MICROWAVE ENGINEERING

COURSE FILE

2018-19

Department of Electronics & Communications Engineering

SREYAS Institute of Engineering & Technology

Tattiannaram, Hyderabad.

CONTENTS OF COURSE FILE

Faculty Name	**Dr. V. A. SANKAR PONNAPALLI**
Designation	Associate Professor, ECE
Department	ECE
Batch	2015-19
Academic Year	2018-19
Year & Semester	IV-I
Section	A&C

Course title	**MICROWAVE ENGINEERING**			
Course code	**A70442**			
Regulation	R16			
Course Duration	16 weeks			
Course structure	Lectures	Tutorials	Practical	Credits
	4	1	0	4
Domain Lead	Dr. V. A. SANKAR PONNAPALLI			
Team of instructors	Mrs. S. Pallavi		-	

Prerequisites	Graduation Level	Credits	Periods/Week
1. Electromagnetics & Transmission lines	UG	4	5
2. Antenna and Wave Propagation	UG	4	5

Evaluation Scheme:				
S.No	Component		Duration	Marks
1	I - mid exam	Descriptive – answer any 2 of 4 – (10) Objective –answer all 20 Questions– (10)	80 Min	20
2	I - Assignment		-	05
3	II - Mid exam	Descriptive – answer any 2 of 4 – (10) Objective –answer all – (10)	80 Min	20
4	II - Assignment		-	5
5	External exam		3 Hours	75

Course Outcomes - Target	CO1-T	CO2-T	CO3-T	CO4-T	CO5-T	CO6-T

Institute Vision :

To be a centre of excellence in technical education to empower the young talent through quality education and innovative engineering for well being of the society.

Institute Mission :

1. Provide quality education with innovative methodology and Intellectual human capital.
2. Provide conducive environment for research and developmental activities.
3. Inculcate holistic approach towards nature, society and human ethics with lifelong learning attitude.

Department Vision :

To excel in Electronics & Communication Engineering education with the knowledge of innovation, research and ethics.

Department Mission:

1. To provide academic environment that promotes student centric learning through quality education and state of the art infrastructure.
2. To make the students aspire towards innovation and research to meet the technological needs of society.
3. To engage the students in activities which inculcate professional practices with social concern.

Programme Educational Objectives :

1. Graduate will be empowered with strong fundamental concepts, analytical capability, programming and problem solving skills.
2. Graduates will be employed, may pursue higher education or undertake research.
3. Graduates will embrace Professional Career Growth with Values & Ethics and urge for lifelong learning.

	Program Outcomes
PO 1	**Engineering Knowledge:** Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.
PO 2	**Problem analysis:** Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.
PO 3	**Design/development of solutions:** Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
PO 4	**Conduct investigations of complex problems:** Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.
PO 5	**Modern tool usage:** Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modeling to complex engineering activities with an understanding of the limitations.
PO 6	**The engineer and society:** Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.
PO 7	**Environment and sustainability:** Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.
PO 8	**Ethics:** Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.
PO 9	**Individual and team work:** Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.
PO 10	**Communication:** Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions
PO 11	**Project management and finance:** Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
PO 12	**Life-long learning:** Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.
	Program specific outcomes
PSO1	Design, analyze and develop modules and systems for applications in advanced electronics and communication systems.
PSO2	Utilize modern tools for modeling and computational techniques in IC fabrication and RF technologies.

	A70442: MICROWAVE ENGINEERING B.Tech. IV Year II Sem.
UNIT-1	**Microwave Transmission Lines-I:** Introduction Microwave Spectrum and Bands, Applicatic of Microwaves Rectangular Waveguides-Expression for field components, Solution of wa equation in rectangular coordinates for TE mode Solution of wave equation in rectangu coordinates for TM modes Characteristic equation and Cut-off frequencies, Filter characterist Dominant and Degenerate modes, Sketches of TE and TM mode fields in the cross section Mo characteristics- Phase and Group velocities, Wavelengths and Impedance relations Problems **Rectangular Guides:** Transmission and Power losses, Impossibilities of TEM mode Micro st lines- introduction Characteristic equation of micro strip lines, Dielectric Constant Effect dielectric constant, Losses in micro strip lines, Quality factor
UNIT-2	**Cavity Resonators**- Introduction, Rectangular cavity resonator Dominant modes and resonant frequencies Quality factor and Coupling coefficients problems **Waveguide Components and Applications:** Coupling mechanisms- Probe, Loop and Aperture types Waveguide discontinuities- Waveguide Windows Tuning Screws and Posts, Matched loads Waveguide attenuators- Resistive card, Rotary vane types Waveguide phase shifters- Dielectric type and rotary vane types Waveguide multiport junctions- E plane H plane tees, Magic Tee Directional couplers- 2 Hole, Bethe hole types Problems on waveguide multiport junctions Ferrites- Composition and characteristics, faraday rotation Ferrite components- gyrator isolator and circulator Scattering matrix- significance, formulation and properties matrix calculations for 2 port junction, e plane and h plane Tee S matrix calculations for magic tee, directional coupler, circulator and isolator
UNIT-3	**Microwave Tubes:** O type and M type classification, O-type tubes: 2 cavity klystrons-structure reentrant cavities, velocity modulation process Applegate diagram, bunching process and small signal theory expressions for output power and efficiency Reflex klystrons-structure, applegate diagram and principle of working Mathematical theory of bunching, power output, efficiency Oscillating modes and output characteristics, effect of repeller voltage on power output problems **Helix TTS:** Significance, types and characteristics of slow wave structures Structure of TWT and Amplification process (qualitative treatment)Suppression of oscillations, gain considerations
UNIT-4	**M-Type Tubes:** Introduction, Cross-field effects Magnetrons- different types8 cavity cylindrical travelling wave magnetron- Hull cut Hartree conditions, modes of resonance and Pi-mode operation Separation of Pi-mode, output characteristics Problems on M type tubes **Microwave Solid State Devices:** Introduction, Classification, Applications TEDs-introduction, Gunn diode principle RWH theory, characteristics Basic Modes of operation, Gunn Oscillation Modes LSA mode Avalanche Transit Time Devices Problems on solid state devices.
UNIT-5	**Microwave Measurements:** Scattering Matrix-Significance formulation and properties S Matrix Calculations for-2 port Junctions E plane and H plane Tees Magic Tee, Circulator and Isolator problems **Description of Microwave Bench**- Different blocks and their features Errors and Precautions, Microwave power measurement Bolometers, Measurement of Attenuation Measurement of Frequency Standing wave measurements, Measurement of Low and High VSWR Measurement of Quality factor, Measurement of Impedance

