III B.Tech ECE II Sem - RF SYSTEM DESIGN (20A04605P)

List of Experiments

- **1.** Design of $\lambda/2$, $\lambda/4$ microstrip transmission line.
- 2. Design and characterization of Micro strip patch antenna.
- 3. Analyse of a Microstrip Transmission Line and standing wave pattern at various frequencies
- 4. Measure the S parameter of a Microstrip Transmission Line and plot the normalised impedance on a smith chart.
- 5. Design of microstrip inductor and capacitor.
- 6. Design of impedance matching network.
- 7. Design and characterization of RF BJT Amplifier and LNA.
- 8. Design of low pass, high pass, band pass and band stop filter at RF.
- 9. Design and characterization of RF Mixer.
- 10. Design and characterization of VCO.
- 11. Design and simulate a Schottky Diode and RF Switch.
- 12. Analyse and measure the gain of a Power Amplifier and equalize its gain using an Equalizer.

Introduction to HFSS

RF SYSTEM DESIGN HFSS

HFSS is a high-performance full-wave electromagnetic (EM) field simulator for arbitrary 3D volumetric passive device modeling that takes advantage of the familiar Microsoft Windows graphical user interface. It integrates simulation, visualization, solid modeling, and automation in an easy-to-learn environment where solutions to your 3D EM problems are quickly and accurately obtained. Ansoft HFSS employs the Finite Element Method (FEM), adaptive meshing, and brilliant graphics to give you unparalleled performance and insight to all of your 3D EM problems. Ansoft HFSS can be used to calculate parameters such as S Parameters, Resonant Frequency, and Fields.

HFSS USES

Typical uses include:

- Package Modeling BGA, QFP, Flip-Chip.
- PCB Board Modeling
 Power/Ground planes, Mesh Grid Grounds, Backplanes.
- Silicon/GaAs

Spiral Inductors, Transformers.

• EMC/EMI

Shield Enclosures, Coupling, Near- or Far-Field Radiation

Antennas/Mobile Communications

Patches, Dipoles, Horns, Conformal Cell Phone Antennas, Quadrafilar Helix, Specific Absorption Rate(SAR), Infinite Arrays, Radar Cross Section(RCS), Frequency Selective Surfaces(FSS).

The Ansoft HFSS window has several optional panels:

- i. Project Manager
- ii. Message Manager
- iii. Property Window
- iv. Progress Window
- v. 3D Modeler Window

These above managers and windows are shown in Fig (1) and their details are given in coming sections.



Project Manager

A Project Manager which contains a design tree which lists the structure of the project is shown in Fig (2).



Message Manager

A Message Manager that allows you to view any errors or warnings that occur before you begin a simulation is shown in Fig (3).

	Message Manager
Message Manager	 Ima_test6 (F:/tmp/hfss9/) Image: Main Image: Main Image: Solution Setup 'Setup1': When using I Image: Solution Setup 'Setup1': When using I
	x

Property Window

A Property Window that displays and allows you to change model parameters or attributes is shown in Fig (4).

Name	Value	Unit
Name	Box1	
Material	Vacuum	*
Solve Inside		
Orientation	Global	
Model		
Display Wireframe		
Color	Edit	
Transparent	0.4	

Progress Window

A Progress Window that displays solution progress is shown in Fig (5).

ogress			
Setup1: Solving Adap	otive Pass #1 - Building Matrix	on	Progress
Solving LumpPort2	Abort	-	- Window
Solving LumpPort2	Abort	•	- Windo

3D Modeler Window

A 3D Modeler Window which contains the model and model tree for the active design is shown in Fig (6), model and model tree are shown in Fig (7) and Fig (8) respectively.



Ansoft HFSS 3D Modeler Window.



3D Modeler Design Tree.



Design Windows

In the Ansoft HFSS Desktop, each project can have multiple designs and each design is displayed in a separate window. You can have multiple projects and design windows open at the same time. Also, you can have multiple views of the same design visible at the same time.

To arrange the windows, you can drag them by the title bar, and resize them by dragging a corner or border. Also, you can select one of the following menu options: Window >Cascade, Window >Tile Vertically, or Window > Tile Horizontally.

To organize your Ansoft HFSS window, you can iconize open designs. Click the Iconize ** symbol in the upper right corner of the document border. An icon appears in the lower part of the Ansoft HFSS window. If the icon is not visible, it may be behind another open document. Resize any open documents as necessary. Select the menu item Window > Arrange Icons to arrange them at the bottom of the Ansoft HFSS window. Select the menu item Window > Close All to close all open design. You are prompted to Save unsaved designs.



Design Window.

Design icons

Toolbars

The toolbar buttons are shortcuts for frequently used commands. Most of the available toolbars are displayed in this illustration of the Ansoft HFSS initial screen, but your Ansoft HFSS window probably will not be arranged this way.

You can customize your toolbar display in a way that is convenient for you. Some toolbars are always displayed; other toolbars display automatically when you select a document of the related type. For example, when you select a 2D report from the project tree, the 2D report toolbar displays, as shown in Fig (9)



Ansoft HFSS Toolbars.

To display or hide individual toolbars

- Right-click the Ansoft HFSS window frame.
 - A list of all the toolbars is displayed. The toolbars with a check mark beside them are visible; the toolbars without a check mark are hidden. Click the toolbar name to turn its display on or off.
- To make changes to the toolbars, select the menu item Tools > Customize.



Ansoft HFSS Panels and Toolbars.

Customize and Arrange Toolbars

To customize toolbars:

- Select the menu item Tools > Customize, or right-click the Ansoft HFSS window frame and click Customize at the bottom of the toolbar list.
- In the Customize dialog, you can do the following: o

View a Description of the toolbar commands.

- i. Select an item from the Component pull-down list.
- ii. Select an item from the Category list.
- iii. Using the mouse click on the Buttons to display the Description.
- iv. Click the Close button when you are finished.

Toggle the visibility of toolbars

- i. From the Toolbar list, toggle the check boxes to control the visibility of the toolbars.
- ii. Click the Close button when you are finished.

lescription, or drag it to a toolbar. Toolbar name:
Project
L. Caracia
SelectAll

Ansoft HFSS customize.

Ansoft HFSS Desktop

The Ansoft HFSS Desktop provides an intuitive, easy-to-use interface for developing passive RF device models. Creating designs, involves the following:

- i. **Parametric Model Generation** creating the geometry, boundaries and excitations.
- ii. Analysis Setup defining solution setup and frequency sweeps.
- iii. **Results** creating 2D reports and field plots.
- iv. **Solve Loop** the solution process is fully automated.

To understand how these processes co-exist, examine the illustration shown In Fig(12).

Ansoft HFSS Desktop.



Opening a HFSS project

This section describes how to open a new or existing project.

Opening a New project

To open a new project:

- i. In an Ansoft HFSS window, select the menu item File > New.
- ii. Select the menu Project > Insert HFSS Design.

Opening an Existing HFSS project

To open an existing project:

- i. In an Ansoft HFSS window, select the menu File > Open. Use the Open dialog to select the project.
- ii. Click Open to open the project

Open			2 🔀
Look in: 🔎	srrousse	🛨 🗗 🗢 💽	
i⇔hf_diffpair.ł ▲hf_diffpair.ł	nfssresults nfss		
File name:🔓	hf_diffpair.hfss		Open
Files of type:	Ansoft HFSS Project Files (*.hfss)	_	Cance

Opening a HFSS project.

Opening an Existing Project from Explorer

You can open a project directly from the Microsoft Windows Explorer. To open a project from Windows Explorer, do one of the following:

- i. Double-click on the name of the project in Windows Explorer.
- ii. Right-click the name of the project in Windows Explorer and select Open from the shortcut menu.

Set Solution Type

This section describes how to set the Solution Type. The Solution Type defines the type of results, how the excitations are defined, and the convergence. The following Solution Types are available:

- i. **Driven Modal** calculates the modal-based S-parameters. The S-matrix solutions will be expressed in terms of the incident and reflected powers of waveguide modes.
- ii. **Driven Terminal** calculates the terminal-based S-parameters of multiconductor transmission line ports. The S-matrix solutions will be expressed in terms of terminal voltages and currents.
- iii. **Eignemode** calculate the eigenmodes, or resonances, of a structure. The Eigenmode solver finds the resonant frequencies of the structure and the fields at those resonant frequencies.

Convergence

- i. **Driven Modal** Delta S for modal S-Parameters. This was the only convergence method available for Driven Solutions in previous versions.
- ii. **Driven Terminal New** Delta S for the single-ended or differential nodal S-Parameters.
- iii. Eigenmode Delta F

To set the solution type:

Select the menu item HFSS > Solution Type Solution Type Window:

- Choose one of the following:
 Driven Madel
 - Driven Modal
 - Driven Terminal
 - o Eigenmode
- Click the OK button



Solution Type.

Parametric Model Creation

The Ansoft HFSS 3D Modeler is designed for ease of use and flexibility. The power of the 3D Modeler is in its unique ability to create fully parametric designs without editing complex macros/model history.

The purpose of this section is to provide an overview of the 3D Modeling capabilities. By understanding the basic concepts outlined here you will be able to quickly take advantage of the full feature set offered by the 3D Parametric Modeler.





Exp.No: 01

MICROSRIP TRANSMISSION LINE

a). Aim: Design of $\lambda/2$, microstrip transmission line.

