, Zo=300. Analyze the transmission line and find the load impedance and input impedance?	10	CO2	L4
3	a	Describe the S-matrix representation of multiport networks?	5	CO3	L2
	b	Write short notes on phase shifters, adapters, attenuators and magic tees?	10	CO4	L2
4	a	Describe the Z parameters in reciprocal networks?	5	CO3	L2
	b	Derive an expression for standing wave ratio and explain?	10	CO2	L3

b. Assignment -1

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

Model Assignment Questions							
Crs Code:	15EC71	Sem:	VII	Marks:	5	Time:	90 - 120 minutes
Course:	MICROWAVE AND ANTENNAS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EC001	Explain the construction of Klystron oscillator and its mechanism of oscillations?	5	CO1	L2
2	1KT15EC003	Describe the modes of oscillations and mode curve of a klystron oscillator?	5	CO1	L2
3	1KT15EC004	Mention the microwave frequencies? Explain briefly about the microwave transmission lines, its devices and systems?	5	CO1	L2
4	1KT15EC005	Derive an expression for Microwave transmission line equations in the voltage and current forms? Explain.	5	CO2	L2
5	1KT15EC006	Derive an expression for the solution of the microwave transmission line? Explain.	5	CO2	L2
6	1KT15EC007	Bring out an expression for reflection and transmission co-efficient of a microwave transmission line?	5	CO2	L2
7	1KT15EC008	With suitable explanation derive an expression for line impedance and line admittance of a microwave transmission lines?	5	CO2	L2
8	1KT15EC009	What are standing waves? Derive an expression for the standing wave ratio and explain?	5	CO2	L2
9	1KT15EC010	Implement the construction of Smith chart?	5	CO2	L2
10	1KT15EC011	Implement the symmetric Z and Y parameters to reciprocal networks?	5	CO2	L2
11	1KT15EC012	Describe the S-matrix implementation of multiport networks?	5	CO2	L2
12	1KT15EC013	A load Z_L = 100 + j50 Ω is connected across a TL with Zo = 50 Ω and l = 0.4λ. At the generator end, d = l, the line is shunted by an impedance Z_s = 100 Ω. What are the input impedance Z_{in} and admittance Yin of the line, including the shunt connected element.	5	CO2	L4
13	1KT15EC014	The TL network described in Example 1 is connected to a generator with open circuit voltage phasor $V_g = 100\angle 0$ V and internal impedance Z_g = 25 Ω. What is the average power (a) input of the shunted line, (b) delivered to the shunt element, delivered to the load.	5	CO2	L4
14	1KT15EC015	A TL of length l = 0.3λ has an input impedance Z_{in} = 50 +	5	CO2	L4

		j50 Ω. Determine the load impedance $Z_L = Z(0)$ and $Y_L = Y(0)$ given that $Z_o = 50\ \Omega$ for the line.			
15	1KT15EC017	A TL of length $l = 0.5\lambda$ and $Z_o = 50\ \Omega$ has a load reflection coefficient $\Gamma_L = 0.5$ and and a shunt connected TL at $d = 0.2\lambda$. The shunt connected TL has $l = 0.3\lambda$, $Z_o = 50\ \Omega$, and a load reflection coefficient $\Gamma_L = -0.5$. Determine the input impedance of the line. What is the load impedance Z_Ls terminating the shunt connected stub? What is the load impedance Z_L	5	CO2	L4
16	1KT15EC019	In a lossless transmission line, the velocity of propagation is 2.5 x 10^8 m/s. Capacitance of the line is 30pF/m. Find the inductance per meter of the line, phase constant at 100MHz, Characteristics impedance of the line	5	CO2	L3
17	1KT15EC020	A 300 m long line has the following constants R=4.5kHz, L=0.15mH, G=60mmho, C=12nF operated at 6MHz frequency. Find the propagation constant, characteristic impedance and velocity of propagation.	5	CO2	L3
18	1KT15EC021	A transmission line is lossless and is 30 m long. It is terminated in the load impedance of Z_L=(30+j20)Ω at 10 MHz. The inductance and the capacitance of the line are are 100nH/m, C=20pF/m. Find the input impedance of the line at the source end and at the mid point of the line.	5	CO2	L3
19	1KT15EC022	A transmission line with a characteristic impedance of 300 ohms is terminated in a purely resistive load. It is found by measurement that the minimum line voltage upon it is 5mV and a maximum of 7.5mV. What is the value of load impedance?	5	CO2	L3
20	1KT15EC023	Determine the length and impedance of a quarter wave transformer that will match a load of 150 ohm to a line of 75ohm at a frequency of 12GHz?	5	CO2	L3
21	1KT15EC024	Explain the construction of Klystron oscillator and its mechanism of oscillations?	5	CO1	L2
22	1KT15EC025	Describe the modes of oscillations and mode curve of a klystron oscillator?	5	CO1	L2
23	1KT15EC026	Mention the microwave frequencies? Explain briefly about the microwave transmission lines, its devices and systems?	5	CO1	L2
24	1KT15EC028	Derive an expression for Microwave transmission line equations in the voltage and current forms? Explain.	5	CO2	L2
25	1KT15EC029	Derive an expression for the solution of the microwave transmission line? Explain.	5	CO2	L2
26	1KT15EC030	Bring out an expression for reflection and transmission co-efficient of a microwave transmission line?	5	CO2	L2