S.No.	Text Books	Publication
1	Microwave Devices and Circuits- Samuel Y. Liao, 3rd Edition, 2003.	Pearson
2	Microwave Principles- Herbert J. Reich, J. G. Skalnik, P. F. Ordung, H. L. Krauss, 2004.	John Wiley & Sons

S.No.	Ref Books	Publication
1	Foundations for Microwave Engineering-R. E. Collin, John Wiley, 2nd Edition,2002.	John Wiley
2	Microwave circuits and Passive Circuits-M.L.Sisodia	New Age International Publishers
3	Microwave Engineering Passive Circuits-Peter A, Rizzi, PHI, 1999.	PHI
4	Electronic and Radio Engineering- F.E.Terman, McGraw-Hill,4th ED.,1955.	McGraw-Hill
5	A. Das and S. K. Das, TMH,2nd ED.,2009.	TMH
6	Microwave Engineering- G.S.Raghuvanshi and K. SatyaPrasad, Cengage Learning,2012.	Cengage Learning

S.No.	Web Link
1	https://onlinecourses.nptel.ac.in/noc18_ee22

S.No.	Journal

S.No.	Gaps in Curriculum
1	Microwave Monolithic Integrated Circuits
2	
3	
4	

S.No.	Topics Beyond Syllabus
1	
2	

C301	Course Objectives
A	Understand the significance microwaves and microwave transmission lines. Analyze wave propagation in TE, TM or TEM modes, in structures such as rectangular waveguides.
B	Develop the knowledge on transmission lines for microwaves, cavity resonators and waveguide components and applications.
C	understand and analyze the operation of microwave tubes like klystron, magnetron, travelling wave tube, etc.
D	Familiarize with microwave solid state devices.
E	Understand the scattering matrix parameters and its use.
F	Introduce the student the microwave test bench for measure different parameters like attenuation, VSWR, impedance etc.

C301	Course Outcomes
1	**Apply Electro-Magnetic wave theory to analyze microwaveparameters.**
2	**Analyze microwave components such as directional couplers, power dividers / combiner etc.,**
3	**Study the performance of specialized microwave tubes such as Klystron and reflex klystron**
4	**Study the performance of specialized microwave tubes such as travelling wave tubes.**
5	**Study the performance of specialized microwave tubes such as M-type tubes and Understand the operation of microwave solid state devices.**
6	**Measure various Microwaveparameters(power, reflection coefficient, VSWR etc.)**

COURSE OBJECTIVES						COs	PROGRAM OUTCOMES (POs)												PSOs	
A	B	C	D	E	F		1	2	3	4	5	6	7	8	9	10	11	12	I	II
3						CO1	**3**	**3**	**1**	-	-	-	**1**	-	-	-	-	**1**	1	1
	3					CO2	**3**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	1	1
		3				CO3	**3**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	1	1
			3			CO4	**3**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	1	1
				3		CO5	**3**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	1	1
					3	CO6	**3**	**3**	**1**	-	-	-	-	-	-	-	-	**1**	1	1

Signature		Signature	

Faculty		HOD	

JAWAHARLAL NEHRU TECHNOLOGICAL UNIVERSITY HYDERABAD
ACADEMIC CALENDAR (2018-19)
FOR NON-AUTONOMOUS CONSTITUENT & AFFILIATED COLLEGES
B. TECH. I YEAR I & II SEMESTERS