Apparatus Required:

- 1. <u>Computer</u>
- 2. <u>Hfss software.</u>

Procedure:

- 1. Open HFSS software and Insert new HFSS design.
- 2. Adjust the co-ordinates.
- 3. Create a ground plane(Rectangular).
- 4. Create a dielectric substrate with FR4_Epoxy material with same size of ground plane with z-height 1.6mm.
- 5. Creating the TL the ground plane & substance.
- 6. Create two ports (port1&port2).
- 7. Now give the perfect E to ground .
- 8. Create assign excitation-lampudport.
- 9. Then create radiation boundary on the designed ground and assign boundary **b**. The radiation should be given to all the faces except at ground.
- 10. Assign frequency and no. of passes.
- 11. Now add freq sweep fast linear count.
- 12. Now check validation and analyze all.
- 13. Then go to results Create model solution rectangular plot new report. Plot both
- 14. Then click HFSS click radiation click far field infinite sphere and give values to phi and theta.
- 15. Then click on results and create far field.
- 16. Click plot of 3D gain-dB new report.

Tabular Column:

DESIGN CONSIDERATIONS Parameters	Width	Length	Height	Position
Ground plane				
substance				
TL				
Port1				
Port2				
radiation boundary				

Date:

Design: MICROSTRIP TRANSMISSION LINE Λ/2 USING HFSS (5 GHZ)



Open HFSS project-click project, open - project insert HFSS design. DESIGN GROUN PLAN: Select click rectangular draw



Double click rectangle1

الكغ

Name : [ground plan] , Colour : edit [as your wish] before name change

after name change

Name Value Unit Evaluated Value Description Read only Name Rectangle1 Image: Construction Good Image: Construction Good Image: Construction Read only	-							Attri	oute					
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Double click create rectangle:

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Axis : z	Command				
	Name	Value	Unit	Evaluated Value	Description
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Y size : 30 mm	YSize	30	mm	2.4mm	
01					
Ok					
	,				
					Show Hidden
-					OK Cancel

Select fit all the contents in the view

CREATE SUBSTANCE

Select draw the BOX and design



Double click box 1 23 Properties: mstrip new ok - HFSSDesign1 - Modeler (rename Attribute substance) Name Value Unit Evaluated Value Description Read-only Material -Name substance Г Material "FR4_epoxy" "FR4_epoxy" edit fr4 - (4.4) Solve Inside **v** Г Orientation Global Select colour Model • Display Wirefra. Г Ok Г Color Edit Transparent 0 Γ Show Hidden Cancel OK

Double click create box

Position 0,0,0	Properties	s: mstrip new ok · nd	- HFSSDesign1 - Modeler				×
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Z size- 1.6mm Ok						Show Hidden	Cancel

DESIGN TRANSMISSION LINE

Select rectangle design center draw



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ename - TL	Name	Value	Unit	Evaluated Value	Description	Read-only
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olour edit	Orientation	Global				
k	Model	~				
ĸ	Display Wirefra					
	Color	Edit				
	Transparent	0				
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Position –	Properties	s: Project1 - HFSS	Design1 - Modeler				8
	Comman	d					
6, 0, 1.6		Name	Value	Unit	Evaluated Value	Description	
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X axis –		Axis	Z				
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3mm							1
Y size –							
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30mm						Show Hidden	
Ok						ок с	ancel

DESIGN PERFECT ELECTRIC BOUNDARY - click TL

 $Right \ click-assign \ boundary-perfect \ E-CLICK-name: \ perfE1 \ - \ ok$



Click ground plan - right click-assign boundary-perfect E - click - name: perfE2 ok



Design **ports** : (1&2)

Change ZX

Select draw rectangle design transmission line port1



Double click rectangle1

Rename port1	Properti	ies: Project1 - HFSS	Design1 - Modeler			2
ok	Comma	and				
	E	Name	Value	Unit	Evaluated Value	Description
Double click		Command	CreateRectangle			
araata		Coordinate Sys	Global			
create		Position	6,0,1.6	mm	6mm , 0mm , 1	
rectangle		Axis	Y			
recoungie	-	XSize	3	mm	3mm	
Position-	-	ZSize	-1.6	mm	-1.6mm	
(6,0,1.6)						
Axis-Y						
X size-3mm	L					Show Hidden
Z size-						
(-1.6mm) ok						OK Cance

Select port1-right click assign excitation-lumped port-click-name1-resistance 50 ohms-next select none new line –draw a line-defined-next-full port impedance 50 ohms finish

Design port2

Take rectangle - Select draw rectangle design transmission line port2



Rename						
rectangle2	Properties: Project1 - H	FSSDesign1 - Modeler				23
-	Command					
double click		1		[=		
port2 ok	Command	Value	Unit	Evaluated Value	Description	
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Crate rectangle	Position	9 ,30 ,1.6	mm	9mm , 30mm , 1		
double click	Axis	Y		-		_
	ZSize	-3	mm	-3mm -1.6mm		-
Position -						
(9,30,1.6)						
Axis - Y						
X size (3mm)	r.				Show Hidden	
Z size (1.6mm)					ок	Cancel
ok						00001

Select port2-right click assign excitation-lumped port-click-name 2-resistance - 50 ohms-next select none new line –draw a line-defined-next-full port impedance - 50 ohms – finish



Select XY

Design radiation boundary

Draw box



RF SYSTEM DESIGN

double click box1	Prope	rties: RANI - HFS	SSDesign1 - Modele	r					X
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Y size-50mm	_	Position XSize	-7.5 ,-7.5 ,-15 30			mm mm	-7.5mm , -7.5m 30mm		_
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Z size-30mm		ZSize	30			mm	30mm		
								C Show Hidder	Cancel
Fit all			1		· ·				
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AM Feb 24, 2023) All Invalid part name: Valid characters PM Feb 24, 2023)	are letters, numbers,	, underscores. (12:13:55	Progress						

Click radiation boundary-right click-assign boundary -radiation click name rad1 ok - 5 × 1 40. 5° 400 to 8° 6° 6° Solids ⇒ Box1 ⇒ Box1 ⇒ CreateBox ⇒ FR4.epoxy ⇒ ⇒ substance ⇒ Sheets ⇒ Lumped Port ⇒ Prefect E Loordinate System Planes Project 1* Project 2* Project 1* Project 1* Project 1* Project 1* Project 1* Project 2* Projec Propertie lue Unit Eva HFSS [ge Mana 🔺 🗙 Project 1 (C:/Users Invalid part name: Valid characters a AM Feb 24, 2023) Invalid part name: Valid characters a PM Feb 24, 2023) , Ild characters an Analysis -right click add solution setup click name setup1 solution frequency-5GHz Maximum number of passes -12 Maximum Delta S-0.02 ok Analysis right click- setup1 right click - add frequency sweep Sweep type : fast Type : linear count Start freq:1GHZ Stop freq:10GHZ Count:101GHZ Click display-see all frequencies ok Result analysis(error checking) Click double click validity Validation Check: Project1 - HFSSDesign1 X HFSS Designdesign setting 🛷 Design Settings 3D model IFSSDesign1 3D Model Boundaries and 🖋 Boundaries and Excitations excitations 🛷 Mesh Operations Validation Check completed. Errors: 1 Warnings: 0 Mesh operation 👪 Analysis Setup 🗸 Optimetrics Analysis setup 🖋 Radiation Optimetrics See Message Window for details. Radiation Close Abort









b). Aim: Design of $\lambda/4$ micro strip transmission line.

Design: MICROSTRIP TRANSMISSION LINE A/4 USING HFSS (5 GHZ)

Open HFSS project-click project, open - project insert HFSS design.



Double click rectangle1

Name : [ground plan] , Colour : edit [as your wish]



RF SYSTEM DESIGN

Double	Propert	ies: mstlambdaby4	nms - HFSSDesign1 - Modeler			[×
click	Comm	and					
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		Axis	Z				
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0.0.0		YSize	15	mm	15mm		
Axis : z X size : 7.5							
mm	I					Show Hidden	
Y size : 15							
mm						OK Can	cel

Ok Select fit all the contents in the view

CREATE SUBSTANCE : Select draw the **BOX** and design





,	Name	Value	Unit	Evaluated Value	Description	Read-only
	Name	substance				
	Material	"FR4_epoxy"		"FR4_epoxy"		
	Solve Inside	~				
	Orientation	Global				
	Model	v				
	Display Wirefra					
	Color	Edit				
	Transparent	0	1			
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RF SYSTEM DESIGN

Double click	Properti	es: mstlambdaby4	nms - HFSSDesign1 - Modeler				23
create box	Comma	and					
Material – edit	Г	Name	Value	Unit	Evaluated Value	Description	
fr4 - (4.4)	-	Command	CreateBox				
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15mm							
Z size-							
1.6mm						Show Hidden	
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DESIGN TRANSMISSION LINE