27	1KT15EC031	With suitable explanation derive an expression for line impedance and line admittance of a microwave transmission lines?	5	CO2	L2
28	1KT15EC032	What are standing waves? Derive an expression for the standing wave ratio and explain?	5	CO2	L2
29	1KT16EC401	Implement the construction of Smith chart?	5	CO2	L2
30	1KT16EC403	Implement the symmetric Z and Y parameters to reciprocal networks?	5	CO2	L2
31	1KT16EC406	Describe the S-matrix implementation of multiport networks?	5	CO2	L2
32	1KT16EC408	A load Z_L = 100 + j50 Ω is connected across a TL with Zo = 50 Ω and l = 0.4λ. At the generator end, d = l, the line is shunted by an impedance Z_s = 100 Ω. What are the input impedance Z_{in} and admittance Yin of the line, including the shunt connected element.	5	CO2	L4
33	1KT16EC411	The TL network described in Example 1 is connected to a generator with open circuit voltage phasor V_g = 100∠0 V and internal impedance Z_g = 25 Ω. What is the average power (a) input of the shunted line, (b) delivered to the shunt element, delivered to the load.	5	CO2	L4
34	1KT15EC036	A TL of length l = 0.3λ has an input impedance Z_{in} = 50 + j50 Ω. Determine the load impedance Z_L = Z(0) and Y_L = Y (0) given that Z_o = 50 Ω for the line.	5	CO2	L4
35	1KT15EC037	A TL of length l = 0.5λ and Z_o = 50 Ω has a load reflection coefficient Γ_L = 0.5 and and a shunt connected TL at d = 0.2λ. The shunt connected TL has l = 0.3λ, Z_o = 50 Ω, and a load reflection coefficient Γ_L = −0.5. Determine the input impedance of the line. What is the load impedance Z_Ls terminating the shunt connected stub? What is the load impedance Z_L	5	CO2	L4
36	1KT15EC038	In a lossless transmission line, the velocity of propagation is 2.5 x 10^8 m/s. Capacitance of the line is 30pF/m. Find the inductance per meter of the line, phase constant at 100MHz, Characteristics impedance of the line	5	CO2	L3
37	1KT15EC039	A 300 m long line has the following constants R=4.5kHz, L=0.15mH, G=60mmho, C=12nF operated at 6MHz frequency. Find the propagation constant, characteristic impedance and velocity of propagation.	5	CO2	L3
38	1KT15EC041	A transmission line is lossless and is 30 m long. It is terminated in the load impedance of Z_L=(30+j20)Ω at 10 MHz. The inductance and the capacitance of the line are are 100nH/m, C=20pF/m. Find the input impedance of the	5	CO2	L3

		line at the source end and at the mid point of the line.			
39	1KT15EC043	A transmission line with a characteristic impedance of 300 ohms is terminated in a purely resistive load. It is found by measurement that the minimum line voltage upon it is 5mV and a maximum of 7.5mV. What is the value of load impedance?	5	CO2	L3
40	1KT15EC044	Determine the length and impedance of a quarter wave transformer that will match a load of 150 ohm to a line of 75ohm at a frequency of 12GHz?	5	CO2	L3
41	1KT15EC045	A TL of length $l = 0.5\lambda$ and $Z_o = 50\ \Omega$ has a load reflection coefficient $\Gamma_L = 0.5$ and and a shunt connected TL at $d = 0.2\lambda$. The shunt connected TL has $l = 0.3\lambda$, $Z_o = 50\ \Omega$, and a load reflection coefficient $\Gamma_L = -0.5$. Determine the input impedance of the line. What is the load impedance Z_Ls terminating the shunt connected stub? What is the load impedance Z_L	5	CO2	L4
42	1KT15EC046	In a lossless transmission line, the velocity of propagation is 2.5×10^8 m/s. Capacitance of the line is 30pF/m. Find the inductance per meter of the line, phase constant at 100MHz, Characteristics impedance of the line	5	CO2	L3
43	1KT15EC047	A 300 m long line has the following constants R=4.5kHz, L=0.15mH, G=60mmho, C=12nF operated at 6MHz frequency. Find the propagation constant, characteristic impedance and velocity of propagation.	5	CO2	L3
44	1KT15EC048	A transmission line is lossless and is 30 m long. It is terminated in the load impedance of $Z_L=(30+j20)\Omega$ at 10 MHz. The inductance and the capacitance of the line are are 100nH/m, C=20pF/m. Find the input impedance of the line at the source end and at the mid point of the line.	5	CO2	L3
45	1KT15EC049	A transmission line with a characteristic impedance of 300 ohms is terminated in a purely resistive load. It is found by measurement that the minimum line voltage upon it is 5mV and a maximum of 7.5mV. What is the value of load impedance?	5	CO2	L3
46	1KT15EC051	Explain the construction of Klystron oscillator and its mechanism of oscillations?	5	CO1	L2
47	1KT15EC052	Describe the modes of oscillations and mode curve of a klystron oscillator?	5	CO1	L2
48	1KT15EC053	Mention the microwave frequencies? Explain briefly about the microwave transmission lines, its devices and systems?	5	CO1	L2
49	1KT15EC054	Derive an expression for Microwave transmission line equations in the voltage and current forms? Explain.	5	CO2	L2

50	1KT15EC055	Derive an expression for the solution of the microwave transmission line? Explain.	5	CO2	L2
51	1KT15EC056	Bring out an expression for reflection and transmission co-efficient of a microwave transmission line?	5	CO2	L2
52	1KT15EC058	With suitable explanation derive an expression for line impedance and line admittance of a microwave transmission lines?	5	CO2	L2
53	1KT15EC059	What are standing waves? Derive an expression for the standing wave ratio and explain?	5	CO2	L2
54	1KT15EC061	Implement the construction of Smith chart?	5	CO2	L2
55	1KT15EC062	Implement the symmetric Z and Y parameters to reciprocal networks?	5	CO2	L2
56	1KT15EC063	Describe the S-matrix implementation of multiport networks?	5	CO2	L2
57	1KT15EC064	A load Z_L = 100 + j50 Ω is connected across a TL with Zo = 50 Ω and l = 0.4λ. At the generator end, d = l, the line is shunted by an impedance Z_s = 100 Ω. What are the input impedance Z_{in} and admittance Yin of the line, including the shunt connected element.	5	CO2	L4
58	1KT15EC067	The TL network described in Example 1 is connected to a generator with open circuit voltage phasor V_g = 100∠0 V and internal impedance Z_g = 25 Ω. What is the average power (a) input of the shunted line, (b) delivered to the shunt element, delivered to the load.	5	CO2	L4
59	1KT16EC412	A TL of length l = 0.3λ has an input impedance Z_{in} = 50 + j50 Ω. Determine the load impedance Z_L = Z(0) and Y_L = Y (0) given that Z_o = 50 Ω for the line.	5	CO2	L4
60	1KT16EC416	A TL of length l = 0.5λ and Z_o = 50 Ω has a load reflection coefficient Γ_L = 0.5 and and a shunt connected TL at d = 0.2λ. The shunt connected TL has l = 0.3λ, Z_o = 50 Ω, and a load reflection coefficient Γ_L = −0.5. Determine the input impedance of the line. What is the load impedance Z_Ls terminating the shunt connected stub? What is the load impedance Z_L	5	CO2	L4
61	1KT16EC419	In a lossless transmission line, the velocity of propagation is 2.5 x 10^8 m/s. Capacitance of the line is 30pF/m. Find the inductance per meter of the line, phase constant at 100MHz, Characteristics impedance of the line	5	CO2	L3
62	1KT16EC420	A 300 m long line has the following constants R=4.5kHz, L=0.15mH, G=60mmho, C=12nF operated at 6MHz frequency. Find the propagation constant, characteristic impedance and velocity of propagation.	5	CO2	L3