I SEM

S. No	EVENT	DATE	Duration
1.	Induction programme	16th to 28th July 2018	2 weeks
2.	Commencement of Instruction	30th July 2018	--
3.	First Mid Term Examinations	24th to 26th Sept. 2018	--
4.	Submission of First Mid Term Exam Marks to University on or before	4th Oct. 2018	--
5.	Parent-Teacher Meeting	13th Oct. 2018	--
6.	Dussehra recess	15th to 20th Oct. 2018	1 week
7.	Last date of Instruction	28th Nov. 2018	16 weeks
8.	Second Mid Term Examinations	29th Nov. to 1st Dec. 2018	--
9.	Preparation Holidays and Practical Examinations	3rd to 8th Dec. 2018	1 week
10.	Submission of Second Mid Term Exam Marks to University on or before	8th Dec. 2018	--
11.	End Semester / Supplementary Examinations	10th to 22nd Dec. 2018	2 weeks
12.	Semester Break	24th to 29th Dec. 2018	1 week

II SEM

S. No	EVENT	DATE	Duration
1.	Commencement of Instruction	31st Dec. 2018	--
2.	First Mid Term Examinations	25th to 27th Feb. 2019	--
3.	Submission of First Mid Term Exam Marks to University on or before	7th March 2019	--
4.	Parent-Teacher Meeting	9th March 2019	--
5.	Last date of Instruction	20th April 2019	16 weeks
6.	Second Mid Term Examinations	22nd to 24th April 2019	--
7.	Preparation Holidays and Practical Examinations	25th April to 1st May 2019	1 week
8.	Submission of Second Mid Term Exam Marks to University on or before	1st May 2019	--
9.	End Semester / Supplementary Examinations	2nd to 16th May 2019	2 weeks
10.	Summer Vacation	17th May to 6th July 2019	7 weeks

DIRECTOR
ACADEMIC & PLANNING, JNTUH

COURSE SCHEDULE

S.No	Unit No	Description	From	To	Total No. Periods
1	I	Introduction to Microwave & Rectangular Waveguide	11-Jul-18	09-Aug-18	14
2	II	Microwave components	12-Aug-18	14-Sep-18	12
3	III	O-Type Tubes & TWT	16-Sep-18	05-Oct-18	10
4	IV	M-Type Tubes & Solid State Devices	08-Oct-18	05-Nov-18	10
5	V	Microwave Measurements	05-Nov-18	27- Nov -2019	09

TIME TABLE

SEC-A	1	2	3	4	Break	5	6	7
MON								
TUE								MWE
WED								MWE (T)
THU	MWE	MWE						
FRI								
SAT			MWE					

SEC-C	1	2	3	4	Break	5	6	7
MON		MWE						
TUE		MWE						
WED								
THU								
FRI	MWE							MWE
SAT				MWE (T)				

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Unit	Week	Lecture	Topic	Co	Method	Text	Planned date	Actual date
Unit 1	Week 1	1	Introduction to Electromagnetic Spectrum and Applications of different frequency designations	1	BB &PPT	R7	9/7/18	
		2	Microwave Spectrum and Bands, Applications of Microwaves	1	BB &PPT	R6	10/7/18	
		3	Advantages and Disadvantages of Microwaves	1	BB &PPT	R6	11/7/18	
		4	Rectangular Waveguides-Expression for field components	1	BB &PPT	R3	12/7/18	
		5	Solution of wave equation in rectangular coordinates for TE mode	1	BB &PPT	T2	16/7/18	
Unit 1	Week 2	6	Solution of wave equation in rectangular coordinates for TM modes	1	BB &PPT	T2	17/7/18	
		7	Characteristic equation and Cut-off frequencies, Filter characteristics	1	BB &PPT	T2	18/7/18	
		8	Dominant and Degenerate modes, Sketches of TE and TM mode fields in the cross section	1	BB &PPT	T2	19/7/18	
		9	Mode characteristics- Phase and Group velocities	1	BB &PPT	R6	21/7/18	
		10	Wavelengths and Impedance relations	1	BB &PPT	R6	23/7/18	
Unit 1	Week 3	11	Problems	1	BB &PPT	T2 &R 6	24/7/18	
		12	Rectangular Guides: Power transmission and, Impossibilities of TEM mode	1	BB &PPT	T2 &R 6	25/7/18	
		13	Power losses	1	BB &PPT	T2 &R 6	26/7/18	
		14	Micro strip lines- introduction	1	BB &PPT	T2 &R 6	28/7/18	
		15	Characteristic equation of micro strip lines, Dielectric Constant	1	BB &PPT	T2 &R 6	30/7/18	
Unit 2	Week 4	16	Effective dielectric constant, Losses in micro strip lines, Quality factor	1	BB &PPT	T2 &R 6	31/7/18	