Select rectangle design center draw

Double click **reactangle1** rename – **TL** Colour edit Ok

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Model							
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Double click Create rectangle:	Properties: mstlambdaby Command) Name Command	/4nms - HFSSDesign1 - N	Nodeler Value		Unit	Evaluated Value	Description
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Double click Create rectangle: Position:	Properties: mstlambdaby Command Command Coordinate Sys. Position	4nms - HFSSDesign1 - N CreateRectangle Global 2.25.0,1.6	Vodeler Value		Unit	Evaluated Value	Description
Double click Create rectangle: Position: 2.25, 0, 1.6	Properties: mstlambdaby Command Command Coordinate Sys. Position Axis YSize	4nms - HFSSDesign1 - N CreateRectangle Global 2.25,0,1.6 Z	Aodeler Value		Unit mm	Evaluated Value	Description
Double click Create rectangle: Position: 2.25, 0, 1.6	Properties: mstlambdaby Command Command Coordinate Sys. Position Axis XSize YSize	4nms - HFSSDesign1 - N CreateRectangle Global 2.25,0,1.6 Z 3 15	Vodeler Value		Unit mm mm	Evaluated Value	Description
Double click Create rectangle: Position: 2.25, 0, 1.6 Axis : z	Properties: mstlambdaby Command Command Coordinate Sys. Position Axis XSize YSize	Anms - HFSSDesign1 - N CreateRectangle Global 2.25,0,1.6 Z 3 15	Vodeler Value		Unit mm mm mm mm	Evaluated Value 2.25mm , 0mm 3mm 15mm	Description
Double click Create rectangle: Position: 2.25, 0, 1.6 Axis : z X axis: 3mm	Properties: mstlambdaby Command Command Coordinate Sys Position Axis XSize YSize	Anms - HFSSDesign1 - N CreateRectangle Global 2.25,0,1.6 Z 3 15	Value		Unit mm mm mm mm	Evaluated Value 2.25mm , 0mm 3mm 15mm	Description
Double click Create rectangle: Position: 2.25, 0, 1.6 Axis : z X axis: 3mm Y size :	Properties: mstlambdaby Command Command Coordinate Sys Position Axis XSize YSize	Anms - HFSSDesign1 - N CreateRectangle Global 2.25,0,1.6 Z 3 15	Value		Unit mm mm mm	Evaluated Value 2.25mm , 0mm 3mm 15mm	Description

DESIGN PERFECT ELECTRIC BOUNDARY - click TL

Right click - assign boundary-perfect E-CLICK-name: perfE1 - ok



Click ground plan - right click-assign boundary-perfect E - click - name: perfE2 ok





Double click re Rename port1 of Double click cre Position-	ctangl ok ate rec	e1 ctangle	nms - HFSSDesign1 - Modeler				
(2.25, 0, 1.6)	Comma	and	-				
Axis-Y	Г	Name	Value		Unit	Evaluated Value	Description
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3mm	-	XSize	3	m	m	3mm	
Z size-		ZSize	-1.6	m	m	-1.6mm]
(-1.6mm)							
ok	Ļ						
Select port1-							Show Hidden
right click							OK Canc

assign excitation-lumped port-click-name1-resistance 50 ohms-next, select none new line –draw a line-defined-next-full port impedance 50 ohms finish

Design port2 Take rectangle - Select draw rectangle design transmission line port2



Select port2-right click assign excitation-lumped port-click-name1-resistance - 50 ohms-next select none new line –draw a line-defined-next-full port impedance - 50 ohms - finish



Select XY

Design radiation boundary

Draw **box**

■ File Edit View Project Draw Modeler □ → □ × ∞ □	HFSS Tools Window Help	lastra ta						_ = ×
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Project Manager	Solids							
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double click box1	Proper	ties: RANI - HFSSDe ute	sign1 - Modeler					×
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VEMU INSTITUTE OF TECHNOLOGY, DEPT OF E.C.E

Cancel

ОК

Double click	Propertie	s: mstlambdaby4	nms - HFSSDesign1 - Modeler			
create box	Commar	nd				
		Name	Value	Unit	Evaluated Value	Description
Position- (-3,-3,-3)		Command	CreateBox			
		Coordinate Sys	Global			
X size-15mm		Position	-3 ,-3 ,-3	mm	-3mm , -3mm ,	
		XSize	15	mm	15mm	
Y size-25mm		YSize	25	mm	25mm	
		ZSize	15	mm	15mm	
Z size-15mm						
ok						
Fit all						
1 it un						Show Hidden

Click radiation boundary-right click-assign boundary -radiation click name rad1 ok



٧

Analysis -right click add solution setup click name setup1 solution frequency-5GHz

Maximum number of passes -12

Maximum Delta S - 0.02 ok

Analysis right click- setup1 right click - add frequency sweep

Sweep type : fast	Validation Check: Project1 - HFSSDesign1	8
Type : linear count		✓ Design Settings
Start freq:1GHZ	W HFSSDesign1	 3D Model Boundaries and Excitations
Stop freq:10GHZ	Validation Check completed. Errors: 1 Warnings: 0	 Mesh Operations Analysis Calus
Count:101GHZ		Arialysis Setup Optimetrics
Click display-see all frequencies ok	See Message Window for details.	✓ Hadiation
Result analysis(error checking)		
Click double click validity	AbortUose	
HFSS Design- design setting		
3D model		
Boundaries and excitation	ons	
Mesh operation		
Analysis setup		
Optimetrics		
Radiation		
Next analysis all-any error rectify-ok		
alidation Check: Project1 - HFSSDesi	gn1	23
HFSSDesign1	 ✓ Design ✓ 3D Mo ✓ Bound 	Settings del aries and Excitations
Validation Check completed.	✓ Mesh 0 ✓ Analys ✓ Optime ✓ Radiat	Dperations is Setup trics ion
Abort Clo	ose	

Model Waveforms: 5 GHZ (SParameter)



3d graphs

E File Edit View Project Report3D HFSS	Tools Window Help	_ 8 ×
🗋 🖬 🖬 🛝 📾 📾 🗡 🗅 🗠 📗		
🐵 🚯 🛛 🕲 🕲 🕲 🕲		
Project Manager • ×		
Constant Constant	B (kalm (a kal) -5, 4746 e 400 -7, 2836 e 4000 -7, 2836 e 4000 -7, 2836 e 4000 -1, 1984 e 4001 -1, 1983 e 4001 -1, 1983 e 4001 -2, 1983 e 4001 -2, 1983 e 4001 -2, 2538 e 4001 -2, 3983 e 4001 -3, 083 e 4001 -3, 083 e 4001 -3, 1983	
V Objects "substance" and "radiation 2023) Objects "substance" and "radiation 2023) Objects "substance" and "radiation Objects "substance" and "radiation Objects "substance" and "radiation Objects "substance" and "radiation 2023)	n" intersect. (9-26-18 AM Feb 27, 2023) a have been created. (92-6.18 AM Feb 27, 2023) n intersect. (93-331 AM Feb 27, 2023) n enver: Local Machine. (10:50:03 AM Feb	
Ready		NUM

Tabular Column:

DESIGN CONSIDERATIONS Parameters	Width	Length	Height	Position
Ground plane				
substance				
TL				
Port1				
Port2				
radiation boundary				

Result:

Conclusion:

Viva questions:

1. Define microstrip antenna?

2. What are the types of microstrip antenna?

3. Give applications of microstrip antenna?

4. Write advantages of microstrip line?

5. Write the characteristics of microstrip transmission line?

Exp: 02 MICRO STRIP PATCH ANTENNA

Date:

Aim: Design and characterization of Micro strip patch antenna.

Apparatus Required:

- 1. <u>Computer</u>
- 2. Hfss software.

Procedure:

- 1. Open HFSS software and Insert new HFSS design.
- 2. Adjust the co-ordinates.
- 3. Create a ground plane(Rectangular 2D).
- 4. Create a dielectric substrate with FR4_Epoxy material with same size of ground plane with z-height 1.6mm.
- 5. Create patch antenna
- 6. Creating the feedline on the ground plane
- 7. Create two ports (port1).
- 8. Now give the perfect E to ground .
- 9. Create assign excitation-lampud port.
- 10. Then create radiation boundary on the designed ground and assign boundary . The radiation should be given to all the faces except at ground.
- 11. Assign frequency and no. of passes.
- 12. Now add freq sweep fast linear count.
- 13. Now check validation and analyze all.
- 14. Then go to results Create model solution rectangular plot new report. Plot both
- 15. Then click HFSS click radiation click far field infinite sphere and give values to phi and theta.
- 16. Then click on results and create far field.
- 17. Click plot of 3D gain-dB new report.

Tabular Column:

DESIGN CONSIDERATIONS Parameters	Width	Length	Height	Position
Ground plane				
Substance				
Patch				
feed				
Port1				
Radiation				

DESIGN: MICROSTRIP MICROSTRIP PATCH ANTENNA USING HFSS (2.4 GHZ) 🗅 🗃 🖶 👗 🛍 🖀 🖉 🔨 으 으 📔 🖲 🕸 🗐 R K? 100 🗊 🛆 🔾 😋 🚍 🔅 10 | • 👉 | XY 💽 | 30 ▼ 5 6 6 6 6 m c2 4k 0 0 ta ±2 k 💋 Vacuum ▼ Model 💽 🔒 🖻 🐝 🎨 🕾 🚧 👘 🖑 Project Manager * X Project 1* By HFSSDesign 1 (DrivenModal) Definitions Project Properties Name Value Unit Evaluated Value Variables 3 (mm)

Open HFSS project-click project, open - project insert HFSS design. CREATE SUBSTANCE Select draw the BOX and design





Select fit all the contents in the view

Double click box 1 (rename substance)

Material - edit fr4 - (4.4)

Select colour,

ok



Double click **create box** Position 0,0,0 X size-7.5mm Y size-15mm

Z size-1.6mm Ok

	Name	Value	Unit	Evaluated Value	Description	
	Command	CreateBox				
	Coordinate Sys	. Global				
	Position	0, 0, 0	mm	Omm , Omm , Omm		
	XSize	17	mm	17mm		
	YSize	24	mm	24mm		
	ZSize	1.6	mm	1.6mm		
1						
DESIGN GROUN PLAN:

Select click rectangular draw



Double click rectangle1

Name: [ground plan], Colour : edit [as your wish]

1					
Name	Value	Unit	Evaluated Value	Description	Read-only
Name	ground				
Orientation	Global				
Model	~				
Display Wirefra					
Color	Edit				
Transparent	0				
				⊡ s	how Hidden