63	1KT16EC421	A transmission line is lossless and is 30 m long. It is terminated in the load impedance of Z_L=(30+j20)Ω at 10 MHz. The inductance and the capacitance of the line are are 100nH/m, C=20pF/m. Find the input impedance of the line at the source end and at the mid point of the line.	5	CO2	L3
64	1KT16EC422	A transmission line with a characteristic impedance of 300 ohms is terminated in a purely resistive load. It is found by measurement that the minimum line voltage upon it is 5mV and a maximum of 7.5mV. What is the value of load impedance?	5	CO2	L3
65	1KT16EC423	Determine the length and impedance of a quarter wave transformer that will match a load of 150 ohm to a line of 75ohm at a frequency of 12GHz?	5	CO2	L3
66	1KT16EC424	The TL network described in Example 1 is connected to a generator with open circuit voltage phasor V_g = 100∠0 V and internal impedance Z_g = 25 Ω. What is the average power (a) input of the shunted line, (b) delivered to the shunt element, delivered to the load.	5	CO2	L4
67	1KT16EC426	A TL of length l = 0.3λ has an input impedance Z_{in} = 50 + j50 Ω. Determine the load impedance Z_L = Z(0) and Y_L = Y (0) given that Z_o = 50 Ω for the line.	5	CO2	L4
68	1KT14EC067	A TL of length l = 0.5λ and Z_o = 50 Ω has a load reflection coefficient Γ_L = 0.5 and and a shunt connected TL at d = 0.2λ. The shunt connected TL has l = 0.3λ, Z_o = 50 Ω, and a load reflection coefficient Γ_L = −0.5. Determine the input impedance of the line. What is the load impedance Z_Ls terminating the shunt connected stub? What is the load impedance Z_L	5	CO2	L4

D2. TEACHING PLAN - 2

Module - 3

Title:	Striplines And Antenna Basics	Appr Time:	12 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Have knowledge of micro, parallel and shielded striplines	CO5	L2
2	Compute the antenna design characteristics using the parameters	CO6	L3
b	*Course Schedule*		
Class No	**Module Content Covered**	**CO**	**Level**

20	Introduction to striplines, Characteristic impedance and effective dielectric of striplines	CO5	L3
21	Losses in microstriplines and quality factor, Parallel striplines	CO5	L3
22	Coplanar striplines and shielded striplines	CO5	L3
23	Introduction to antennas	CO6	L2
24	Radiation patterns, Radiation intensity	CO6	L2
25	Beam width, Radian and Steradian, Beam area, Beam efficiency	CO6	L2
26	Directivity, Gain and Resolution	CO6	L2
27	Antenna Aperture, Maximum power transfer, Antenna bandwidth, Radio communication link	CO6	L2
28	Effective height, Antenna efficiency, Antenna Field Zones and Polarization	CO6	L2
29	Numericals on antenna parameters	CO6	L3
30	Numericals on antenna parameters	CO6	L3
31	Numericals on antenna parameters	CO6	L3
c	**Application Areas**	**CO**	**Level**
1	Printed circuit boards of radio receivers, mother boards	CO5	L2
2	Transmission and reception of signals of any frequency	CO6	L3
d	**Review Questions**	-	-
18	Explain with suitable expressions the characteristic impedance and effective dielectric of striplines?	CO1	L1
19	Summarize the losses in microstriplines and derive an expression for quality factor of a microstripline?	CO1	L3
20	Explain in detail the Parallel striplines?	CO2	L2
21	Describe with suitable expressions the coplanar and shielded striplines	CO2	L2
22	Compare the different radiation patterns of the antenna	CO2	L2
23	Review the radiation intensity and beam width of an antenna	CO2	L2
24	Compute the expressions for Radian and Steradian	CO2	L2
25	Associate and explain beam area and beam efficiency of an antenna	CO2	L2
26	Derive suitable expressions for directivity and gain of an antenna	CO2	L2
27	What is an antenna Aperture? Explain the physical and effective apertures?	CO2	L2
28	Define antenna bandwidth with suitable expressions?	CO2	L2
29	Derive suitable expressions for effective height and antenna efficiency of an antenna?	CO2	L2
30	Summarize the antenna Field Zones and Polarization concept?	CO2	L2
31	Explain radio communication link with suitable diagram?	CO2	L2

e	**Experiances**	-	-
1			
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5			

Module – 4

Title:	Antenna Point sources and Arrays And Electric DIpoles	Appr Time:	13 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Extend the antenna parameters to the array of point sources	CO7	L3
2	Examine the field parameters of electric dipole antennas	CO8	L4
b	*Course Schedule*		
Class No	**Module Content Covered**	**CO**	**Level**
32	Introduction to point sources, power theorem, power patterns, Radiation intensity	CO7	L3
33	Directivity of directional power patterns, Directivity of bidirectional power patterns	CO7	L3
34	Field patterns and its application, Introduction to antenna arrays	CO7	L3
35	Array of two isotropic point sources, same amplitude and phase, same amplitude and opposite phase	CO7	L3
36	Array of two isotropic point sources, same amplitude and quadrature phase, general case, Pattern multiplication	CO7	L3
37	Linear array of n isotropic point sources of equal amplitude and spacing: Broad side, end fire and extended endfire array cases	CO7	L3
38	Linear array of n isotropic point sources of equal amplitude and spacing: extended endfire array cases	CO7	L3
39	Numericals on point sources	CO7	L3
40	Numericals on point sources	CO7	L3
41	Introduction to short electric dipoles, Fields of a short dipole.	CO8	L4
42	Radiation resistance of short dipole	CO8	L4
43	Radiation resistance of thin linear antenna	CO8	L4
44	Radiation resistance of lambda/2 dipole	CO8	L4
c	**Application Areas**	**CO**	**Level**
1	Mathematical modeling of light, electromagnetic radiation, sound,	CO7	L3

	heat, fluid pollution		
2	A driven element used in feeding the elaborate directional antennas like horn, yagi-uda antennas	CO8	L4
d	**Review Questions**	-	-
32	What are point sources? Derive an expression for power theorem?	CO7	L3
33	Distinguish between the power patterns and field patterns?	CO7	L3
34	What is pattern multiplication? Explain with suitable expressions the array of two isotropic point sources with same amplitude and phase?	CO7	L3
35	Explain with suitable expressions the array of two isotropic point sources with same amplitude and opposite phase?	CO7	L3
36	Explain with suitable expressions the array of two isotropic point sources with same amplitude and quadrature phase?	CO7	L3
37	Explain the array of n isotropic point sources of equal amplitude and phase for broadside, endfire and extended end fire cases	CO7	L3
38	Define the fields of a short dipole?	CO8	L4
39	Derive an expression for the radiation resistance of a short dipole	CO8	L4
40	Derive an expression for the radiation resistance of thin linear antennas	CO8	L4
41	Derive an expression for the radiation resistance of a lambda/2 antenna	CO8	L4
e	**Experiences**	-	-
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5			