		17	Introduction, Rectangular cavity resonator Dominant modes and Resonant frequencies	1	BB &PPT	T2 &R 6	1/8/18	
		18	Quality factor and Coupling coefficients	1	BB &PPT	T2 &R 6	2/8/18	
		19	problems	1	BB &PPT	T2 &R 6	4/8/18	
		20	Waveguide Components and Applications: Coupling mechanisms- Probe, Loop and Aperture types	2	BB &PPT	T2 &R 6	7/8/18	
Unit 2	Week 5	21	Waveguide discontinuities- Waveguide Windows	2	BB &PP T	T2 &R6	8/8/18	
		22	Tuning Screws and Posts, Matched loads	2	BB &PP T	T2 &R6	9/8/18	
		23	Waveguide attenuators- Resistive card, Rotary vane types	2	BB &PP T	T2 &R6	13/8/18	
		24	Waveguide phase shifters- Dielectric type and rotary vane types	2	BB &PP T	T2 &R6	14/8/18	
		25	Waveguide multiport junctions- E plane H plane tees, Magic Tee	2	BB &PP T	T2 &R6	16/8/18	
Unit 2	Week 6	26	Directional couplers- 2 Hole, Bethe hole types	2	BB &PP T	T2 &R6	18/8/18	
		27	Problems on waveguide multiport junctions	2	BB &PP T	T2 &R6	20/8/18	
		28	Ferrites- Composition and characteristics, faraday rotation Ferrite components- gyrator	2	BB &PP T	T2 &R6	21/8/18	
		29	isolator and circulator	2	BB &PP T	T2 &R6	23/8/18	
		30	Scattering matrix- significance, formulation and properties	2	BB &PP T	T2 &R6	25/8/18	

Unit 3	Week 7	31	S matrix calculations for 2 port junction, e plane and h plane tee	2	BB &PPT	T2 &R6	27/8/18	
		32	S matrix calculations for magic tee, directional coupler, circulator and isolator	2	BB &PPT	T2 &R6	28/8/18	
		33	O type and M type classification, O-type tubes		BB &PPT		29/8/18	
		34	2 cavity klystrons- structure , reentrant cavities, velocity modulation process	3	BB &PPT	T1	30/8/18	
		35	Applegate diagram, bunching process and small signal theory	3	BB &PPT	T1	01/9/18	
Unit 3	Week 8	36	expressions for output power and efficiency	3	BB &PPT	T1	10/9/18	
		37	Reflex klystrons- structure, applegate diagram and principle of working	3	BB &PPT	T1	11/9/18	
		38	Mathematical theory of bunching, power output, efficiency	3	BB &PPT	T1	12/9/18	
		39	Oscillating modes and output characteristics, effect of repeller voltage on power output	3	BB &PPT	T1	13/9/18	
		40	problems	3	BB &PPT	T1	15/9/18	
Unit 3	Week 9	41	HELIX TWTS: Significance, types and characteristics of slow wave structures	4	BB &PPT	T1	17/9/18	06-Mar-19
		42	Structure of TWT and amplification process (qualitative treatment)	4	BB &PPT	T1	18/9/18	
		43	Suppression of oscillations, gain considerations	4	BB &PPT	T1	19/9/18	
		44	Introduction, Cross-field effects , Magnetrons- different types	5	BB &PPT	T1	20/9/18	
		45	8 cavity cylindrical travelling wave	5	BB	T1	22/9/18	

			magnetron- Hull cut		&PPT			
Unit 4	Week 10	46	Hartree conditions, modes of resonance and Pi-mode operation	5	BB &PPT	T1	24/9/18	
		47	Separation of Pi-mode, output characteristics	5	BB &PPT	T1	25/9/18	
		48	Problems on M type tubes	5	BB &PPT	T1	26/9/18	
		49	Microwave Solid State Devices :Introduction, Classification, Applications	5	BB &PPT	T1	27/9/18	
		50	TEDs- introduction, Gunn diode principle	5	BB &PPT	T1	29/9/18	
Unit 4	Week 11	51	RWH theory, characteristics	5	BB &PPT	T1	1/10/18	
		52	Basic Modes of operation, Gunn Oscillation Modes	5	BB &PPT	T1	3/10/18	
		53	LSA mode Avalanche Transit Time Devices	5	BB &PPT	T1	4/10/18	
		54	Problems on solid state devices	5	BB &PPT	T1	6/10/18	
		55	problems	5	BB &PPT	T1	8/10/18	
Unit 4	Week 12	56	Scattering Matrix- Significance formulation and properties	6	BB &PPT	T2 &R6	9/10/18	
		57	S Matrix Calculations for-2 port Junctions	6	BB &PPT	T2 &R6	10/10/18	
		58	E plane and H plane Tees	6	BB &PPT	T2 &R6	11/10/18	
		59	Magic Tee, Circulator and Isolator	6	BB &PP	T2 &R6	22/10/18	