Double click create rectangle:

	Properties: Project3 - HFS	SDesign1 - Modeler					23
Position : 0,0,0	Command						
	Name	Value	Unit	Evaluated Value	Description		Ī
A ·	Command	CreateRectangle					
Axis : z	Coordinate Sys.	Global					
	Position	0.0.0	mm	Omm, Omm, Omm			
	Axis	Z					
X size : 17mm	XSize	17	mm	17mm			
	YSize	24	mm	24mm			
Y size : 24 mm							
Ol							
ОК						Show Hidden	
						OK Can	ncel

DESIGN PATCH ANTENNA



Select	rectangle	design	center	draw
	0	0		

Double click	Propertie	es: Project3 - HFS	SSDesign1 - M	odeler							8
resotorgla1		. Name	Mahar	1.11-3	Evel-stad Vel	Dener	-*	Baad ask.			
reactangier,		Name	PATCH	Unit	Evaluated val	ue Desch	ption	Read-only			
		Orientation	Global								
rename –		Model	~								
		Display Wirefra									
PATCH.		Color	Edit	1							
1111011,		Transparent	0	1							
Colour - edit											
Ok											
Double click									⊏ s	how Hidden	
_										ок	Cancel
Create	D	D : 10 UE00									
	Properties:	Project3 - HESS	Design1 - Moo	deler							253
rectangle:	Command										
B					- L						
Desition: 16		Name	Val	ue	Unit	Evaluated Value	Descr	iption			
1 08111011. 4,0,		Coordinate Sun	Global	lie							
		Position	4.6.1.6		mm 4	mm 6mm 1					
1.6		Axis	7								
		XSize	10		1	Omm					
Axis: z		YSize	12		mm 1	1mm					
X axis: 10mm											
Y size: 12mm											
O^{k}									Sho	ow Hidden	
ŬK.										ок	Cancel
DESIGN FEED:	: Select	click rect	angular	draw	7						
		- AT									



Double click reactangle1,

rename – **FEED,** Colour - edit Ok

- 1	Name	Value	Unit	Evaluated Value	Description	Read-only		
ſ	Name	FEED						
ſ	Orientation	Global						
ſ	Model	~						
ſ	Display Wirefra	- E						
	Color	Edit	1					
Γ	Transparent	0	1					
							Show Hidden	

Double click Create rectangle:

Position: 7.5,8, 1.6 Axis: z X axis: 2 mm Y size: -8 mm

Name	Value	Unit	Evaluated Value	Description	
Command	CreateRectangle				
Coordinate Sys	Global				
Position	7.5 ,8 ,1.6	mm	7.5mm , 8mm ,		
Axis	Z				
XSize	2	mm	2mm		
YSize	-8	mm	-8mm		



RF SYSTEM DESIGN

	Propertie	s: nmspatcha - H	FSSDesign1 - Modeler				23
Double click	Comman	nd					
no ston al s 1		Name	Value	Unit	Evaluated Value	Description	
rectangle1		Command	CreateRectangle				
		Coordinate Sys	Global				
Rename nort1		Position	7.5 ,0 ,1.6	mm	7.5mm , 0mm ,		
Rename por tr		Axis	Z	_			
ok		XSize	2	mm	2mm		
Double click		YSize	-4	mm	-4mm		
amosto mostonglo							
create rectangle							
Position-							
(7.5, 0, 1.6)							
Axis-Y						I	Show Hidden
X size- 2mm							OK Cancel
Z size-(-4mm)							On Cancer

Select port1-right click assign excitation-lumped port-click-name1-resistance 50 ohms-next, select none new line –draw a line-defined-next-full port impedance 50 ohms finish



Design radiation boundary



III B.Tech II



Fit all

Click radiation boundary-right click-assign boundary -radiation click name rad1 ok



Analysis --right click add solution setup click name setup1 solution frequency-2.4GHz

Maximum number of passes -12

Maximum Delta S - 0.02 ok

_

Analysis right click- setup1 right click	- add frequency sweep	
Sweep type : fast	Validation Check: Project1 - HFSSDesign1	X
Type : linear count		Design Settings
Start freq:1GHZ		 3D Model Boundaries and Excitations
Stop freq:10GHZ	Validation Check completed. Errors: 1 Warnings:	0 V Mesh Operations
Count:101GHZ		Optimetrics Radiation
Click display-see all frequencies ok	See Message Window for details.	
Result analysis(error checking)	Abort Close	
Click double click validity		,
HFSS Design- design setting		
3D model		
Boundaries and excitation	18	
Mesh operation		
Analysis setup		
Optimetrics		
Radiation		
Next analysis all-any error rectify-ok		
Validation Check: Project1 - HFSSDes	ign1	E S
HFSSDesign1		esign Settings D Model Joundaries and Excitations
Validation Check completed.		1esh Operations Analysis Setup
	✓ C ✓ F)ptimetrics }adiation
Abort C	lose	

Model Waveforms: 2.4 GHZ (S Parameter)



vswr graph



3d graphs - 8 × 💽 👯 🖸 🕴 🗶 🧶 🗈 🖉 🗠 🦷 R 🕅 🕅 🖸 🕱 🕄 🔍 🗟 🔍 🔍 🚸 🚯 🚳 🏹 🐼 🚳 dB(GainTotal) -5. 4740e +000 -7. 2839e +000 -9. 0938e +000 -1. 0934e +001 -1. 5734e +001 -1. 45724e +001 -1. 4154e +001 -2. 1763e +001 -2. 5373e +001 -2. 5373e +001 -2. 533e +001 -3. 2623e +001 -3. 4432e +001 Project Manager Project Manager Project Manager The Beauts Source State S Theta Z . Properties • × Name Value Unit Evaluated Value Name Scale Max 54.4... E E Scale Max 54.7... Spectrum F Type Spectrum Ram.... E • Report3D Objects "substance" and "radiation" intersect. (9:26:18 AM Feb 27, 2023) Solution Setup: No solution setups have been created. (9:26:18 AM Feb 27, 2023) Objects "substance" and "radiation" intersect. (9:33:31 AM Feb 27, 2023) Objects "substance" and "radiation" intersect. (9:33:31 AM Feb 27, 2023) Message Mana 🔺 🗙 × Progress NUM Ready

Model wave



Formulas:

Result:

Conclusion:

Viva questions:

1. What is micro strip patch antenna?

2. What is micro strip antenna used for?

3. What are the 3 types of micro strip antenna?

4. What is the difference between micro strip antenna and patch antenna?

5. What is micro strip antenna and its characteristics?

Exp.No: 03

Date:

MICROSTRIP TRANSMISSION LINE AND STANDING WAVE PATTERN

Aim: Analyse of a Microstrip Transmission Line and standing wave pattern at various frequencies

Apparatus Required:

- 1. <u>Computer</u>
- 2. Hfss software.

Procedure:

- 1. Open HFSS software and Insert new HFSS design.
- 2. Adjust the co-ordinates.
- 3. Create a ground plane(Rectangular).
- 4. Create a dielectric substrate with FR4_Epoxy material with same size of ground plane with z-height 1.6mm.
- 5. Creating the TL the ground plane & substance.
- 6. Create two ports (port1&port2).
- 7. Now give the perfect E to ground .
- 8. Create assign excitation-lampudport.
- 9. Then create radiation boundary on the designed ground and assign boundary **b**. The radiation should be given to all the faces except at ground.
- 10. Assign frequency and no. of passes.
- 11. Now add freq sweep fast linear count.
- 12. Now check validation and analyze all.
- 13. Then go to results Create model solution rectangular plot new report. Plot both
- 14. Then click HFSS click radiation click far field infinite sphere and give values to phi and theta.
- 15. Then click on results and create far field.
- 16. Click plot of 3D gain-dB new report.

Tabular Column:

DESIGN CONSIDERATIONS Parameters	Width	Length	Height	Position
Ground plane				
substance				
TL				
Port1				
Port2				
radiation boundary				

10 (mm)



Double click rectangle1

Name Value Unit Evaluated Value

Project 1 (C:/Users/ECE LAB/Documents/Ansoft/)
 HFSSDesign1 (DrivenModal)

Project Properties

Attribute

Name : [ground plan], Colour : edit [as your wish]

FSSDesign 1 (Driven Modal) Invalid part name: Valid characters are letters, numbers, underscores. (11:13:01 AM Feb 24, 2023)



odress

III B.Tech II

	Name	Value	Unit	Evaluated Value	Description	1
Position : 0,0,0	Command	CreateRectangle				
	Coordinate Sys	Global				
Axis : z	Position	0.0.0	mm	Omm , Omm , Omm		
	Axis	Z				
V .:	XSize	30	mm	30mm		
X size : 30 mm	YSize	60	mm	60mm		
Y size : 60 mm						
Ok	7.5					
					— :	Show Hidden

Select fit all the contents in the view

CREATE SUBSTANCE

Select draw the \boldsymbol{BOX} and design



Properties: mstrip new ok - HFSSDesign1 - Modeler

Double click **box 1** (rename **substance**)

Material – edit fr4 -

(4.4)

Select colour

Ok

e						
	Name	Value	Unit	Evaluated Value	Description	Read-only
	Name	substance				
	Material	"FR4_epoxy"		"FR4_epoxy"		
	Solve Inside	v				
	Orientation	Global				
	Model	✓				
	Display Wirefra					
	Color	Edit				
	Transparent	0				Γ
					∏ Sł	ok I ca