E2. CIA EXAM – 2

a. Model Question Paper - 2

Crs Code:	15EC71	Sem:	VII	Marks:	30	Time:	75 minutes
Course:	MICROWAVE AND ANTENNAS						

-	-	Note: Answer any 2 questions, each carry equal marks.	Marks	CO	Level
1	a	List and explain the types of striplines?	7	CO5	L2
	b	Define the following terms with respect to antenna: I) Directivity ii) Radiation resistance iii) Effective height iv) antenna aperture	8	CO6	L3
2	a	The power received by the receiving antenna at a distance of 0.5 km	5	CO6	L3

		over free space at a frequency of 1GHz is 01.8Mw. Calculate the input to the transmitting antenna if gain of transmitting antenna and receiving antenna is 25dB and 20dB respectively. The gain is with respect to isotropic sources			
	b	State and explain the power theorems in terms of power density and radiation intensity	5	CO7	L3
	c	Show that the exact directivity of unidirectional pattern $U=U_m \cos^n\phi$	5	CO7	L3
3	a	Extract the field pattern for the array of two isotropic point sources of same amplitude and opposite phase?	7	CO7	L3
	b	Derive an expression for the radiation resistance of the Hertzian dipole antenna	8	CO8	L4
4	a	Extract the field pattern for the ordinary linear end fire array of n isotropic point sources of equal amplitude and spacing	7	CO7	L3
	b	Prove that the radiation resistance of a thin linear antenna is 75 ohm	8	CO8	L4

b. Assignment – 2

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

Model Assignment Questions							
Crs Code:	15EC71	Sem:	VII	Marks:	5	Time:	90 – 120 minutes
Course:	MICROWAVES AND ANTENNAS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EC001	A short antenna with a uniform current distribution in free space has $IdL=3x10^{-4}$ Am. Calculate the $\|E_\theta\|$ for θ=90° and ϕ=0°. If λ= 10cm and r=200cm assuming far field components	5	CO7	L3
2	1KT15EC003	The radiation resistance of an antenna is 72Ω and the loss resistance is 8Ω. What is the directivity if the gain is 30	5	CO7	L3
3	1KT15EC004	Calculate the radiation resistance of λ/10 wire dipole in free space	5	CO7	L3
4	1KT15EC005	Find the current required to radiate a power of 100W at 100MHz from a 0.01m Hertzian dipole	5	CO7	L3
5	1KT15EC006	Explain with suitable expressions the array of two isotropic point sources with same amplitude and opposite phase?	5	CO7	L3
6	1KT15EC007	An antenna receives a maximum power of 2μW from a radio station. Calculate its maximum effective area if the antenna is located in the far field of the station where |E| = 50mV/m	5	CO7	L3
7	1KT15EC008	A microwave relay link is to be designed such that the		CO7	L3

		transmitting and receiving antennas are separated by 30 miles. The directive gains of both the antennas are equal to 45dB. Assuming both antennas lossless and matched at 3 GHz, find what power is transmitted by the transmitter to have received power in 1mW			
8	1KT15EC009	Explain with suitable expressions the array of two isotropic point sources with same amplitude and quadrature phase?	5	CO7	L3
9	1KT15EC010	Explain the array of n isotropic point sources of equal amplitude and phase for broadside, endfire and extended end fire cases	5	CO7	L3
10	1KT15EC011	Define the fields of a short dipole?	5	CO8	L4
11	1KT15EC012	Derive an expression for the radiation resistance of a short dipole	5	CO8	L4
12	1KT15EC013	Derive an expression for the radiation resistance of thin linear antennas	5	CO8	L4
13	1KT15EC014	Derive an expression for the radiation resistance of a lambda/2 antenna	5	CO8	L4
14	1KT15EC015	A short antenna with a uniform current distribution in free space has $IdL=3x10^{-4}$ Am. Calculate the $\|E_\theta\|$ for $\theta=90°$ and $\phi=0°$. If $\lambda=$ 10cm and r=200cm assuming far field components	5	CO7	L3
15	1KT15EC017	The radiation resistance of an antenna is 72Ω and the loss resistance is 8Ω. What is the directivity if the gain is 30	5	CO7	L3
16	1KT15EC019	Calculate the radiation resistance of $\lambda/10$ wire dipole in free space	5	CO7	L3
17	1KT15EC020	Find the current required to radiate a power of 100W at 100MHz from a 0.01m Hertzian dipole	5	CO7	L3
18	1KT15EC021	Explain with suitable expressions the array of two isotropic point sources with same amplitude and opposite phase?	5	CO7	L3
19	1KT15EC022	An antenna receives a maximum power of 2μW from a radio station. Calculate its maximum effective area if the antenna is located in the far field of the station where $\|E\|$ = 50mV/m	5	CO1	L1
20	1KT15EC023	A microwave relay link is to be designed such that the transmitting and receiving antennas are separated by 30 miles. The directive gains of both the antennas are equal to 45dB. Assuming both antennas lossless and matched at 3 GHz, find what power is transmitted by the transmitter to have received power in 1mW	5	CO7	L3
21	1KT15EC024	If the noise figure of the antenna at room temperature is 1.1dB, what is the effective noise temperature	5	CO7	L3
22	1KT15EC025	Determine maximum effective aperture of an antenna	5	CO7	L3