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		60	problems	6	BB &PPT	T2 &R6	23/10/18	
Unit 5	Week 13	61	Description of Microwave Bench- Different blocks and their features	6	BB &PPT	T1	24/10/18	
		62	Errors and Precautions, Microwave power measurement	6	BB &PPT	T1	25/10/18	
		63	Bolometers, Measurement of Attenuation	6	BB &PPT	T1	27/10/18	
		64	Measurement of Frequency	6	BB &PPT	T1	29/10/18	
		65	Standing wave measurements	6	BB &PPT	T1	30/10/18	
Unit 5	Week 14	66	Measurement of Low and High VSWR	6	BB &PPT	T1	31/10/18	
		67	Measurement of Quality factor, Measurement of Impedance	6	BB &PPT	T1	01/11/18	
		68	Problems	6	BB &PPT		03/11/18	
		69	Revision	6	BB &PPT		05/11/18	
		70						

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Unit	Week	Lecture	Topic	Co	Method	Text	Planned date	Actual date
Unit 1	Week 1	1	Introduction to Electromagnetic Spectrum and Applications of different frequency designations	1	BB &PPT	R7	9-Jul-18	
		2	Microwave Spectrum and Bands, Applications of Microwaves	1	BB &PPT	R6	10-Jul-18	
		3	Advantages and Disadvantages of Microwaves	1	BB &PPT	R6	13-Jul-18	
		4	Rectangular Waveguides-Expression for field components	1	BB &PPT	R3	14-Jul-18	
		5	Solution of wave equation in rectangular coordinates for TE mode	1	BB &PPT	T2	16-Jul-18	
Unit 1	Week 2	6	Solution of wave equation in rectangular coordinates for TM modes	1	BB &PPT	T2	17-Jul-18	
		7	Characteristic equation and Cut-off frequencies, Filter characteristics	1	BB &PPT	T2	20-Jul-18	
		8	Dominant and Degenerate modes, Sketches of TE and TM mode fields in the cross section	1	BB &PPT	T2	21-Jul-18	
		9	Mode characteristics- Phase and Group velocities	1	BB &PPT	R6	23-Jul-18	
		10	Wavelengths and Impedance relations	1	BB &PPT	R6	24-Jul-18	
Unit 1	Week 3	11	Problems	1	BB &PPT	T2 &R6	27-Jul-18	
		12	Rectangular Guides: Power transmission and, Impossibilities of TEM mode	1	BB &PPT	T2 &R6	28-Jul-18	
		13	Power losses	1	BB &PPT	T2 &R6	30-Jul-18	
		14	Micro strip lines- introduction	1	BB &PPT	T2 &R6	31-Jul-18	
		15	Characteristic equation of micro strip lines, Dielectric Constant	1	BB &PPT	T2 &R6	3-Aug-18	
Unit 2	Week 4	16	Effective dielectric constant, Losses in micro strip lines, Quality factor	1	BB &PPT	T2 &R6	4-Aug-18	
		17	Introduction, Rectangular cavity resonator Dominant modes and Resonant	1	BB &PPT	T2 &R6	6-Aug-18	

			frequencies					
		18	Quality factor and Coupling coefficients	1	BB &PPT	T2 &R6	7-Aug-18	
		19	problems	1	BB &PPT	T2 &R6	10-Aug-18	
		20	Waveguide Components and Applications: Coupling mechanisms- Probe, Loop and Aperture types	2	BB &PPT	T2 &R6	11-Aug-18	
Unit 2	Week 5	21	Waveguide discontinuities- Waveguide Windows	2	BB &PPT	T2 &R6	13-Aug-18	
		22	Tuning Screws and Posts, Matched loads	2	BB &PPT	T2 &R6	14-Aug-18	
		23	Waveguide attenuators- Resistive card, Rotary vane types	2	BB &PPT	T2 &R6	17-Aug-18	
		24	Waveguide phase shifters- Dielectric type and rotary vane types	2	BB &PPT	T2 &R6	18-Aug-18	
		25	Waveguide multiport junctions- E plane H plane tees, Magic Tee	2	BB &PPT	T2 &R6	20-Aug-18	
Unit 2	Week 6	26	Directional couplers- 2 Hole, Bethe hole types	2	BB &PPT	T2 &R6	21-Aug-18	
		27	Problems on waveguide multiport junctions	2	BB &PPT	T2 &R6	24-Aug-18	
		28	Ferrites- Composition and characteristics, faraday rotation Ferrite components- gyrator	2	BB &PPT	T2 &R6	25-Aug-18	
		29	isolator and circulator	2	BB &PPT	T2 &R6	27-Aug-18	
		30	Scattering matrix- significance, formulation and properties	2	BB &PPT	T2 &R6	28-Aug-18	
Unit 3	Week 7	31	S matrix calculations for 2 port junction, e plane and h plane tee	2	BB &PPT	T2 &R6	31-Aug-18	
		32	S matrix calculations for magic tee, directional coupler, circulator and isolator	2	BB &PPT	T2 &R6	1-Sep-18	
		33	O type and M type classification, O-type tubes		BB &PPT		3-Sep-18	
		34	2 cavity klystrons- structure , reentrant cavities, velocity modulation process	3	BB &PPT	T1	4-Sep-18	
		35	Applegate diagram, bunching process and small signal theory	3	BB &PPT	T1	7-Sep-18	
Unit 3	Week 8	36	expressions for output power and efficiency	3	BB	T1	8-Sep-18	

