



ANDHRA LOYOLA INSTITUTE OF ENGINEERING AND TECHNOLOGY

(Approved by AICTE, New Delhi & Affiliated to JNTU Kakinada)

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Department of ECE

Assistant Professor

Lesson Plan for a Day

Term/Semester/Year: III Year Sem- II - Syllabus 2020-21

MICRO LESSON PLAN

Course Objectives

- Understand fundamental characteristics of waveguides and Micro-strip lines through electromagnetic field analysis.
- Understand the basic properties of waveguide components and Ferrite materials composition
- Understand the function, design, and integration of the major microwave components oscillators, power amplifier.
- Understand a Microwave test bench setup for measurements.

Course Outcomes

1	Factual	CO1: Design different modes in waveguide structures
2	Conceptual	CO2: Calculate S-matrix for various waveguide components and splitting the microwave energy in a desired Direction
3	Procedural	CO3: Distinguish between Microwave tubes and Solid State Devices, calculation of efficiency of devices.
4	Applied	CO4: Measure various microwave parameters using a Microwave test bench

TEXT BOOKS:

1. Microwave Devices and Circuits – Samuel Y. Liao, PHI, 3rd Edition, 1994.
2. Foundations for Microwave Engineering – R.E. Collin, IEEE Press, John Wiley, 2nd Edition, 2002.

Contents/Activities

1	Factual	Reading Prescribed Text book Video Lectures
2	Conceptual	NPTEL Lectures
3	Procedural	Some reference books Simulations IEEE Journal papers Quiz
4	Applied	Solving Exercises Simulations & Analysis Assignments Mini projects

Schedule and Sequence: Day Plan for Lesson 1 - **Microwave Transmission Lines**

Lesson 1– Total Classes 9

Lesson-1 Total Classes -9	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Introduction, Microwave Spectrum and Bands, Advantages of Microwaves	To understand electromagnetic spectrum and advantages of Microwaves	MWE Textbook https://pdf.wecabrio.com/microwave-engineering-samuel-liao.pdf Videos https://www.youtube.com/watch?v=JdXogpO_wgU&list=PLgwJf8NK-2e6A4Mtxud6xPHE1UecxWsHW&index=2	PPT presentation (40 Min) Summary (5min) Doubts clarification (5 min)	Discussion forum on advantages of Microwaves
Day-2	Applications of Microwaves	To understand Microwave Applications	Lecture Video https://www.youtube.com/watch?v=AJzawoX25F0&list=PLgwJf8NK-2e6A4Mtxud6xPHE1UecxWsHW&index=3	Revise previousclass – (5 mins) PPT presentation (40 min) Doubts clarification (5 min)	Discussion forum on applications of Microwaves
Day -3	Transmission Line Theory, Rectangular	To understand different waveguide	Lecture Video	Revise previousclass – (5 mins)	Assignment:

	Waveguides – TM mode analysis	structures and analyze rectangular waveguide through TM mode	https://www.youtube.com/watch?v=zPly9nLu1fA	Chalk and Board (40 min) Doubts clarification (5 min)	TM mode analysis of Rectangular waveguide
Day - 4	TE mode analysis	To analyze rectangular waveguide through TE mode	Lecture Video https://www.youtube.com/watch?v=wBi2934qYi4	Revise previousclass – (5 mins) Chalk and Board (40 min) Doubts clarification (5 min)	Assignment: Deign of Rectangular waveguide through HFSS
Day-5	Expressions for Cut-off Frequencies	To analyze the cut-off frequency for rectangular waveguide in TE and TM mode	Lecture Video https://www.youtube.com/watch?v=l3bt35JDrkA	Revise previousclass – (5 mins) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on cut-off frequency
Day-6	Dominant and Degenerate Modes, Sketches of TE and TM mode fields in the cross-section	To identify the dominant and degenerate modes in Rectangular waveguide in TE and TM mode and understand the sketches of fields	Lecture Video https://www.youtube.com/watch?v=6Etvrtvqfc0 https://www.youtube.com/watch?v=yW8QUzt78tI	Revise previousclass – (5 mins) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Observe Field patterns of TE and TM modes using HFSS
Day-7	Power Transmission and Power Losses in Rectangular Guide. Related Problems	To understand and analyze power transmission and losses in waveguide	Lecture Video https://www.youtube.com/watch?v=y3mhRX5zvU4	Revise previousclass – (5 mins) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Power Transmission and power losses in rectangular waveguide
Day-8	Mode Characteristics – Phase and Group Velocity ,Wavelengths	To understand and analyze waveguide parameters	Lecture Video https://www.youtube.com/watch?v=dovtg-kG8uY	Revise previousclass – (5 mins) PPT presentation (40 min)	Assignment: Problems on waveguide parameters