		having small side lobes. The half power beam widths in the perpendicular planes intersecting in beam axis is 35° and 40°			
23	1KT15EC026	A linear array consists of four equal isotropic inphase point sources with spacing equal to λ/3. Calculate the directivity and beamwidth if the total length of the array is λ	5	CO8	L3
24	1KT15EC028	An end fire array with elements spaced at λ/2 and with axes of elements at right angles to the line of array is required to have directivity of 36. Determine array alength and width of major lobe.	5	CO8	L3
25	1KT15EC029	Compute the expressions for Radian and Steradian	5	CO7	L2
26	1KT15EC030	Associate and explain beam area and beam efficiency of an antenna	5	CO7	L2
27	1KT15EC031	For two element array consisting identical radiators carrying equal currents in phase, obtain positions of maxima and minima of the radiation pattern if the distance of seperation d= λ	5	CO8	L3
28	1KT15EC032	Explain the principle of Pattern multiplication.	5	CO8	L3
29	1KT16EC401	What are point sources? Derive an expression for power theorem?	5	CO7	L3
30	1KT16EC403	Distinguish between the power patterns and field patterns?	5	CO8	L2
31	1KT16EC406	What is pattern multiplication? Explain with suitable expressions the array of two isotropic point sources with same amplitude and phase?	5	CO8	L2
32	1KT16EC408	A broadside array of identical antennas consists 8 isotropic radiators separated by distance λ/2. Find the radiation field in a plane containing the line of array showing directions of maxima and null	5	CO8	L3
33	1KT16EC411	Summarize the losses in microstriplines and derive an expression for quality factor of a microstripline?	5	CO5	L2
34	1KT15EC036	Explain in detail the Parallel striplines?	5	CO5	L2
35	1KT15EC037	Describe with suitable expressions the coplanar and shielded striplines	5	CO5	L2
36	1KT15EC038	Compare the different radiation patterns of the antenna	5	CO6	L2
37	1KT15EC039	Review the radiation intensity and beam width of an antenna	5	CO6	L2
38	1KT15EC041	Find the length and BFWN for broadside and endfire array if the directive gain is 15	5	CO8	L3
39	1KT15EC043	Calculate the radiation resistance of a dipole antenna of length λ/8m.	5	CO8	L3
40	1KT15EC044	Calculate the radiation resistance of an antenna of length λ/10m and λ/50m	5	CO8	L3

41	1KT15EC045	A magnetic field strength of 5μA/m is required at a point on θ=π/2, 2 km away from an antenna in free space. Neglecting ohmic loss, how much power must the antenna transmit if it is, I) a Hertzian dipole of length λ/25 ii) a half wave dipole iiii) a quarter wave dipole	5	CO8	L3
42	1KT15EC046	Determine maximum effective aperture of an antenna having small side lobes. The half power beam widths in the perpendicular planes intersecting in beam axis is 35° and 40°	5	CO7	L3
43	1KT15EC047	A linear array consists of four equal isotropic inphase point sources with spacing equal to λ/3. Calculate the directivity and beamwidth if the total length of the array is λ	5	CO8	L3
44	1KT15EC048	An end fire array with elements spaced at λ/2 and with axes of elements at right angles to the line of array is required to have directivity of 36. Determine array alength and width of major lobe.	5	CO8	L3
45	1KT15EC049	Define antenna bandwidth with suitable expressions?	5	CO6	L2
46	1KT15EC051	Derive suitable expressions for effective height and antenna efficiency of an antenna?	5	CO6	L2
47	1KT15EC052	Summarize the antenna Field Zones and Polarization concept?	5	CO6	L2
48	1KT15EC053	Explain radio communication link with suitable diagram?	5	CO6	L2
49	1KT15EC054	Find the length and BFWN for broadside and endfire array if the directive gain is 15	5	CO8	L3
50	1KT15EC055	Calculate the radiation resistance of a dipole antenna of length λ/8m.	5	CO8	L3
51	1KT15EC056	Calculate the radiation resistance of an antenna of length λ/10m and λ/50m	5	CO8	L3
52	1KT15EC058	A magnetic field strength of 5μA/m is required at a point on θ=π/2, 2 km away from an antenna in free space. Neglecting ohmic loss, how much power must the antenna transmit if it is, I) a Hertzian dipole of length λ/25 ii) a half wave dipole iiii) a quarter wave dipole	5	CO8	L3
53	1KT15EC059	Calculate the dimensions of a half wave dipole antenna operating at 100MHz in the free space . What is its radiation resistance . Give the total power radiated if it is fed with a current of amplitude 25A	5	CO8	L3
54	1KT15EC061	Explain the principle of Pattern multiplication.	5	CO7	L2
55	1KT15EC062	What are point sources? Derive an expression for power theorem?	5	CO7	L3
56	1KT15EC063	Distinguish between the power patterns and field patterns?	5	CO7	L3
57	1KT15EC064	What is pattern multiplication? Explain with suitable	5	CO7	L3

		expressions the array of two isotropic point sources with same amplitude and phase?			
58	1KT15EC067	A magnetic field strength of 5μA/m is required at a point on θ=π/2, 2 km away from an antenna in free space. Neglecting ohmic loss, how much power must the antenna transmit if it is, I) a Hertzian dipole of length λ/25 ii) a half wave dipole iiii) a quarter wave dipole	5	CO8	L3
59	1KT16EC412	Calculate the dimensions of a half wave dipole antenna operating at 100MHz in the free space . What is its radiation resistance . Give the total power radiated if it is fed with a current of amplitude 25A	5	CO8	L3
60	1KT16EC416	Derive suitable expressions for directivity and gain of an antenna	5	CO6	L2
61	1KT16EC419	What is an antenna Aperture? Explain the physical and effective apertures?	5	CO6	L2
62	1KT16EC420	Sketch the radiation pattern of a two element array having identical radiators spaced λ/4 apart and current in one radiator lags behind other by 90°	5	CO7	L3
63	1KT16EC421	Find the minimum spacing between the elements in a broadside array of 10 isotropic radiators to have directivity of 7dB	5	CO7	L3
64	1KT16EC422	A uniform linear array consists 16 isotropic point sources with a spacing of λ/4. If the phase difference is 90°, claculate I) HPBW, ii) Directivity iii) Beam solid angle iv) effective aperture	5	CO7	L3
65	1KT16EC423	Derive Hansen-Woodyard condition for n element end fire array for enhancing its directivity	5	CO7	L2
66	1KT16EC424	A magnetic field strength of 5μA/m is required at a point on θ=π/2, 2 km away from an antenna in free space. Neglecting ohmic loss, how much power must the antenna transmit if it is, I) a Hertzian dipole of length λ/25 ii) a half wave dipole iiii) a quarter wave dipole	5	CO8	L3
67	1KT16EC426	Determine maximum effective aperture of an antenna having small side lobes. The half power beam widths in the perpendicular planes intersecting in beam axis is 35° and 40°	5	CO7	L3
68	1KT14EC067	A linear array consists of four equal isotropic inphase point sources with spacing equal to λ/3. Calculate the directivity and beamwidth if the total length of the array is λ	5	CO8	L3