					&PPT			
		37	Reflex klystrons- structure, applegate diagram and principle of working	3	BB &PPT	T1	10-Sep-18	
		38	Mathematical theory of bunching, power output, efficiency	3	BB &PPT	T1	11-Sep-18	
		39	Oscillating modes and output characteristics, effect of repeller voltage on power output	3	BB &PPT	T1	14-Sep-18	
		40	problems	3	BB &PPT	T1	15-Sep-18	
Unit 3	Week 9	41	HELIX TWTS: Significance, types and characteristics of slow wave structures	4	BB &PPT	T1	17-Sep-18	06-Mar-19
		42	Structure of TWT and amplification process (qualitative treatment)	4	BB &PPT	T1	18-Sep-18	
		43	Suppression of oscillations, gain considerations	4	BB &PPT	T1	21-Sep-18	
		44	Introduction, Cross-field effects , Magnetrons- different types	5	BB &PPT	T1	22-Sep-18	
		45	8 cavity cylindrical travelling wave magnetron- Hull cut	5	BB &PPT	T1	24-Sep-18	
Unit 4	Week 10	46	Hartree conditions, modes of resonance and Pi-mode operation	5	BB &PPT	T1	25-Sep-18	
		47	Separation of Pi-mode, output characteristics	5	BB &PPT	T1	28-Sep-18	
		48	Problems on M type tubes	5	BB &PPT	T1	29-Sep-18	
		49	Microwave Solid State Devices :Introduction, Classification, Applications	5	BB &PPT	T1	1-Oct-18	
		50	TEDs- introduction, Gunn diode principle	5	BB &PPT	T1	2-Oct-18	
Unit 4	Week 11	51	RWH theory, characteristics	5	BB &PPT	T1	5-Oct-18	
		52	Basic Modes of operation, Gunn Oscillation Modes	5	BB &PPT	T1	6-Oct-18	
		53	LSA mode Avalanche Transit Time Devices	5	BB &PPT	T1	8-Oct-18	
		54	Problems on solid state devices	5	BB &PPT	T1	9-Oct-18	
		55	problems	5	BB	T1	12-Oct-18	

					&PPT			
Unit 4	Week 12	56	Scattering Matrix- Significance formulation and properties	6	BB &PPT	T2 &R6	13-Oct-18	
		57	S Matrix Calculations for-2 port Junctions	6	BB &PPT	T2 &R6	15-Oct-18	
		58	E plane and H plane Tees	6	BB &PPT	T2 &R6	16-Oct-18	
		59	Magic Tee, Circulator and Isolator	6	BB &PPT	T2 &R6	19-Oct-18	
		60	problems	6	BB &PPT	T2 &R6	20-Oct-18	
Unit 5	Week 13	61	Description of Microwave Bench- Different blocks and their features	6	BB &PPT	T1	22-Oct-18	
		62	Errors and Precautions, Microwave power measurement	6	BB &PPT	T1	23-Oct-18	
		63	Bolometers, Measurement of Attenuation	6	BB &PPT	T1	26-Oct-18	
		64	Measurement of Frequency	6	BB &PPT	T1	27-Oct-18	
		65	Standing wave measurements	6	BB &PPT	T1	29-Oct-18	
Unit 5	Week 14	66	Measurement of Low and High VSWR	6	BB &PPT	T1	30-Oct-18	
		67	Measurement of Quality factor, Measurement of Impedance	6	BB &PPT	T1	2-Nov-18	
		68	Problems	6	BB &PPT		3-Nov-18	
		69	Revision			R7	5-Nov-18	

Signature Faculty		**Signature HOD**	

S.No.	Description	BTL	COs	Marks
1	Derive wave equation for TM wave and obtain the field components in a rectangular wave guide?	TL2	CO1	2
2	Explain Faraday rotation with neat diagram and explain the working of a ferrite isolator?	TL2	CO2	2
3	List out the limitations of conventional tubes at microwave frequencies?	TL2	CO3	1
4	Distinguish between TE and TM modes of the propagation in rectangular waveguide?	TL4	CO1	2
5	Define E-H plane TEE junction. Why a hybrid E--H plane Tee referred to as Magic Tee. Derive the scattering matrix for all these Tees.	TL2	CO2	2
6	Compare 'O' type and 'M' type tubes.	TL4	CO3	1
7	A rectangular wave guide has dimensions of 7x3.5cm and is operated on dominant mode at a frequency of 5GHz.find cutoff frequency, Impedance of TE&TM mode?	TL4	CO1	2
8	Explain directional coupler with near sketch? And derive the scattering matrix of directional coupler?	TL2/4	CO2	2
9	Define reentrant cavity?	TL1	CO3	1
10	Define the dominant and degenerate modes? Explain the significance of dominant modes? Indicate dominant mode in rectangular wave guide?	TL1/2	CO1	2
11	Derive the expression for quality factor and coupling coefficient of cavity resonator.	TL2/4	CO2	2
12	Classify microwave tubes.	TL5	CO3	1