X

RF SYSTEM DESIGN

III B.Tech II

	Name	Value	Unit	Evaluated Value	Description	ſ
sition 0,0,0	Command	CreateBox				
	Coordinate Sys	. Global				
size-30mm	Position	0, 0, 0	mm	0mm , 0mm , 0mm		
	XSize	30	mm	30mm		
/ size-60mm	YSize	60	mm	60mm		
	ZSize	1.6	mm	1.6mm		
size-1.6mm						
Ok						
	51 C					

DESIGN TRANSMISSION LINE

Select rectangle design center draw



Double click reactangle1

rename -	Propertie	es: RANI - HFSSDe	sign1 - Modeler					X
TL	Attribute	•						
Colour adit		Name	Value	Unit	Evaluated Value	Description	Read-only	
Colour eult		Name	TL					
01		Orientation	Global					
Ok		Model	✓					
		Display Wirefra						
		Color	Edit					
		Transparent	0	1				
						☐ Sho	w Hidden	ancel
								ancel

sition –	Command					
, 0, 1.6	Name	Value	Unit	Evaluated Value	Description	
	Command	CreateRectangle				
	Coordinate Sys	Global				
ds - z	Position	12 .0 .1.6	mm	12mm , 0mm , 1		
	Axis	Z				
avis - 6mm	XSize	6	mm	6mm		
	YSize	60	mm	60mm		
size - 60mm						
-					☐ Sho	ow Hidden

DESIGN PERFECT ELECTRIC BOUNDARY - click TL

Right click – assign boundary-perfect E-CLICK-name: perfE1 - ok



Click ground plan - right click-assign boundary-perfect E - click - name: perfE2 ok



Change ZX

Select draw rectangle design transmission line port1

■ File Edit View Project Draw Modeler □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □ □	HFSS Tools Window Help	♥ 0 8 @ ● 0 0 0 9 0 9 0 0 1 1 1 1 1 1 1 1	S S @ (© © Q Q ⊗ 2 2 ⊾ ≤ vacuum	8 8 8 8 1 ~ 1	- 『
Project Manager	Solids image: Planes image: Planes image: Planes image: Planes					
Properties Name Value Unit Evaluated Value HFSS			0	5	10 (mm)	
Double click rect	t angle1 Properties: Project5 - HF: Command	SSDesign1 - Modeler				8
port1 ok		P	1	1		
	Name	Value.	Unit	Evaluated Value	Description	
Double click	Coordinate Sve	Global				
create	Position	12 0 1 6	mm	12mm 0mm 1		
rectangle	Axis	Y		12110 ; 5110 ; 1		
Position-	XSize	6	mm	6mm		
(12016)	ZSize	-1.6	mm	-1.6mm		
Axis-Y X size- 6mm Z size-				·		

Select port1-right click assign excitation-lumped port-click-name1-resistance 50 ohms-next select none new line –draw a line-defined-next-full port impedance 50 ohms finish

Design port2

Take rectangle - Select draw rectangle design transmission line port2



Rename rectangle2 double click port2 ok

ion -	Name	Value	Unit	Evaluated Value	Description	
$(0, 1, \epsilon)$	Command	CreateRectangle				
0,1.0)	Coordinate Sys	. Global				
- Y	Position	18,60,1.6	mm	18mm , 60mm ,		
e-	Axis	Y				
℃	XSize	-6	mm	-6mm		
ım)	ZSize	-1.6	mm	-1.6mm		
e						
mm)						
,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,,						

Select port2-right click assign excitation-lumped port-click-name 2-resistance - 50 ohms-next select none new line -draw a line-defined-next-full port impedance - 50 ohms - finish



Select XY

Design radiation boundary

Draw **box**



rename	Name	Value	[]	Init Evaluated Value	Description	Bead-only
	Name	Box1			Cosciption	c.sd-only
radiation boundary	Material	"air"		"air"		
ł	Solve Inside	v				
Material – edit	Orientation	Global				
oir	Display Wirefr	₽				
all	Color	Edit				
ok	Transparent	0				
Colour						
ean	1				_	
						Show Hidden
ok						
ok						ок Са
ok Double click	operties: Project5 - HESS	Design1 - Modeler				ок Са
ok Double click pr	roperties: Project5 - HFSS	Design1 - Modeler				ок Са
ok Double click pr create box	roperties: Project5 - HFSS Command	Design1 - Modeler				ок Са
ok Double click create box Position-	roperties: Project5 - HFSS Command	Design1 - Modeler Vølue	Unit	Evaluated Value	Description	ок са
ok Double click create box Position- (-7.57.515)	Command Name	Design1 - Modeler Value CreateBox	Unit	Evaluated Value	Description	ок Са
ok Double click create box Position- (-7.5,-7.5,-15)	Command Name Command Command	Design1 - Modeler Value CreateBox Global	Unit	Evaluated Value	Description	ок Са
ok Double click create box Position- (-7.5,-7.5,-15) X size-	Command Name Command Command Desition	Design1 - Modeler Value CreateBox Global -7.5 ,-7.5 ,-15	Unit	Evaluated Value	Description	ок Са
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm	Command Name Command Command Coordinate Sys Position XSize	Design1 - Modeler Value CreateBox Global -7.57.515 50	Unit mm mm	Evaluated Value	Description	ок Са
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size-	Command Name Command Command Coordinate Sys Position XSize YSize	Design1 - Modeler Value CreateBox Global -7.57.515 50 80 50	Unit mm mm mm	Evaluated Value	Description	OK Ca
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size-	Command Name Command Coordinate Sys Position XSize YSize ZSize	Design1 - Modeler Value CreateBox Global -7.5 -7.5 -15 50 80 50	Unit mm mm mm mm	Evaluated Value -7.5mm , -7.5m 50mm 80mm 50mm 50mm	Description	OK Ca
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size- 80mm	Command Name Command Coordinate Sys Position XSize YSize ZSize	Design1 - Modeler Value CreateBox Global -7.57.515 50 80 50	Unit mm mm mm mm mm	Evaluated Value	Description	ОК Са
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size- 80mm Z size-	Command Name Command Command Coordinate Sys Position XSize YSize ZSize	Design1 - Modeler Value CreateBox Global -7.5 -7.5 -15 50 80 50	Unit mm mm mm mm mm	Evaluated Value -7.5mm , -7.5m 50mm 80mm 50mm	Description	OK Ca
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size- 80mm Z size-	Command Name Command Command Coordinate Sys Position XSize YSize ZSize	Design1 - Modeler Value CreateBox Global -7.57.515 50 80 50	Unit mm mm mm mm	Evaluated Value	Description	OK Ca
ok Double click create box Position- (-7.5,-7.5,-15) X size- 50mm Y size- 80mm Z size- 50mm	Command Name Command Command Coordinate Sys Position XSize YSize ZSize	Design1 - Modeler Value CreateBox Global -7.57.515 50 80 50	Unit mm mm mm mm	Evaluated Value	Description	ОК Са

Click radiation boundary-right click-assign boundary -radiation click name rad1 ok



Analysis –right click add solution setu	up click name setup1 solution frequency-2.4	4GHz & 3.4GHz
Maximum number of passes -12	Edit Sweep	
Maximum Delta S-0.02 ok	Sweep Type: Fast	I✔ Enabled
Analysis right click-	Frequency Setup	Count Frequency
setup1 right click –	Type: LinearCount Start 1 GHz Display >>	96 9.55GHz 97 9.64GHz 98 9.73GHz
add frequency sweep	Count 101	99 9.82GHz 100 9.91GHz
Sweep type : fast	 ✓ Save Fields ✓ Generate Fields (All Frequencies) 	101 10GH2
Type : linear count	Time Domain Calculation	
Start freq:1GHZ	Interpolating Sweep Options DC Extrapolations	tion Optionsate to DC
Stop freq:10GHZ	Error Tolerance: 0.5 %	Solved Frequency 0.1 GHz 💌
Count:101GHZ	Advanced Options	~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~~
Click display-see all frequencies ok	OK Cancel Set Def	aults Use Defaults
Result analysis(error checking)		
Click double click validity		
HFSS Design- design setting	Validation Check: Project1 - HFSSDesign1	X
3D model		
Boundaries and excitations	Result HFSSDesign1	Design Settings
Mesh operation		 JD Model Downlation and Evolutions
Analysis setup		Boundaries and Excitations
Optimetrics	Validation Check completed. Errors: 1 Warnings: 0	Mesh Uperations
Radiation		👹 Analysis Setup
		🖋 Optimetrics
		🖋 Radiation
	See Message Window for details.	
	Abort Close	



Model Waveforms: 2.4 GHZ (S Parameter)



III B.Tech II





Result:

Viva questions:

- 1. What is transmission line?
- 2. What is the frequency of microstrip transmission line?
- 3. What is standing wave pattern in transmission line?
- 4. What are the different types of microstrip transmission lines?
- 5. What is the formula of microstrip transmission line?

Date:

S PARAMETER OF A MICRO STRIP TRANSMISSION LINE

Aim: Measure the S parameter of a Micro strip Transmission Line and plot the hoemalised impedance on a smith chart.