	and Impedance Relations			Doubts clarification (5 min)	
Day-9	Problems on Waveguide parameters	To understand and analyze problems on waveguide parameters	Lecture Video https://www.youtube.com/watch?v=FZYFaW4ciTY	Revise previousclass – (5 mins) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on waveguide parameters Quiz on Microwave Transmission Lines

Schedule and Sequence: Day Plan for Lesson 2 - Circular Waveguides

Lesson 2– Total Classes 9

Lesson-2 Total Classes -9	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Introduction, Nature of Fields, Characteristic Equation,	To understand and analyze circular waveguide through TE mode	Lecture Video https://www.youtube.com/watch?v=h_MqOMQix20	Discussion on pre-requisites (10 Min) Chalk and Board (30 Min) Doubts clarification (10 min)	Assignment: Circular waveguide TE mode analysis
Day-2	Circular WG analysis	To understand and analyze circular waveguide through TM and TEM mode	Lecture Video https://www.youtube.com/watch?v=CCBdeVRMip8	Revise previousclass – (5 mins) Chalk and Board (40 min) Doubts clarification (5 min)	Assignment: Design of Circular waveguide through HFSS and determine cut-off frequency
Day -3	Dominant and Degenerate Modes. Impossibility of TEM mode	To identify dominant and degenerate modes in circular waveguide	https://www.youtube.com/watch?v=rrgou8Qne_E	Revise previousclass – (5 mins) PPT Presentation (40 min)	Assignment: Dominant and Degenerate Modes in circular waveguide

				Doubts clarification (5 min)	
Day - 4	Micro-strip Lines– Introduction, Zo Relations,	To understand the concept of Micro-strip line and Determine relation for characteristic impedance	Lecture Video https://www.youtube.com/watch?v=ZTKDZ6QPMIE	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Design of Micro-strip line using HFSS and observe field pattern
Day-5	Effective Dielectric Constant, Losses, Q Factor	To determine Q-Factor and Dielectric constant for Micro-strip line	Lecture Video https://www.youtube.com/watch?v=Ya0IDMOTuPA	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Q-Factor and Dielectric constant for Micro-strip line
Day-6	Cavity Resonators– Introduction, Rectangular and Cylindrical Cavities- Resonant Frequencies	To understand the concept of Cavity resonator and determine the resonant frequencies for rectangular and circular waveguide for TE and TM mode	Lecture Video https://www.youtube.com/watch?v=ij760lCUtfw	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Design of Rectangular and circular cavity resonator using HFSS and observe field patterns
Day-7	Field expressions	To analyze rectangular and circular cavity resonator through TE and TM mode	Lecture Video https://www.youtube.com/watch?v=gsLJNC84Vrc	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Design of Rectangular and circular cavity resonator using HFSS and observe field patterns
Day-8	Q factor and Coupling Coefficients	To determine coupling Coefficients and Q factor for Cavity resonator	Lecture Video https://www.youtube.com/watch?v=1U11VP7Fgq4	Revise previousclass – (5 mins) PPT Presentation (40 min)	Assignment: Design of Rectangular and circular cavity resonator using HFSS and observe field patterns

				Doubts clarification (5 min)	
Day-9	Excitation techniques-waveguides and Cavities	To understand the mechanism of excitation of waveguides and cavities for TE and TM mode	Lecture Video https://www.youtube.com/watch?v=WAgEiyr_GjY	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Implementation of TE and TM mode for waveguides using HFSS Quiz on Circular waveguides

Schedule and Sequence: Day Plan for Lesson 3 – Microwave Tubes

Lesson 3– Total Classes 9

Session/week/ Lesson-1 Total Classes -9	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Limitations and Losses of conventional tubes at microwave frequencies	To Understand the Limitations and Losses of conventional tubes at microwave frequencies	Lecture Video https://www.youtube.com/watch?v=5Ab1ZXcEwRg	Discussion on pre-requisites (10 Min) PPT presentation (30 Min) Doubts clarification (10 min)	Discussion forum on Limitations and Losses of conventional tubes at microwave frequencies
Day-2	Microwave tubes – O type and M type classification s.	To understand the classification of Microwave tubes	Lecture Video https://www.youtube.com/watch?v=goeuUrrPVYQ	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: classification of Microwave tubes
Day -3	O-type tubes : 2 Cavity Klystrons – Structure	To Understand the concept of Two cavity Klystron	Lecture Video https://www.youtube.com/watch?v=yPpreB0_6cA	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Practical applications of Two cavity Klystron

Day - 4	Reentrant Cavities, Velocity Modulation Process and Applegate Diagram	Understand the concept of Reentrant cavities and analyze the velocity modulation equation for 2 Cavity klystron	Lecture Video https://www.youtube.com/watch?v=Ksv9QcPsL00 https://www.youtube.com/watch?v=B6Glxl_2mg	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Two cavity Klystron Amplifier
Day-5	Bunching Process and Small Signal Theory – Expressions for o/p Power and Efficiency	To understand and analyze bunching process, output power	Lecture Video https://www.youtube.com/watch?v=fEMerwZwjSk	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Two cavity Klystron Amplifier
Day-6	Reflex Klystrons – Structure, Applegate Diagram Principle of working,	To Understand the concept of Reflex Klystron	Lecture Video https://www.youtube.com/watch?v=3MFHFuddLZI	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Practical applications of Reflex Klystron oscillator
Day-7	Mathematical Theory of Bunching, Power Output, Efficiency	To understand and analyze velocity modulation, bunching process and efficiency for Reflex Klystron	Lecture Video https://www.youtube.com/watch?v=fEMerwZwjSk	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Reflex Klystron oscillator
Day-8	Electronic Admittance; Oscillating Modes and o/p Characteristics	To determine Electronic admittance of Reflex Klystron and observe the output characteristics	Lecture Video https://www.youtube.com/watch?v=3MFHFuddLZI	Revise previousclass – (5 mins) PPT Presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Reflex Klystron oscillator
Day-9	Electronic and Mechanical Tuning,	To understand the concept of Electronic and	Lecture Video https://www.youtube.com/watch?v=PAqWflbx8Z8	Revise previousclass – (5 mins)	Assignment: Problems on Electronic and Mechanical Tuning

	Related Problems	Mechanical Tuning		PPT Presentation (40 min) Doubts clarification (5 min)	Quiz on Microwave Tubes
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Schedule and Sequence: Day Plan for Lesson 4 – **HELIX TWTS**

Lesson 4– Total Classes 8

Session/week/ Lesson-1 Total Classes -8	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Significance, Types and Characteristics of Slow Wave Structures, Structure of TWT	To Understand the concept of Slow Wave Structures	Videos https://www.youtube.com/watch?v=IMywVY_au20 https://www.youtube.com/watch?v=bvexKR1I0Rg	Discussion on pre-requisites (10 Min) PPT presentation (30 Min) Doubts clarification (10 min)	Discussion on difference between Klystron and Helix TWT
Day-2	Amplification Process (qualitative treatment), Suppression of Oscillations	To understand the concept of Helix TWT	Videos https://www.youtube.com/watch?v=6wuxnkc4t4	Revise previous class – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Determine Axial Electric field for Helix TWT
Day -3	Nature of the four Propagation Constants	To understand and analyze the four propagation constants in Helix TWT	Videos: https://www.youtube.com/watch?v=00PS5YgPo3c	Revise previous class – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Determine Nature of the four Propagation Constants for Helix TWT
Day - 4	Gain Considerations	To determine Axial Electric field, output current and gain for Helix TWT	Videos https://www.youtube.com/watch?v=74ftc4FCmJM	Revise previous class – (5 min) PPT presentation (40 min)	Assignment: Problems on Helix TWT

				Doubts clarification (5 min)	
Day-5	Cross-field effects, Magnetrons – Types	To understand the concept crossed field tubes	Videos https://www.youtube.com/watch?v=XJl9YBeCp_I	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on Crossed field tubes and Linear beam tubes
Day-6	8-Cavity Cylindrical Travelling Wave	To understand and analyze the concept of Magnetron	Videos https://www.youtube.com/watch?v=gnPVPfVmFwE	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Applications of Magnetron
Day-7	Magnetron – Hull Cut-off Conditions	To determine Hull Cut-off Condition for Magnetron	Videos https://www.youtube.com/watch?v=DKxcPN9yxvI	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Hull cut off condition
Day-7	Hartree Conditions	To determine Hartree Condition for Magnetron	Videos https://www.youtube.com/watch?v=DKxcPN9yxvI	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Hartree off condition
Day-8	Modes of Resonance and PI-Mode Operation Separation of PI-Mode, o/p characteristics.	To understand the concept of Modes of Resonance	Videos https://www.youtube.com/watch?v=ty8H9_OGKsE	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Helix TWT and Magnetron Quiz on Helix TWT and Magnetron

Schedule and Sequence: Day Plan for Lesson 5 – **Waveguide Components and Applications - I**

Lesson 5– Total Classes 11

Session/week/ Lesson-1 Total Classes -11	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Coupling Mechanisms –Probe, Loop, Aperture types	To Understand the various coupling mechanisms	Videos https://www.youtube.com/watch?v=K8AailaWBOU	Discussion on pre-requisites (10 Min) PPT presentation (30 Min) Doubts clarification (10 min)	Discussion on different coupling mechanisms
Day-2	WG Discontinuities – irises, Screws and Posts, Matched Loads	To understand the concept of WG Discontinuities various types	Videos https://www.youtube.com/watch?v=FzEMotd17nk https://www.youtube.com/watch?v=TwHPKULI4A	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on impedance matching
Day -3	Waveguide Attenuators Resistive Card, Rotary Vane types; WG Phase Shifters - Dielectric, Rotary Vane types	To understand the different types of waveguide attenuators and waveguide Phase shifters	Videos https://www.youtube.com/watch?v=iBO9GC5COww https://www.youtube.com/watch?v=5MfTmxdMcg4	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on waveguide attenuators and phase shifters
Day - 4	Scattering Matrix– Significance, Formulation and Properties	To understand and analyze scattering parameters for N port Network	Videos https://www.youtube.com/watch?v=ndZBmO1L-dk	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on various Network parameters

Day-5	Multiport Junctions: S-Matrix Calculations for E-plane Tee Junction	To determine Scattering Matrix for E-plane Tee Junction	Videos https://www.youtube.com/watch?v=5Q4TNO1gMc	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Scattering parameters calculations
Day-6	S-Matrix Calculations for H-plane Tee Junction	To determine Scattering Matrix for H-plane Tee Junction	Videos https://www.youtube.com/watch?v=F2HQTglm2Zg	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on Scattering parameters calculations
Day-7	Magic Tee	To determine Scattering Matrix for Magic Tee Junction and understand the applications of Magic tee	Videos https://www.youtube.com/watch?v=if30sXaKWkY	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on various Tee Junctions
Day-8	Hybrid Ring Directional Couplers – 2Hole, Bethe Hole types,	To determine Scattering Matrix for Hybrid Ring Junction and understand the concept of directional coupler and its S-Matrix	Videos https://www.youtube.com/watch?v=AS4XC6qP-Xs	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on S-Matrix calculation for directional coupler
Day-9	Ferrite Components– Faraday Rotation	To understand the concept faraday rotation principle	Videos https://www.youtube.com/watch?v=GshXfonRkuc	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on ferrite components behaviour
Day-10	Construction and operation of Gyrator,	To understand the concept Gyrator and Isolator and	Videos	Revise previousclass – (5 min)	Discussion on use of ferrite devices in Microwave applications