S.No.	Description	BTL	COs	Marks
1	Explain the construction and working principle of 8 cavity cylindrical Magnetron? Derive an expression for the Hull Cut-Off equation for cylindrical magnetron?	TL2/4	CO4	2
2	Draw the Schematic block diagram of typical microwave Bench setup and explain the functionality of each component?	TL2/5	CO5	2
3	what is velocity modulation?	TL2/4	CO3	1
4	Explain the construction of the GUNN diode using RWH theory?	TL2/5	CO4	2
5	Explain how the frequency can be measured?	TL2	CO5	2
6	Describe the principle operation of Avalanche Transit Time devices and explain the Operation of IMPATT Diode?	TL2/4	CO4	1
7	Explain how microwave attenuation can be measured	TL2	CO5	2
8	Explain how microwave attenuation can be measured	TL2/4	CO3	2
9	What are slow wave structure?	TL2/4	CO4	1
10	Explain about several modes of operation of GUNN diode?	TL1/2	CO5	2
11	Explain measurement of low and high VSWR?	TL2/4	CO3	2
12	Draw and explain the Applegate Diagram of a two cavity klystron ?	TL5	CO3	1

S.No.	UNIT- I
1	Define dominant and degenerative modes of waveguide.
2	A rectangular waveguide has dimensions 2.5 X 5 cms. Determine the guide wavelength, phase constant and phase velocity at a wavelength of 4.5 cms for dominant mode.
3	What is a Microwave spectrum bands? Explain briefly the applications of microwaves at various frequency bands.
4	A Rectangular wave guide is filled by dielectric material of εr= 9 and has dimensions of 7 × 3.5 cm. It operates in the dominant TE mode. i. Determine the cut off frequency. ii. Find the phase velocity in the guide at a frequency of 2 GHz iii. Find the guided wave length at 2GHz.
5	Derive the expression for cutoff frequency of TEmn mode in rectangular wave guide.
6	Obtain the wave equations for TE mode.
7	Obtain the wave equations for TM mode.
8	Obtain an expression for microwave impedance for TE waves in rectangular wave guide.
9	Derive an expression for microwave impedance for TM waves in rectangular wave guide.
10	Obtain the expression for power transmission in waveguide

S.No.	UNIT - II
1	Derive the expression for Rectangular cavity resonator.
2	Prove that a cavity resonator is nothing but an LC circuit.
3	Discuss about E-H plane Tee junction. Why a hybrid E-H plane Tee referred to as Magic Tee. Derive the scattering matrix for E-H plane Tee junction.
4	Explain the applications of Directional Couplers and obtain scattering matrix.
5	Write about quality factor of a cavity resonator.
6	Explain the principle of working a Magic Tee junction with neat schematics?
7	Discuss the principle of working of E-H plane Tee junction with neat schematics?
8	Write the principle of working of two-hole Directional coupler with neat schematics?
9	Explain the two-hole Directional coupler and write applications of directional couplers?
10	Discuss the following characteristics related to Directional coupler i)Coupling factor ii)Directivity iii) Isolation

S.No.	UNIT - III
1	What is Gunn effect? Explain the operation of Gunn diode.
2	Explain is the principle of working for Two – Cavity Klystron with velocity diagram.
3	Derive the expression for output power & Efficiency of a 2 cavity klystron.
4	Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.
5	What are the limitations of conventional tubes at microwave frequencies? Explain how these limitations can be overcome.
6	Name different methods of generating microwave power. Describe the necessary theory & Working of reflex klystron.
7	Explain in detail bunching process & obtain expression for bunching parameter in a two cavity klystron amplifier.
8	Write the principle of operation of a reflex Klystron oscillator and derive an expression for the bunching parameter.
9	Explain the construction & working of two cavity klystron amplifier.
10	Write the operation of a reflex klystron By means of applegate diagram?

S.No.	UNIT - IV
1	Explain the working Magnetron with π mode oscillation.
2	List out the differences in performances and applications of Klystrons and TWTs.
3	What is meant by Avalanche Transit Time Devices? Explain the operation, construction and Applications of IMPATT.
4	How is bunching achieved in a cavity magnetron? Explain the phase focusing effect.
5	Determined the Gunn effect using the two valley theory.
6	Derive the criterion for classifying the modes of operation for Gunn effect diodes.
7	Explain the physical structure and construction of IMPATT diodes.
8	Write short notes on "LSA mode in GUNN diode".
9	Describe the operation of TRAPATT diode.
10	Describe the operation of BARITT diode.

S.No.	UNIT - V
1	Explain the measurement of attenuation using power ratio method
2	Write about the Slotted line method for impedance measurement.
3	Draw a neat diagram of microwave test bench and explain about each block along with its features.
4	Explain the measurement of microwave power using bolometer method.
5	Discuss the measurement of phase shift.
6	Determined the method of measurement of high VSWR.
7	Explain the RF substitution method of measurement of Attenuation.
8	Write about the measurement of Q of a cavity resonator.
9	Discuss the measurement of frequency using wave meter method.
10	Explain the high power measurements using calorimetric method.