Apparatus Required:

- 1. <u>Computer</u>
- 2. matlab software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

program:

clear all close all clc l=rfckt.txline('Termination','Open','StubMode','Series','z0',75) k=analyze(l,logspace(5,10,1000)) figure subplot(2,2,1) plot(l,'S11','dB') title('Termination Open StubMode Series S11') subplot(2,2,2) semilogy(l,'S12','dB') title('Termination Open StubMode Series S12') subplot(2,2,3) semilogy(l,'S21','dB') title('Termination Open StubMode Series S21') subplot(2,2,4)plot(1,'S22','dB') title('Termination Open StubMode Series S22') j=rfckt.txline('Termination','Open','StubMode','Shunt','z0',75) g=analyze(j,logspace(5,10,1000)) figure subplot(2,2,1)plot(j, S11', dB')title('Termination Open StubMode Shunt S11') subplot(2,2,2)semilogy(j,'S12','dB') title('Termination Open StubMode Shunt S12') subplot(2,2,3)semilogy(j,'S21','dB') title('Termination Open StubMode Shunt S21') subplot(2,2,4)plot(j, S22', dB')title('Termination Open StubMode Shunt S22') m=rfckt.txline('Termination','Short','StubMode','Series','z0',75) v=analyze(m,logspace(5,10,1000)) figure subplot(2,2,1)plot(m, S11', dB')title('Termination Short StubMode Series S11') subplot(2,2,2)semilogy(m,'S12','dB') title('Termination Short StubMode Series S12') subplot(2,2,3)semilogy(m, 'S21', 'dB') title('Termination Short StubMode Series S21') subplot(2,2,4)plot(m,'S22','dB') title('Termination Short StubMode Series S22') n=rfckt.txline('Termination','Short','StubMode','Shunt','z0',75) b=analyze(n,logspace(5,10,1000)) figure subplot(2,2,1)plot(n, S11', dB')title('Termination Short StubMode Shunt S11') subplot(2,2,2)semilogy(n,'S12','dB') title('Termination Short StubMode Shunt S12') subplot(2,2,3)semilogy(n,'S21','dB') title('Termination Short StubMode Shunt S21') subplot(2,2,4)plot(n, S22', dB')title('Termination Short StubMode Shunt S22')





Calculation:

I = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Series' Termination: 'Open' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [] Name: 'Transmission Line' k = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Series' Termination: 'Open' Freq: 1.0000e+09 ZO: 75

PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Transmission Line' j = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Shunt' Termination: 'Open' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [] Name: 'Transmission Line' g = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Shunt' Termination: 'Open' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Transmission Line' m = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Series' Termination: 'Short' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [] Name: 'Transmission Line' v = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Series' Termination: 'Short' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [1×1 rfdata.data]

Name: 'Transmission Line' n = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Shunt' Termination: 'Short' Freq: 1.0000e+09 ZO: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [] Name: 'Transmission Line' b = rfckt.txline with properties: LineLength: 0.0100 StubMode: 'Shunt' Termination: 'Short' Freq: 1.0000e+09 Z0: 75 PV: 299792458 Loss: 0 IntpType: 'Linear' nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Transmission Line'

Result:

Conclusion:

Viva questions:

1. Write applications of Smith chart?

2. What is the need of S-parameters in transmission line?

3. What is normalized impedance?

4. Write properties of S-parameters?

5. Define losses in S-parameters?

Exp: 05

Date:

MICROSTRIP INDUCTOR AND CAPACITOR

Aim: Design of microstrip inductor and capacitor.

Apparatus Required:

- 1. <u>Computer</u>
- 2. <u>matlab software.</u>

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

<u>program:</u>

```
clc
clear all
close all
h = rfckt.seriesrlc('L', 4e-06, 'C', 5e-7);
y = analyze(h, logspace(4, 10, 500));
g = rfckt.shuntrlc('L', 4.7e-06, 'C', 5e-07);
z = analyze(g, logspace(4, 10, 500));
k = analyze(h, logspace(4, 10, 1000));
figure(1)
subplot(3, 2, 1)
loglog(h, 'S21', 'dB')
title('SeriesRLC')
subplot(3, 2, 2)
loglog(h, 'S21', 'angle')
title('SeriesRLC Phase')
subplot(3, 2, 3)
loglog(g, 'S21', 'dB')
title('ShuntRLC')
subplot(3, 2, 4)
loglog(g, 'S21', 'angle')
title('ShuntRLC Phase')
subplot(3, 2, 5)
```

loglog(k, 'S21', 'dB') title('Txline') subplot(3, 2, 6)
loglog(k, 'S21', 'angle') title('Txline Phase') **Calculation:** h = rfckt.seriesrlc with properties: R: 0 L: 4.0000e-06 C: 5.0000e-07 nPort: 2 AnalyzedResult: [] Name: 'Series RLC' y = rfckt.seriesrlc with properties: R: 0 L: 4.0000e-06 C: 5.0000e-07 nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Series RLC' g = rfckt.shuntrlc with properties: R: Inf L: 4.7000e-06 C: 5.0000e-07 nPort: 2 AnalyzedResult: [] Name: 'Shunt RLC' z = rfckt.shuntrlc with properties: R: Inf L: 4.7000e-06 C: 5.0000e-07 nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Shunt RLC' k = rfckt.seriesrlc with properties: R: 0 L: 4.0000e-06 C: 5.0000e-07 nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Series RLC'

Result:

Model Waveforms:



Viva questions:

- 1. Give the physical dimensions of the spiral inductor?
- 2. Write the inductance equation in microstrip?
- 3. Write applications of spiral inductor?

- 4. Write the capacitance equation in microstrip?
- 5. Write the applications of capacitor microstrip?

Exp: 06

Date:

IMPEDANCE MATCHING NETWORK

Aim: Design of impedance matching network.

Apparatus Required:

- 1. Computer
- 2. Mat lab (19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

program:

```
close all
clc
z0=50
d=1
c=3*10e8
B=-500:10:500
zin= -(1i*(z0*cotd(rad2deg(B*d))));
figure
plot(B,abs(zin))
xlabel('B')
ylabel('Zin')
title('Input impedance of an open circuited Tx line')
```

<u>Calculation:</u>
z0 = 50
d = 1
c = 3.0000e+09
B = Columns 1 through 20
-500 -490 -480 -470 -460 -450 -440 -430 -420 -410 -400 -390 -380 -370 -360 -350 -340 -330 -320
-310
Columns 21 through 40
-300 -290 -280 -270 -260 -250 -240 -230 -220 -210 -200 -190 -180 -170 -160 -150 -140 -130 -120
-110
Columns 41 through 60
-100 -90 -80 -70 -60 -50 -40 -30 -20 -10 0 10 20 30 40 50 60 70 80 90
Columns 61 through 80
100 110 120 130 140 150 160 170 180 190 200 210 220 230 240 250 260 270 280
290
Columns 81 through 100
300 310 320 330 340 350 360 370 380 390 400 410 420 430 440 450 460 470 480
490
Column 101

500

Model Waveforms:



Result:

1. What is the need for impedance matching?

2. Explain single and double stub tuners?

3. Write all the matching methods?

4. Draw three element matching network?

5. Draw formation of matching network?

Exp: 07

III B.Tech II

Date:

RF BJT AMPLIFIER AND LNA

Aim: Design and characterization of RF BJT Amplifier and LNA

Apparatus Required:

- 1. Computer
- 2. Mat lab (19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

program: RfBJT Amplifier

```
clear all
close all
clc
h=rfckt.amplifier()
s=sparameters(h);
figure(),
subplot(2,2,1)
plot(h,'S11','dB')
title('Amplifier S11'),
subplot(2,2,2),
plot(h,'S12','dB')
title('Amplifier S12')
subplot(2,2,3),
plot(h,'S21','dB')
title('Amplifier S11')
subplot(2,2,4),
plot(h, 'S22', 'dB')
title('Amplifier S12')
figure();
plot(h,'Gt','dB');
title('Amplifier gain');
```

program: RfBJT LNAmplifier

clear all;
close all;
clc;
TL1=txlineMicrostrip('Width',3.41730e-3,'Height',1.524e-
3, EpsilonR', 3.48, LossTangent', 0.0037, LineLength', 8.9e-3, Thickness', 0.0035e-
3, 'StubMode', 'Shunt', 'Termination', 'Open');
TL2=txlineMicrostrip('Width',3.41730e-3,'Height',1.524e-
3, EpsilonR', 3.48, LossTangent', 0.0037, LineLength', 14.7e3, Thickness', 0.0035e-3);
amp1 = nport('f551432p.s2p');
freq=2e9:10e6:3e9;
casamp=circuit([amp1,clone(amp1)],'amplifiers'); % amplifier ciruit without MNW.
S2=sparameters(casamp,freq);
TL3=txlineMicrostrip('Width',3.41730e-3,'Height',1.524e-
3, 'EpsilonR', 3.48, 'LossTangent', 0.0037, 'LineLength', 22.47e-3, 'Thickness', 0.0035e-3);
TL4=txlineMicrostrip('Width',3.41730e-3,'Height',1.524e-
3, EpsilonR', 3.48, LossTangent', 0.0037, 'LineLength', 5.66e-3, 'Thickness', 0.0035e-
3, 'StubMode', 'Shunt', 'Termination', 'Open');
c=circuit([TL1, TL2,clone(amp1),clone(amp1),TL3, TL4]); % two-stage LNA with MNW
figure
S3=sparameters(c,freq);
rfplot(S2,1,1)
hold on;
rfplot(S3,1,1)
legend(S11 of Two-Stage LNA Without MNW', S11 of Two-Stage LNA with MNW');
title('Input Reflection Coefficients of Two-Stage LNA');
grid on;
figure
rfplot(S2,2,2)
hold on;
rfplot(S3,2,2)
legend(' S22 of Without MNW', ' S22 of With MNW');
title('Output Reflection Coefficients of Two-Stage LNA');
grid on;
OUTPUT:



Calculation:

RfBJT Amplifier :

h = rfckt.amplifier with properties: NoiseData: [1×1 rfdata.noise] NonlinearData: [1×1 rfdata.power] IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Amplifier'

Model Waveforms:



Result:

Viva questions:

1. What is low noise amplifier?

2. Give the noise figure formula of LNA?

3. Write LNA matching technique?

4. Write RF BJT amplifier biasing methods?

5. Write RF BJT and LNA applications?

III B.Tech II

Date:

RF FILTER

Aim: Design of low pass, high pass, band pass and band stop filter at RF.