D3. TEACHING PLAN - 3

Module – 5

Title:	LOOP AND HORN ANTENNA AND ANTENNA TYPES	Appr Time:	10 Hrs
a	*Course Outcomes*	-	**Blooms**
-	The student should be able to:	-	**Level**
1	Explain the working of horn and loop antennas	CO9	L2
2	Compare the working of helical, parabola, Yagi-Uda and log-periodic antennas	CO10	L2
b	*Course Schedule*		
Class No	**Module Content Covered**	**CO**	**Level**
45	Introduction, Small loop, Comparison of Far fields of Small Loop and Short Dipole	CO9	L2
46	The Loop Antenna General Case	CO9	L2
47	Far field Patterns of Circular Loop Antenna with Uniform Current	CO9	L2
48	Radiation Resistance of Loops, Directivity of Circular Loop Antennas with Uniform Current	CO9	L2
49	Horn antennas Rectangular Horn Antennas.	CO9	L2
50	Helical Antenna, Helical Geometry	CO10	L2
51	Practical Design Considerations of Helical Antenna	CO10	L2
52	Yagi-Uda array	CO10	L2
53	Parabola General Properties	CO10	L2
54	Log Periodic Antenna	CO10	L2
c	**Application Areas**	**CO**	**Level**
1	Horn-Transmission in wider bandwidth, increasing the directivity and reduces the spurious responses of the parabolic reflector, short range radar system(speed enforcement cameras), Loop- Finding directions in radars, aircraft and radio receivers	CO9	L2
2	Helical-Circularly polarized radio waves for satellite communication, Parabolic-direct the radio waves in radio telescopes, Yagi-Uda-high directivity for log distance communication, Log-Periodic-Wide bandwidth UHF terrestrial TV	CO10	L2
d	**Review Questions**	-	-
42	Define and Explain loop antenna for different shapes?	CO9	L2
43	Obtain the field pattern of the transmitting loop antenna?	CO9	L2
44	Derive expressions for field components of the loop antenna?	CO9	L2
45	Obtain the expressions for the radiation resistance of the loop	CO9	L2

	antenna		
46	Discuss the different cases for the loop antennas for the calculation of the directivity of the same	CO9	L2
47	List and explain the applications of the loop antenna.	CO9	L2
48	Explain the Babinet's principles for the electromagnetic fields	CO9	L2
49	Explain how horn antennas are constructed. Explain the differnet types of horn antenna.	CO9	L2
50	Derive design equations for the horn antenna	CO9	L2
51	Derive expressions for the field at a point on the axis of E-plane sectoral horn.	CO9	L2
52	Explain how GPR systems differ than the general radar systems. What are the different considerations for antenna used in GPR systems	CO10	L2
53	What is log periodic antenna? Explain with neat sketch the log periodic antenna?	CO10	L2
54	Explain the structure of helix in helical antenna using neat sketches of perpendicular and end fire modes.	CO10	L2
55	What is a parasitic element? Explain with a neat sketch the array of parasitic elements?	CO10	L2
56	Derive an expression for the gain of two element parasitic array in free space with $\lambda/2$ dipole as driven element?	CO10	L2
57	Explain in detail, the yagi-uda antenna. Write the design equations for dimensions of different elements of antenna	CO10	L2
58	Write a note on paraboloid? Explain the principle of parabolic reflector with the help of a neat diagram.	CO10	L2
59	Explain the reflector and director actions of yagi-uda antenna	CO10	L2
60	Mention the applications of helical, log periodic, parabolic and yagi-uda antennas	CO10	L2
e	**Experiences**	-	-
1		CO10	L2
2			
3			
4		CO9	L3
5			

E3. CIA EXAM – 3

a. Model Question Paper - 3

Crs Code:	15EC71	Sem:	VII	Marks:	30	Time:	75 minutes
Course:	MICROWAVE AND ANTENNAS						

-	-	**Note: Answer any 2 questions, each carry equal marks.**	**Mark**	**CO**	**Level**

			s		
1	a	Obtain the field pattern of the transmitting loop antenna?	5	CO9	L2
	b	Derive expressions for field components of the loop antenna?	5	CO9	L2
	c	Obtain the expressions for the radiation resistance of the loop antenna	5	CO9	L2
2	a	Explain the Babinet's principles for the electromagnetic fields	5	CO9	L2
	b	Explain how horn antennas are constructed. Explain the differnet types of horn antenna.	5	CO9	L2
	c	Derive design equations for the horn antenna	5	CO9	L2
3	a	Calculate the directivity of 20 turn helix with $\alpha=12°$ and circumference equal to one wavelength	5	CO10	L2
	b	Explain in detail, the yagi-uda antenna. Write the design equations for dimensions of different elements of antenna	5	CO10	L2
	c	Write a note on paraboloid? Explain the principle of parabolic reflector with the help of a neat diagram.	5	CO10	L2
4	a	For a 20 turn helical antenna operating at 3GHz with the circumference of 10cm and spacing between the turns 0.3λ is operating at 3GHz. Calculate the directivity and half power beam width.	5	CO10	L2
	b	What is log periodic antenna? Explain with neat sketch the log periodic antenna?	5	CO10	L2
	c	Explain the structure of helix in helical antenna using neat sketches of perpendicular and end fire modes.	5	CO10	L2

b. Assignment – 3

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

Model Assignment Questions							
Crs Code:	15EC71	Sem:	VII	Marks:	5	Time:	90 – 120 minutes
Course:	MICROWAVE AND ANTENNAS						
Note: Each student to answer 2-3 assignments. Each assignment carries equal mark.							

SNo	USN	Assignment Description	Marks	CO	Level
1	1KT15EC001	For a 20 turn helical antenna operating at 3GHz with the circumference of 10cm and spacing between the turns 0.3λ is operating at 3GHz. Calculate the directivity and half power beam width.	5	CO10	L2
2	1KT15EC003	Calculate the directivity of 20 turn helix with $\alpha=12°$ and circumference equal to one wavelength	5	CO10	L2

3	1KT15EC004	Define and Explain loop antenna for different shapes?	5	CO9	L2
4	1KT15EC005	Obtain the field pattern of the transmitting loop antenna?	5	CO9	L2
5	1KT15EC006	Derive expressions for field components of the loop antenna?	5	CO9	L2
6	1KT15EC007	Obtain the expressions for the radiation resistance of the loop antenna	5	CO9	L2
7	1KT15EC008	Discuss the different cases for the loop antennas for the calculation of the directivity of the same	5	CO9	L2
8	1KT15EC009	List and explain the applications of the loop antenna.	5	CO9	L2
9	1KT15EC010	Explain the Babinet's principles for the electromagnetic fields	5	CO9	L2
10	1KT15EC011	Explain how horn antennas are constructed. Explain the differnet types of horn antenna.	5	CO9	L2
11	1KT15EC012	Derive design equations for the horn antenna	5	CO9	L2
12	1KT15EC013	Derive expressions for the field at a point on the axis of E-plane sectoral horn.	5	CO9	L2
13	1KT15EC014	Explain how GPR systems differ than the general radar systems. What are the different considerations for antenna used in GPR systems	5	CO10	L2
14	1KT15EC015	What is log periodic antenna? Explain with neat sketch the log periodic antenna?	5	CO10	L2
15	1KT15EC017	Explain the structure of helix in helical antenna using neat sketches of perpendicular and end fire modes.	5	CO10	L2
16	1KT15EC019	What is a parasitic element? Explain with a neat sketch the array of parasitic elements?	5	CO10	L2
17	1KT15EC020	Derive an expression for the gain of two element parasitic array in free space with $\lambda/2$ dipole as driven element?	5	CO10	L2
18	1KT15EC021	Explain in detail, the yagi-uda antenna. Write the design equations for dimensions of different elements of antenna	5	CO10	L2
19	1KT15EC022	Write a note on paraboloid? Explain the principle of parabolic reflector with the help of a neat diagram.	5	CO10	L2
20	1KT15EC023	Explain the reflector and director actions of yagi-uda antenna	5	CO10	L2
21	1KT15EC024	Mention the applications of helical, log periodic, parabolic and yagi-uda antennas	5	CO10	L2
22	1KT15EC025	For a 20 turn helical antenna operating at 3GHz with the circumference of 10cm and spacing between the turns 0.3λ is operating at 3GHz. Calculate the directivity and half power beam width.	5	CO10	L2
23	1KT15EC026	Calculate the directivity of 20 turn helix with $\alpha=12°$ and circumference equal to one wavelength	5	CO10	L2
24	1KT15EC028	Define and Explain loop antenna for different shapes?	5	CO9	L2

25	1KT15EC029	Obtain the field pattern of the transmitting loop antenna?	5	CO9	L2
26	1KT15EC030	Derive expressions for field components of the loop antenna?	5	CO9	L2
27	1KT15EC031	Obtain the expressions for the radiation resistance of the loop antenna	5	CO9	L2
28	1KT15EC032	Discuss the different cases for the loop antennas for the calculation of the directivity of the same	5	CO9	L2
29	1KT16EC401	List and explain the applications of the loop antenna.	5	CO9	L2
30	1KT16EC403	Explain the Babinet's principles for the electromagnetic fields	5	CO9	L2
31	1KT16EC406	Explain how horn antennas are constructed. Explain the differnet types of horn antenna.	5	CO9	L2
32	1KT16EC408	Derive design equations for the horn antenna	5	CO9	L2
33	1KT16EC411	Derive expressions for the field at a point on the axis of E-plane sectoral horn.	5	CO9	L2
34	1KT15EC036	Explain how GPR systems differ than the general radar systems. What are the different considerations for antenna used in GPR systems	5	CO10	L2
35	1KT15EC037	What is log periodic antenna? Explain with neat sketch the log periodic antenna?	5	CO10	L2
36	1KT15EC038	Explain the structure of helix in helical antenna using neat sketches of perpendicular and end fire modes.	5	CO10	L2
37	1KT15EC039	What is a parasitic element? Explain with a neat sketch the array of parasitic elements?	5	CO10	L2
38	1KT15EC041	Derive an expression for the gain of two element parasitic array in free space with $\lambda/2$ dipole as driven element?	5	CO10	L2
39	1KT15EC043	Explain in detail, the yagi-uda antenna. Write the design equations for dimensions of different elements of antenna	5	CO10	L2
40	1KT15EC044	Write a note on paraboloid? Explain the principle of parabolic reflector with the help of a neat diagram.	5	CO10	L2
41	1KT15EC045	Explain the reflector and director actions of yagi-uda antenna	5	CO10	L2
42	1KT15EC046	Mention the applications of helical, log periodic, parabolic and yagi-uda antennas	5	CO10	L2
43	1KT15EC047	For a 20 turn helical antenna operating at 3GHz with the circumference of 10cm and spacing between the turns 0.3λ is operating at 3GHz. Calculate the directivity and half power beam width.	5	CO10	L2
44	1KT15EC048	Calculate the directivity of 20 turn helix with $\alpha=12^{\circ}$ and circumference equal to one wavelength	5	CO10	L2
45	1KT15EC049	Define and Explain loop antenna for different shapes?	5	CO9	L2
46	1KT15EC051	Obtain the field pattern of the transmitting loop antenna?	5	CO9	L2