S.No.	Assignment - I	BTL	COs	Marks
1	A Rectangular wave guide is filled by dielectric material of $\varepsilon_r = 9$ and has dimensions of 7 × 3.5 cm. It operates in the dominant TE mode. i. Determine the cut off frequency. ii. Find the phase velocity in the guide at a frequency of 2 GHz iii. Find the guided wave length at 2GHz.	TL5	Co1	5
2	Derive wave equation for TM wave and obtain the field components in a rectangular wave guide?	TL2	CO1	5
3	Discuss about E-H plane Tee junction. Why a hybrid E-H plane Tee referred to as Magic Tee. Derive the scattering matrix for E-H plane Tee junction.	TL5	Co2	5
4	Explain Faraday rotation with neat diagram and explain the working of a ferrite isolator?	TL2	CO2	5
5	Explain is the principle of working for Two – Cavity Klystron with velocity diagram.	TL5	Co3	5

S.No.	Assignment - II	BTL	COs	Marks
1	Explain the construction and working principle of 8 cavity cylindrical Magnetron? Derive an expression for the Hull Cut-Off equation for cylindrical magnetron?	TL2/4	CO4	5
2	Determined the Gunn effect using the two valley theory.	TL3	CO5	5
3	Explain the measurement of microwave power using bolometer method.	TL6	CO6	5
4	Describe the principle operation of Avalanche Transit Time devices and explain the Operation of IMPATT Diode?	TL2/4	CO4	5

Guest Lectures				
Date	**Resource person**	**Organization**	**Topic**	**No. of Students Attended**
Seminars				
Date	**Resource person**	**Organization**	**Topic**	**No. of Students Attended**
27/09/2018	Dr. V M Pandharipande, Ex Vice Chancellor, B. A. M. U, Ex Director VNIT Adjunct Professor, ECE Dept. OU	ECE Dept. University College of Engineering, Osmania University, Hyderabad	High Frequency Circuits and Systems - Analysis, Design, Synthesis	15
Industry /Field Visits				
Date	**Organization / field**	**Place of visit**	**Coordinator**	**No. of Students Attended**

Date	Period	No. of Students Attended	Theory/ Test
13-Sep-18		08	Theory
11-Nov-18		08	Theory

S. No	Hall Ticket No.	Name	Remarks
1	15VE1A0405	Boora Krishna Mohan Goud	
2	15VE1A0428	Koppolu Kavyasri	
3	15VE1A0430	Malchalam Vijay Kumar	
4	15VE1A0437	Murari Kumar Agarwal	
5	15VE1A0454	Sudhagani Sandeep Goud	
6	15VE1A04E1	Kasa Madhukanth	
7	15VE1A04G9	Ratanpalke Saikrishna	
8	15VE1A04G4	Palagummi Madhuri	

	Date of Review	Remarks	Signature
Review 1 (Before Commencement)			
Review 2 (Before MID-I)			
Review 3 (Before MID-II)			

COURSE COMPLETION CERTIFICATE

This is to certify that Mr/Mrs …Dr. V. A. Sankar Ponnapalii had completed the syllabus and course work for the allocated subject …Microwave Engineering ..of …IV year …I. semester for the academic year…2018-19...

Remarks:

HOD

PRINCIPAL **IQAC**

1	CORSE MATERIAL
2	QUESTION BANK
3	DESCRIPTIVE QUESTIONS
4	OBJECTIVE QUESTIONS

1	TUTORIAL PROBLEMS
2	SOLUTIONS
3	SAMPLE SCRIPTS

1	PREVIOUS QUESTION PAPERS
2	MODEL PAPERS

1	MID QUESTION PAPERS
2	SOLUTIONS
3	SAMPLE SCRIPTS

1	ASSIGNMENTS
2	SOLUTIONS
3	SAMPLE SCRIPTS

1	CO-PO ATTAINMENT SHEET
2	PASS PERCENTAGE
3	PERFORMANCAE EVALUATION

C301	Course Outcomes	Target	Attainment	Remarks
CO 1	Apply Electro-Magnetic waves to microwave systems and analyze its parameters and to Design Rectangular waveguide, micro strip transmission lines.			
CO 2	To understand various parameters of cavity resonator . Design & Analyze microwave components such as directional couplers, power dividers / combiner etc.,			
CO 3	Understand and analyze the operation of microwave tubes like two cavity Klystron, Magnetron, travelling wave tubes.			
CO 4	Understand and Analyze the characteristics and operation of Microwave solid state devices.			
CO 5	Understand the scattering matrix parameters and its use.			
CO 6	Perform the various Microwave measurements parameters (power, reflection coefficient, VSWR etc) using Microwave Bench setup.			
	Average Course Attainment			

Head of the Committee
(Dept Assessment & Audit Committee)

HOD **PRINCIPAL** **IQAC**