Apparatus Required:

- 1. Computer
- 2. Matlab(19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

Calculation:

(bpf&bsf)

filter1 = rfckt.lcbandpasspi with properties: L: [2×1 double] C: [2×1 double] nPort: 2 AnalyzedResult: [] Name: 'LC Bandpass Pi' ans = rfckt.lcbandpasspi with properties: L: [2×1 double] C: [2×1 double] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'LC Bandpass Pi' filter2 = rfckt.lcbandstoppi with properties: L: [2×1 double] C: [2×1 double] nPort: 2 AnalyzedResult: [] Name: 'LC Bandstop Pi' ans = rfckt.lcbandstoppi with properties:

L: [2×1 double] C: [2×1 double] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'LC Bandstop Pi' s1 = sparameters: S-parameters object NumPorts: 2 Frequencies: [1000×1 double] Parameters: [2×2×1000 double] Impedance: 50.0000 + 0.0000i rfparam(obj,i,j) returns S-parameter Sij s2 = sparameters: S-parameters object NumPorts: 2 Frequencies: [1000×1 double] Parameters: [2×2×1000 double] Impedance: 50.0000 + 0.0000i rfparam(obj,i,j) returns S-parameter Sij (lpf&hpf): h = rfckt.lclowpasstee with properties: L: 1.0000e-09 C: 2.0000e-11 nPort: 2 AnalyzedResult: [] Name: 'LC Lowpass Tee' m = rfckt.lclowpasstee with properties: L: 1.0000e-09 C: 2.0000e-11 nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'LC Lowpass Tee' I = rfckt.lchighpasstee with properties: L: 5.0000e-07 C: 2.0000e-05 nPort: 2 AnalyzedResult: [] Name: 'LC Highpass Tee' n = rfckt.lchighpasstee with properties: L: 5.0000e-07 C: 2.0000e-05 nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'LC Highpass Tee'

program: (bpf&bsf)

```
clear all
close all
clc
filter1 = rfckt.lcbandpasspi('C',[1e-12 4e-12],'L',[2e-9 2.5e-9]);
analyze(filter1,logspace(5,10,1000));
filter2 = rfckt.lcbandstoppi('C',[1e-12 4e-12],'L',[2e-9 2.5e-9]);
analyze(filter2,logspace(5,10,1000));
s1=sparameters(filter1);
s2=sparameters(filter2);
figure()
```

```
subplot(2, 2, 1);
plot(filter1,'S11','dB');
title('BANDPASS');
subplot(2, 2, 2);
plot(filter1, 'S12', 'dB');
title('BANDPASS');
subplot(2, 2, 3);
plot(filter1,'S21','dB');
title('BANDPASS');
subplot(2,2,4);
plot(filter1,'S22','dB');
title('BANDPASS');
figure()
subplot(2,2,1);
plot(filter2,'S11','dB');
title('BANDSTOP');
subplot(2,2,2);
plot(filter2, 'S12', 'dB');
title('BANDSTOP');
subplot(2,2,3);
plot(filter2,'S21','dB');
title('BANDSTOP');
subplot(2,2,4);
plot(filter2,'S22','dB');
title('BANDSTOP');
program: (lpf&hpf)
clear all
close all
clc
h = rfckt.lclowpasstee('C', 20e-12, 'L', 10e-10)
m = analyze(h, logspace(1, 9, 1000))
s = extract(h,'S-parameters',75);
l = rfckt.lchighpasstee('C', 2e-5, 'L', 5e-7)
n = analyze(l,logspace(1,9,1000))
figure
subplot(2,2,1)
plot(h,'S11','dB')
title('S11 lowpass')
subplot(2,2,2)
semilogy(h,'S12','dB')
title('S12 lowpass')
subplot(2,2,3)
semilogy(h,'S21','dB')
title('S21 lowpass')
```

semilogy(n, S12, dB) title('S12 lowpass') subplot(2,2,3) semilogy(h,'S21','dB') title('S21 lowpass') subplot(2,2,4) plot(h,'S22','dB') title('S22 lowpass') figure subplot(2,2,1) plot(1,'S11','dB') title('S11 highpass') subplot(2,2,2) semilogy(1,'S12','dB') title('S12 highpass') subplot(2,2,3) semilogy(1,'S21','dB') title('S21 highpass') subplot(2,2,4)

plot(l,'S22','dB') title('S22 highpass')



Result:

Viva questions:

1. Define all pass filters?

2. Define notch filters?

3. Write characteristics of filter at RF filters?

4. Applications of LPF, HPF and BPF?

5. What is the need of RF filters?

RF MIXER

Date:

Aim: Design and characterization of RF Mixer.

Apparatus Required:

- 1. Computer
- 2. Matlab(19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

Program:

clc; clear all: close all; %Create RF and IF bandpass filters fi1 = read(rfckt.passive,'RFBudget_RF.s2p'); fi2 = read(rfckt.passive, 'RFBudget IF.s2p'); %Create RF and IF amplifiers ai1 = rfckt.amplifier('NetworkData', ... rfdata.network('Type','S','Freq',2.1e9,'Data',[0,0;3.98,0]), ... 'NoiseData',2,'NonlinearData',35); ai2 = rfckt.amplifier('NetworkData', ... rfdata.network('Type','S','Freq',2.1e9,'Data',[0,0;31.66,0]), ... 'NoiseData',8,'NonlinearData',37); %Create a demodulator and microstrip transmission line mi1 = rfckt.mixer('NetworkData', ... rfdata.network('Type','S','Freq',2.1e9,'Data',[0,0;0.501,0]),... "MixerType", 'Downconverter', 'FLO', 2.03e9, 'NoiseData', 4, 'NonlinearData', 50); tx1 = rfckt.microstrip('Thickness',0.0075e-6); %Cascade the circuit $c = rfckt.cascade('Ckts', \{fi1 ai1 mi1 fi2 ai2 tx1\});$ % Analyze the cascaded circuit analyze(c,linspace(2.08e9,2.12e9,100)); % Plot the magnitude of the S21 parameter for the cascade plot(c,'s21','db') hold on; plot(c,'s11','db')

Calculation:

fi1 = rfckt.passive with properties: IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Passive' fi2 = rfckt.passive with properties: IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Passive' ai1 = rfckt.amplifier with properties: NoiseData: 2 NonlinearData: 35 IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Amplifier' ai2 = rfckt.amplifier with properties: NoiseData: 8 NonlinearData: 37 IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Amplifier' mi1 = rfckt.mixer with properties: MixerSpurData: [] MixerType: 'Downconverter' FLO: 2.0300e+09 FreqOffset: [] PhaseNoiseLevel: [] NoiseData: 4 NonlinearData: 50 IntpType: 'Linear' NetworkData: [1×1 rfdata.network] nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Mixer' tx1 = rfckt.microstrip with properties: Width: 6.0000e-04 Height: 6.3500e-04 Thickness: 7.5000e-09 EpsilonR: 9.8000 LossTangent: 0 SigmaCond: Inf LineLength: 0.0100 StubMode: 'NotAStub' Termination: 'NotApplicable' nPort: 2 AnalyzedResult: [] Name: 'Microstrip Transmission Line'

c = rfckt.cascade with properties: Ckts: {1×6 cell} nPort: 2 AnalyzedResult: [] Name: 'Cascaded Network' ans = rfckt.cascade with properties: Ckts: {1×6 cell} nPort: 2 AnalyzedResult: [1×1 rfdata.data] Name: 'Cascaded Network'

Model Waveforms:



Result:

Viva questions:

1. What is mixer?

- 2. What is the need for mixer in communications?
- 3. Write ports in RF mixer?

4. Define isolation in RF mixer?

5. Define image rejection?

Date:

SCHOTTKY DIODE AND RF SWITCH

Aim: Design and simulate a Schottky Diode and RF Switch.

Apparatus Required:

- 1. Computer
- 2. Matlab(19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window \Figure window

program:

%%% Create the variables and equations clc; clear all; close all; clear Degrees Time R Vin Vr Vd Id; Vd = 0.3;R = 2;for (j=0:1:9) for (k=1:1:360) Vin(k + (j*360)) = 1.0 * sind(k - 1);Time(k + (j* 360)) = (k + (j* 360)) / 360;end end for (i=1:1:length(Vin)) if (Vin(i) > 0.3)Vr(i) = (Vin(i) - Vd);else Vr(i) = 0;end end Id = (Vr / R);%%% Create the subplots figure(1)

subplot(3,1,1);

plot(Time, Vin); grid; title ('Time Vs Vin'); xlabel('Time (seconds)'); ylabel('Vin (V)'); subplot(3,1,2);plot(Time, Vr, 'r'); grid; title ('Time Vs Vr'); xlabel('Time (seconds)'); ylabel('Vr (V)'); subplot(3,1,3);plot(Time, Id, 'm'); grid; title ('Time Vs Id'); xlabel('Time (seconds)'); ylabel('Id (A)'); %% %Test conditions Rm = 997;Vin = [0 0.5 1 1.5 2 2.5 3 3.5 4 4.5 5 5.5 6 6.5 7 7.5 8 8.5 9 9.5 10]; %%% Diode in forward bias % Vr_forward =Vr; Vr forward = [0 0.268 0.739 1.223 1.712 2.204 2.697 3.190 3.685 4.180 ... 4.675 5.170 5.666 6.162 6.659 7.155 7.651 8.148 8.645 9.141 9.637]; Vd forward = (Vin - Vr forward); Id_forward = (Vr_forward / Rm); %%% Diode in reverse bias % Vr_reverse =zeros(1,length(Vr)); 0000000000;Vd_reverse = -(Vin - Vr_reverse); Id_reverse = -(Vr_reverse / Rm); %%% Plot results figure(2) subplot(2, 1, 1); plot(Vd_forward, Id_forward, 'k-o'); grid title('Vd Vs Id for measured Schottky Barrier Diode (forward bias)'); xlabel('Vd (V)'); ylabel('Id (A)'); subplot(2, 1, 2); plot(Vd_forward, Id_forward, 'k-o'); hold on grid on plot(Vd_reverse, Id_reverse, 'r-o'); title('Vd Vs Id for measured Schottky Barrier Diode'); xlabel('Vd (V)'); ylabel('Id (A)');