47	1KT15EC052	Derive expressions for field components of the loop antenna?	5	CO9	L2
48	1KT15EC053	Obtain the expressions for the radiation resistance of the loop antenna	5	CO9	L2
49	1KT15EC054	Discuss the different cases for the loop antennas for the calculation of the directivity of the same	5	CO9	L2
50	1KT15EC055	List and explain the applications of the loop antenna.	5	CO9	L2
51	1KT15EC056	Explain the Babinet's principles for the electromagnetic fields	5	CO9	L2
52	1KT15EC058	Explain how horn antennas are constructed. Explain the differnet types of horn antenna.	5	CO9	L2
53	1KT15EC059	Derive design equations for the horn antenna	5	CO9	L2
54	1KT15EC061	Derive expressions for the field at a point on the axis of E-plane sectoral horn.	5	CO9	L2
55	1KT15EC062	Explain how GPR systems differ than the general radar systems. What are the different considerations for antenna used in GPR systems	5	CO10	L2
56	1KT15EC063	What is log periodic antenna? Explain with neat sketch the log periodic antenna?	5	CO10	L2
57	1KT15EC064	Explain the structure of helix in helical antenna using neat sketches of perpendicular and end fire modes.	5	CO10	L2
58	1KT15EC067	What is a parasitic element? Explain with a neat sketch the array of parasitic elements?	5	CO10	L2
59	1KT16EC412	Derive an expression for the gain of two element parasitic array in free space with $\lambda/2$ dipole as driven element?	5	CO10	L2
60	1KT16EC416	Explain in detail, the yagi-uda antenna. Write the design equations for dimensions of different elements of antenna	5	CO10	L2
61	1KT16EC419	Write a note on paraboloid? Explain the principle of parabolic reflector with the help of a neat diagram.	5	CO10	L2
62	1KT16EC420	Explain the reflector and director actions of yagi-uda antenna	5	CO10	L2
63	1KT16EC421	Mention the applications of helical, log periodic, parabolic and yagi-uda antennas	5	CO10	L2
64	1KT16EC422	For a 20 turn helical antenna operating at 3GHz with the circumference of 10cm and spacing between the turns 0.3λ is operating at 3GHz. Calculate the directivity and half power beam width.	5	CO10	L2
65	1KT16EC423	Calculate the directivity of 20 turn helix with $\alpha=12^{\circ}$ and circumference equal to one wavelength	5	CO10	L2
66	1KT16EC424	Define and Explain loop antenna for different shapes?	5	CO9	L2
67	1KT16EC426	Obtain the field pattern of the transmitting loop antenna?	5	CO9	L2
68	1KT14EC067	Derive expressions for field components of the loop	5	CO9	L2

		antenna?			

F. EXAM PREPARATION

1. University Model Question Paper

Course:	MICROWAVE AND ANTENNAS					Month / Year	May /2018
Crs Code:	15EC71	Sem:	VII	Marks:	80	Time:	180 minutes

-	Note	Answer all FIVE full questions. All questions carry equal marks.	Marks	CO	Level
1	a		16 / 20	CO1	
	b				
	c			CO2	
	d				
		OR			
-	a		16 / 20	CO1	
	b			CO2	
	c				
	d				
2	a		16 / 20	C03	
	b				
	c			CO4	
	d				
		OR			
-	a		16 / 20	CO3	
	b			CO4	
	c				
	d				
3	a		16 / 20	CO5	
	b				
	c			CO6	
	d				
		OR			
-	a		16 / 20	CO5	

	b				
	c			CO6	
	d				
4	a		16 / 20	CO7	
	b				
	c			C08	
	d				
		OR			
-	a		16 / 20	CO7	
	b			CO8	
	c				
	d				
5	a		16 / 20	CO9	
	b			CO10	
	c				
	d				
		OR			
	a		16 / 20	CO9	
	b				
	c			C010	
	d				

2. SEE Important Questions

Course:	MICROWAVE AND ANTENNAS					Month / Year	May /2018
Crs Code:	15EC71	Sem:	7	Marks:	80	Time:	180 minutes

	Note	Answer all FIVE full questions. All questions carry equal marks.	-	-	
Module	Qno.	Important Question	**Marks**	**CO**	**Year**
1	1	Explain the mechanism of klystron oscillator in different modes with the help of its maximum power parameters	10	CO1	2004
	2	Derive an equation for Staring from the fundamentals, derive the expression for the voltage and on the transmission line. b. An open wire line has R = 10 SI's/km, L = 0.0037 henry/km, C current at any	10	CO2	2013

		point			
	3	With a neat diagram, explain the working of a two-hole directional coupler. Also derive the Scattering matrix of the same	10	CO2	2013
	4	A load impedance of 26-j1652's is required to be connected to a line of characteristic impedance 100 O's by using a short circuited stub of length, I located at a distance, d from the load. The wavelength of operation is 1 m. Using Smith chart find d and I. Write the procedural steps.	10	CO2	2013
	5	Derive an expression for the line impedance Z, at point P, at a distance 'd' from the receiving end interms of ZL and Zo	10	CO2	2012
2	1	State and prove the following properties of scattering parameters : i) Symmetry property ii) Unitary property iii) Zero property iv) Phase shifting property.	10	CO3	2012
	2	What are the different properties of Scattering parameters? Explain briefly.	8	CO3	2010
	3	With necessary conditions write the Scattering matrix representation of multiport network	8	CO3	2010
	4	Explain magic tee and its applications.	10	CO4	2012
	5	With a neat diagram, explain the working of a E-plane Tee junction. Also derive its Scattering matrix.	10	CO4	2012
3	1	Explain the construction and field pattern for micro strip line.	8	CO5	2012
	2	A strip (shielded strip line) has the following parameters : Dielectric constant of insulator tr = 2.56 ; Strip width w = 63.5mm Strip thickness t = 35mm ; Shield depth d = 180mm. Compute i) Characteristic impedance ii) K factor iii) Fringe capacitance.	8	CO5	2012
	3	Explain the construction and field pattern for microstrip line.	8	CO5	2013
	4	Explain the following terms with proper expressions: i) Directivity ii) Field pattern iii) Half power beam width.	9	CO6	2010
	5	Explain the different radiation patterns for an antenna	9	CO6	2014
4	1	Determine the directivity of the system if the radiation intensity i) $U = U_m \cos^3\theta$ ii) $U = U_m \sin\theta \sin^2\Phi$.	10	CO7	2009
	2	Derive an expression for array factor of an array of N—isotropic sources.	10	CO7	2009
	3	Show that the radiation resistance of λ/2 is 73 ohms	10	CO7	2011
	4	Derive an expression for maximum effective Aperture, A_{em}. Also show that A_{en}, of λ/2 dipole is 0.1372.	10	CO8	2009

	5	Derive the expressions for the field components of a short dipole starting with expressions of electric potential and vector magnetic potential. Also determine the far field components.	14	CO8	2009
5	1	Derive Far field expressions for small loop antenna.	10	CO9	2011
	2	Explain Babinet's principle with illustrations. Discuss features of complementary antenna.	10	CO9	2011
	3	Write short notes on: i) Horn antenna ii) Loop antenna.	10	CO9	2010
	4	Describe a Helical Antenna. Explain its two modes of operation with relevant expressions.	12	CO10	2012
	5	Write short note on I) Log periodic antenna ii) yagi uda antenna	12	CO10	2009