	Isolator and its S-Matrix	determine its S-Matrix	https://www.youtube.com/watch?v=uJBq7T00EEg https://www.youtube.com/watch?v=MzfYQvzpA9A	PPT presentation (40 min) Doubts clarification (5 min)	
Day-11	Circulator	To understand the concept Circulator and determine its S-Matrix	Videos https://www.youtube.com/watch?v=au9tNIvHxvA	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on use of ferrite devices in Microwave applications Quiz on Waveguide components and its applications

Schedule and Sequence: Day Plan for Lesson 6 – Microwave Solid State Devices

Lesson 6– Total Classes 10

Session/week/ Lesson-1 Total Classes -10	Topic	Objectives	Before Class - Videos, e-Books, Case studies	In-Class – Activities, Quiz (Micro teaching)	Post Class - Assignment, Discussion Forum
Day-1	Introduction, Classification, Applications. TEDs –Characteristics	To classify microwave solid state devices and understand the applications of solid state devices	Videos https://www.youtube.com/watch?v=7T6p0Hx23KA	Discussion on pre-requisites (10 Min) PPT presentation (30 Min) Summery (5min) Doubts clarification (10 min)	Discussion on types of Microwave solid state devices
Day-2	Introduction, Gunn Diode – Principle, RWH Theory	To understand the principle of Gunn diode and Two valley theory	Lecture Video https://www.youtube.com/watch?v=EDgq4u_xvgo	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on practical applications of Gunn Diode

Day -3	Basic Modes of Operation, Oscillation Modes	To Understand the various modes of operation of Gunn diode	Lecture Video https://www.youtube.com/watch?v=loebcNhnEOw	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on practical applications of Gunn Diode
Day - 4	Transit Time Devices – Introduction IMPATT	To understand the basic principle of IMPATT Diode	Lecture Video https://www.youtube.com/watch?v=byAogY_pOUM	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on Avalanche transit time devices
Day-5	TRAPATT Diodes	To understand the basic principle of operation of TRAPTT Diode	Lecture Video https://www.youtube.com/watch?v=llGntJWJbks	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on Avalanche transit time devices
Day-6	Description of Microwave Bench – Precautions	To understand Microwave Bench Setup for measurements	Videos: https://www.youtube.com/watch?v=HoX9XXn027w	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on Microwave Bench setup
Day-7	Different Blocks and their Features in Bench Setup	To understand basic properties of waveguide components and measurement instruments	Videos: https://www.youtube.com/watch?v=HoX9XXn027w	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Discussion on Microwave Bench setup
Day-8	Microwave Power Measurement : Bolometer Method.	To measure parameters like attenuation, power using	Videos: https://www.youtube.com/watch?v=nnSYF2f1x9c	Revise previousclass – (5 min) PPT presentation	Assignment: Problems on measurement of various parameters

	Measurement of Attenuation	Microwave Bench Setup		(40 min) Doubts clarification (5 min)	using microwave bench setup
Day-9	Frequency, VSWR, Measurements	To measure parameters like VSWR, Frequency using Microwave Bench Setup	Videos: https://www.youtube.com/watch?v=nnSYF2f1x9c	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Assignment: Problems on measurement of various parameters using microwave bench setup
Day-10	Cavity Q. Impedance Measurements.	To measure parameters like Quality Factor, Impedance using Microwave Bench Setup	Lecture video: https://www.youtube.com/watch?v=nnSYF2f1x9c	Revise previousclass – (5 min) PPT presentation (40 min) Doubts clarification (5 min)	Quiz on Solid state Devices and Microwave Measurements