Calculation:

```
Vd_forward = Columns 1 through 12
                       0 0.2320 0.2610 0.2770 0.2880 0.2960 0.3030 0.3100 0.3150 0.3200 0.3250
0.3300
     Columns 13 through 21
         0.3340 \quad 0.3380 \quad 0.3410 \quad 0.3450 \quad 0.3490 \quad 0.3520 \quad 0.3550 \quad 0.3590 \quad 0.3630
Id_forward = Columns 1 through 12
                       0 \quad 0.0003 \quad 0.0007 \quad 0.0012 \quad 0.0017 \quad 0.0022 \quad 0.0027 \quad 0.0032 \quad 0.0037 \quad 0.0042 \quad 0.0047 \\
0.0052
     Columns 13 through 21
          0.0057 0.0062 0.0067 0.0072 0.0077 0.0082 0.0087 0.0092 0.0097
Vd_reverse = Columns 1 through 12
                       0 \quad -0.5000 \quad -1.0000 \quad -1.5000 \quad -2.0000 \quad -2.5000 \quad -3.0000 \quad -3.5000 \quad -4.0000 \quad -4.5000 \quad -5.0000 \quad 
5.5000
     Columns 13 through 21
        -6.0000 -6.5000 -7.0000 -7.5000 -8.0000 -8.5000 -9.0000 -9.5000 -10.0000
Id reverse = Columns 1 through 20
             0 0 0 0 0 0 0 0 0 0 0 0 0 0
                                                                                                                                                                                                                                                  0
                                                                                                                                                                                                                                                                    0
                                                                                                                                                                                                                                                                                  0 0
                                                                                                                                                                                                                                                                                                                      0 0
                                                                                                                                                                                                                                                                                                                                                            0
     Column 21
```

Model Waveforms:



Result:

Viva questions:

1. What is schottkey diode?

2. Write applications of schottky diode?

3. Define RF switch?

4. Give the differences of switch and relay?

5. Give the range of radio frequency?

Date:

POWER AMPLIFIER

Aim: Analyse and measure the gain of a Power Amplifier and equalize its gain using an Equalizer.

Apparatus Required:

- 1. Computer
- 2. Matlab(19b) software.

Theory:

Procedure:

- 1. Open MATLAB
- 2. Open new M-file
- 3. Type the program
- 4. Save in current directory
- 5. Compile and Run the program
- 6. For the output see command window $\$ Figure window

Applications:

Calculation:

Program:
clc;
clear all;
close all;
t=0:0.01:10;
%%%input
Yin = sin(2*pi*2*t) + cos(2*pi*3*t);
%%% amplifier output with noise
A=5;
Yout = $A^{(sin(2*pi*2*t)+cos(2*pi*3*t))};$
figure(1)
plot(t,Yin,t,Yout)
%%% amplifier output with noise
A=5;
$Yout_noise = A^*(sin(2^*pi^*2^*t) + cos(2^*pi^*3^*t)) + rand(1, length(Yin));$
figure(2)
plot(t,Yin,t,Yout_noise)
%%%gain calculation
<pre>gain = abs(Yout/Yin);</pre>
<pre>gain_noise = abs(Yout_noise/Yin);</pre>
figure;
TransferPA = abs(Yout./Yin);
TransferPA_noise = abs(Yout_noise./Yin);
plot(abs(Yin),20*log10(TransferPA),'r-o',abs(Yin),20*log10(TransferPA_noise),'b.');
% plot(20*log10(abs(Yin)),20*log10(TransferPA),'r- .',20*log10(abs(Yin)),20*log10(TransferPA_noise),'b.');
xlabel('Input Voltage Absolute Value(V)')
ylabel('Magnitude Power Gain (dB)');

Model Waveforms:



Result:

Conclusion:

Viva questions:

1. What is power amplifier?

2. Define low loss RF equalizer?

3. What is gain equalizer?

4. Define lattice and bridged T-equalizers?

5. Write applications of power amplifiers?

Date:

VCO

Aim: Design and characterization of VCO.

Apparatus Required:

1.Computer

2.Matlab(19b) software.

Theory:

Procedure:

1.Open MATLAB

2.Open new M-file

3.Type the program

4.Save in current directory

5.Compile and Run the program

6.For the output see command window \Figure window

Applications:

Calculation:

```
Program:
clc;
clear all;
close all;
 Fs = 10000;
 t = 0:1/Fs:2;
  x = sin(2*pi*t);
 range=[0.1 0.4]*Fs;
 Fc = mean(range);
  x_max = max(max(abs(x)));
    kf = (Fc/Fs)*2*pi/x_max;
     y = cos(2*pi*Fc*t + kf*cumsum(x));
    plot(t,y);
  figure(2)
 spectrogram(y,kaiser(256,5),220,512,Fs,'yaxis');
 %%%%Using command VCO
% fs = 10000;
% t = 0:1/fs:2;
% x = sin(2*pi*t);
% y= vco(x,[0.1 0.4]*fs,fs);
% plot(y);
% figure(2)
% spectrogram(y,kaiser(256,5),220,512,fs,'yaxis')
```







Result:

Conclusion:

Viva questions:

1. What is VCO?

2. Give the differences VCO and oscillator?

3. What is PLL?

4. Write the working principle of VCO?

5. Applications of VCO?

ADVANCED EXPERIMENTS

Date:

Patch antenna using MATLAB

Aim: Design and characterization of Micro strip patch antenna.

Apparatus Required:

1.Computer

2.Matlab(19b) software.

Theory:

Procedure:

- 1.Open MATLAB
- 2.Open new M-file
- 3. Type the program
- 4.Save in current directory
- 5. Compile and Run the program
- 6.For the output see command window \Figure window

Applications:

Calculation:

Program:

```
clc;
clear all;
close all;
freq
           = 10.35e9;
patchLength = 12e-3;
patchWidth = 17.73e-3;
patchHeight = 1.56e-3;
lengthgp = 55e-3;
          = 55e-3;
widthgp
feedoffset = [2.9e-3 0];
ant = patchMicrostrip('Length', patchLength, 'Width', patchWidth,
                                                                          . . .
    'Height', patchHeight, 'GroundPlaneLength', lengthgp,
                                                                          . . .
    'GroundPlaneWidth', widthgp, 'FeedOffset', feedoffset);
show(ant);
figure(1);
pattern(ant, freq, 90, 0:1:180, 'CoordinateSystem', 'rectangular',
                                                                          . . .
    'Polarization', 'H');
figure(2);
pattern(ant, freq, 90, 0:1:180, 'CoordinateSystem', 'rectangular',
                                                                          . . .
    'Polarization', 'V');
figure(3);
pattern(ant, freq, 0, 0:1:180, 'CoordinateSystem', 'rectangular',
                                                                          . . .
    'Polarization', 'V');
figure(4);
pattern(ant, freq, 0, 0:1:180, 'CoordinateSystem', 'rectangular',
                                                                          . . .
    'Polarization', 'H');
```

<figure>

Result:

Conclusion:

Viva questions:

III B.Tech II

Date:

Folded dipole (yagi-uda) antenna using MATLAB

Aim: Design and characterization of folded dipole (yagi-uda) antenna.

Apparatus Required:

1.Computer

2.Matlab(19b) software.

Theory:

Procedure:

- 1.Open MATLAB
- 2.Open new M-file
- 3. Type the program
- 4.Save in current directory
- 5.Compile and Run the program
- 6.For the output see command window \Figure window

Applications:

Calculation:

Program:

```
clc;
clear all;
close all;
freq = 165e6;
wirediameter = 19e-3;
c = physconst('lightspeed');
lambda = c/freq;
d = dipoleFolded;
d.Length = lambda/2;
d.Width = cylinder2strip(wirediameter/2);
d.Spacing = d.Length/60;
Numdirs = 4;
refLength = 0.5;
dirLength = 0.5*ones(1,Numdirs);
refSpacing = 0.3;
dirSpacing = 0.25*ones(1,Numdirs);
initialdesign = [dirLength refSpacing dirSpacing].*lambda;
yagidesign = yagiUda;
yagidesign.Exciter = d;
yagidesign.NumDirectors = Numdirs;
yagidesign.ReflectorLength = refLength*lambda;
yagidesign.DirectorLength = dirLength.*lambda;
yagidesign.ReflectorSpacing = refSpacing*lambda;
yagidesign.DirectorSpacing = dirSpacing*lambda;
show(yagidesign)
fig1 = figure;
pattern(yagidesign, freq);
fig3 = figure;
pattern(yagidesign, freq, 0, 0:1:359);
fig4 = figure;
pattern(yagidesign, freq, 90, 0:1:359);
```

Model Graph





Result:

Conclusion:

Viva questions: