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Note : Remove “Table of Content” before including in CP Book

A. LABORATORY INFORMATION

1. Lab Overview

Degree:	BE	*Program:*	EC
Year / Semester :	4/7	*Academic Year:*	2018-19
Course Title:	Advanced Digital Communication Lab	*Course Code:*	15ECL76
Credit / L-T-P:	4 / 4-0-0	*SEE Duration:*	180 Minutes
Total Contact Hours:	62 Hrs	*SEE Marks:*	80 Marks
CIA Marks:	40	*Assignment*	
Course Plan Author:	N S MYTHREYE	*Sign*	Dt :
Checked By:		*Sign*	Dt :

2. Lab Content

Unit	**Title of the Experiments**	**Lab Hours**	**Concept**	**Blooms Level**
1	Time Division Multiplexing and Demultiplexing of two bandlimited signals	3	TDM	L4
2	ASK generation and detection	3	Digital modulation techniques	L4
3	FSK generation and detection	3	Digital modulation techniques	L4
4	PSK generation and detection	3	Digital modulation techniques	L4
5	Determination of a.Coupling and isolation characteristics of microstrip directional coupler. b.Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate	3	Microwave active devices	L4
6	Determination of Power division and isolation of microstrip power divider	3	Microwave passive devices	L4
7	Measurement of directivity and gain of microstrip dipole and Yagi antennas	3	Microwave antennas	L4
8	Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.		Losses in optical fiber	L4
9	Simulate NRZ, RZ, half-sinusoid and raised cosine pulses and generate eye diagram for binary polar signaling.	3	Coding of binary polar	L4

			signalling	
10	Simulate the Pulse code modulation and demodulation system and display the waveforms	3	Digital modulation techniques	L4
11	Simulate the QPSK and DPSK transmitter and receiver	3	Digital Modulation techniques	L4

3. Lab Material

Unit	Details	Available
1	Text books	
	Simon Haykin, —Digital Communication System, John Wiley & sons, First Edition	In Lib
	Microwave Engineering -Annapurna Das, Sisir K Das TMH Publication, 2nd Edition	
	Antennas and Wave Propagation, John D. Krauss, Ronald J Marhefka and Ahmad S Khan,4th Special Indian Edition , McGraw-Hill Education Pvt. Ltd	
2	Reference books	
	B.P.Lathi and Zhi Ding, —Modern Digital and Analog communication System, Oxford University Press, 4th Edition	In dept
	GerdKeiser ,Optical Fiber Communication, 5th Edition, McGraw Hill Education(India) Private Limited, 2015.	
	Ian A Glover and Peter M Grant, —Digital Communication, Pearson Education, Third Edition, 2010	
3	Others (Web, Video, Simulation, Notes etc.)	
	https://www.vturesource.com/2011/01/advanced-communication-lab.html	Not Available
	https://www.slideshare.net/ajal4u/advanced-communication-lab-manual	

4. Lab Prerequisites:

-	-	Base Course:		-	-
SNo	Course Code	Course Name	Topic / Description	Sem	Remarks
1	17EC61	Digital communication	Knowledge on Multiplexing	6	
2	17EC61	Digital communication	Knowledge on Digital modulation techniques	6	
3	17EC71	Microwaves and Antennas	Knowledge on microwave active and passive components and antennas	7	Plan Gap Course
4	17EC82	Fiber Optics and Networks	Knowledge on optical fibers and antennas	8	Plan Gap Course
5	17EC61	Digital communication	Knowledge NRZ, RZ binary polar signalling	6	

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

5. General Instructions

SNo	Instructions	Remarks
1	Observation book and Lab record are compulsory.	
2	Students should report to the concerned lab as per the time table.	
3	After completion of the program, certification of the concerned staff in-charge in the observation book is necessary.	
4	Student should bring a notebook of 100 pages and should enter the readings /observations into the notebook while performing the experiment.	
5	The record of observations along with the detailed experimental procedure of the experiment in the Immediate last session should be submitted and certified staff member in-charge.	
6	Should attempt all problems / assignments given in the list session wise.	
7	It is responsibility to conduct the experiment individually.	
8	When the experiment is completed, should disconnect the setup made by them, and should return all the components/instruments taken for the purpose.	
9	Any damage of the equipment or burn-out components will be viewed seriously either by putting penalty or by dismissing the total group of students from the lab for the semester/year	
10	Completed lab assignments should be submitted in the form of a Lab Record in which you have to write the Aim, components required, theory, procedure, circuit diagram and design along with graphs/ waveform and results for given design values	

6. Lab Specific Instructions

SNo	Specific Instructions	Remarks
1	Rules established in lecture/lab regarding protection, working with exposed high voltage, horseplay, etc. apply to all individuals working in the lab area.	
2	Working alone in the lab will not be permitted where exposed voltages exceeding 25 volts are present.	
3	Carry out the experiments in such a way that the equipment will not be damaged or destroyed.	
4	Follow all written and verbal instructions carefully. If you do not understand the	

	instructions, the handouts and the procedures, ask the instructor or teaching assistant	
5	The workplace has to be tidy before, during and after the experiment.	
6	Read the handout and procedures before starting the experiments	
7	Turn off all test equipment, return equipment, tools, and test leads to their proper storage area	

B. OBE PARAMETERS

1. Lab / Course Outcomes

#	COs	Teach. Hours	Concept	Instr Method	Assessment Method	Blooms' Level
1	Explain the generation and multiplexing of signal in transmitter and the concept of demultiplexing in receiver	3	TDM	Demonstrate	Slip Test	L4
2	Compare and modulate and demodulate the message signal using ASK,FSK and PSK	9	Digital modulation techniques	Demonstrate	Assignment	L4
3	Measure the parameters in microwave test bench and analyse the behaviour of microwave active devices using S parameters.	6	Microwave active devices	Demonstrate	Assignment and Slip Test	L4
4	Evaluate the performance of dipole and yagi uda antenna and plot the directivity and gain.	6	Microwave antennas	Simulation	Assignment	L4
5	Evaluate the losses through an optical fiber cable and estimate the same using 0.5m 21m.	3	Losses in optical fiber	Tutorial	Slip test	L4
6	Differentiate all the coding techniques of bipolar signalling and generate eye diagram. (RZ, NRZ, Bipolar)	6	Coding of binary polar signalling	Tutorial	Assignment	L4
7	Differentiate the digital modulation techniques and plot the same by waveforms. (QPSK, DPSK, PCM)	9	Modulation techniques in digital modulatio	Demonstrate	Assignment and Slip Test	L4

			n			
-	**Total**	**42**	-	-	-	-

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

2. Lab Applications

SNo	Application Area	CO	Level
1	Evaluate time and space complexity and calculate performance	CO1	L4
2	Understanding searching and sorting	CO2	L4
3	Use AND / OR graph, spanning trees	CO3	L4
4	Use Backtracking technique for searching a set of solutions or for searching an optimal solution	CO4	L4
5	Apply Greedy method for finding optimal solution	CO5	L4
6	Apply Dynamic Programming to find a sequence of decisions	CO6	L4
7	Evaluate traveling sales man problem by using dynamic programming	CO7	L4
8	Apply Branch and Bound for solving combinatorial optimization problems	CO8	L2
9	Able to differentiate NP – Hard and NP – Complete Problems	CO9	L2

Note: Write 1 or 2 applications per CO.

3. Articulation Matrix

(CO – PO MAPPING)

-	Course Outcomes	Program Outcomes												
#	COs	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10	PO 11	PO 12	Level
15ECL76.1	Explain the generation and multiplexing of signal in transmitter and the concept of demultiplexing in receiver	3	3	3	3	-	-	-	-	3	-	-	-	L4
15ECL76.2	Compare and modulate and demodulate the message signal using ASK,FSK and PSK	3	3	3	3	-	-	-	-	3	-	-	-	L4
15ECL76.3	Measure the parameters in microwave test bench and analyse the behaviour of microwave active devices using S parameters.	3	3	3	3	3	-	-	-	3	-	-	-	L4
15ECL76.4	Evaluate the performance of dipole and yagi uda antenna and plot the directivity and gain.	3	3	3	3	3	-	-	-	3	-	-	-	L4

15ECL76.5	Evaluate the losses through an optical fiber cable and estimate the same using 0.5m 21m.	3	3	3	3	3	–	–	–	3	–	–	–	L4
15ECL76.6	Differentiate all the coding techniques of bipolar signalling and generate eye diagram. (RZ, NRZ, Bipolar)	3	3	3	3	3	–	–	–	3	–	–	–	L4
15ECL76.7	Differentiate the digital modulation techniques and plot the same by waveforms. (QPSK, DPSK, PCM)	3	3	3	3	3	–	–	–	3	–	–	–	L4
15ECL76	Average	**3**	**3**	**3**	**3**	**2**	**-**	**-**	**-**	**3**	**-**	**-**	**-**	

Note: Mention the mapping strength as 1, 2, or 3

4. Mapping Justification

Mapping		Mapping Level	Justification
CO	**PO**	**-**	**-**
CO1	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO1	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO1	PO3		Design and development of the circuit is involved in this experiment
CO1	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO1	PO9		The experiments are conducted in multidisciplinary functional teams
CO2	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO2	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO2	PO3		Design and development of the circuit is involved in this experiment
CO2	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO2	PO9		The experiments are conducted in multidisciplinary functional teams
CO3	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO3	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO3	PO3		Design and development of the circuit is involved in this experiment
CO3	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO3	PO5		Modern microwave test bench, microstrip devices are used along with

			the microwave signal source and the VSWR meter
CO3	PO9		The experiments are conducted in multidisciplinary functional teams
CO4	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO4	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO4	PO3		Design and development of the circuit is involved in this experiment
CO4	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO4	PO5		The modern equipment in microwave, I.e, the microwave signal source and VSWR meter and the printed dipole and yagi uda antennas are used
CO4	PO9		The experiments are conducted in multidisciplinary functional teams
CO5	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO5	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO5	PO3		Design and development of the circuit is involved in this experiment
CO5	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO5	PO5		The optical fiber tool kit used
CO5	PO9		The experiments are conducted in multidisciplinary functional teams
CO6	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO6	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO6	PO3		Design and development of the circuit is involved in this experiment
CO6	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO6	PO5		Use of MATLAB programming software is necessary
CO6	PO9		The experiments are conducted in multidisciplinary functional teams
CO7	PO1		The experiment has the application of mathematics, science and engineering fundamentals
CO7	PO2		The conduction of this experiment includes the identification, formulation and analysis, reaching the substantiated conclusions
CO7	PO3		Design and development of the circuit is involved in this experiment
CO7	PO4		The problems faced during the design and conduction of the experiment is investigated and resolved
CO7	PO5		Use of MATLAB programming software is necessary
CO7	PO9		The experiments are conducted in multidisciplinary functional teams

Note: Write justification for each CO-PO mapping.

5. Curricular Gap and Content

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1	Microwaves and Antennas	Theoritical introduction in the class and demonstration in lab		Self	
2	Fiber Optics and Networks	Introducing the optical network through video demonstration		Self	

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

6. Content Beyond Syllabus

SNo	Gap Topic	Actions Planned	Schedule Planned	Resources Person	PO Mapping
1					
2					
3					
4					
5					
6					
7					
8					
9					
10					
11					
12					
13					
14					
15					

Note: Anything not covered above is included here.

C. COURSE ASSESSMENT

1. Course Coverage

Unit	Title	Teaching Hours	No. of question in Exam							CO	Levels
			CIA-1	CIA-2	CIA-3	Asg-1	Asg-2	Asg-3	SEE		
1	Explain the generation and	3	1	-	-	-	-	-	1	CO1	L4

	multiplexing of signal in transmitter and the concept of demultiplexing in receiver										
2	Compare and modulate and demodulate the message signal using ASK,FSK and PSK	9	1	-	-	-	-	-	1	CO2	L4
3	Measure the parameters in microwave test bench and analyse the behaviour of microwave active devices using S parameters.	6	1	-	-	-	-	-	1	CO3	L4
4	Evaluate the performance of dipole and yagi uda antenna and plot the directivity and gain.	6	1	-	-	-	-	-	1	CO4	L4
5	Evaluate the losses through an optical fiber cable and estimate the same using 0.5m 21m.	3	1	-	-	-	-	-	1	CO5	L4
6	Differentiate all the coding techniques of bipolar signalling and generate eye diagram. (RZ, NRZ, Bipolar)	6	1	-	-	-	-	-	1	CO6	L4
7	Differentiate the digital modulation techniques and plot the same by waveforms. (QPSK, DPSK, PCM)	9	1	-	-	-	-	-	1	CO7	L4
-	**Total**	**42**	**7**	**8**	**5**	**5**	**5**	**5**	**20**	**-**	**-**

Note: Write CO based on the theory course.

2. Continuous Internal Assessment (CIA)

Evaluation	Weightage in Marks	CO	Levels
CIA Exam – 1	20	CO1, CO2,	L4
CIA Exam – 2	20	CO3, CO4	L4
CIA Exam – 3	20	CO5, CO6, CO7,	L4
Assignment – 1			
Assignment – 2			
Assignment – 3			
Seminar – 1			

Seminar – 2			
Seminar – 3			
Other Activities – define – Slip test			
Final CIA Marks	**40**	**-**	**-**

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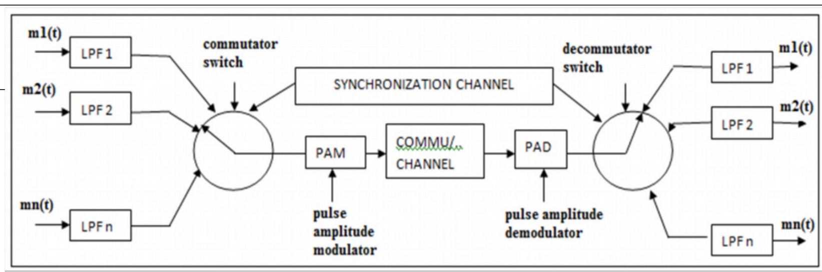
SNo	Description	Marks
1	Observation and Weekly Laboratory Activities	04 Marks
2	Record Writing	8 Marks for each Expt
3	Internal Exam Assessment	80 Marks
4	Internal Assessment	20 Marks
5	SEE	80 Marks
-	**Total**	**100 Marks**

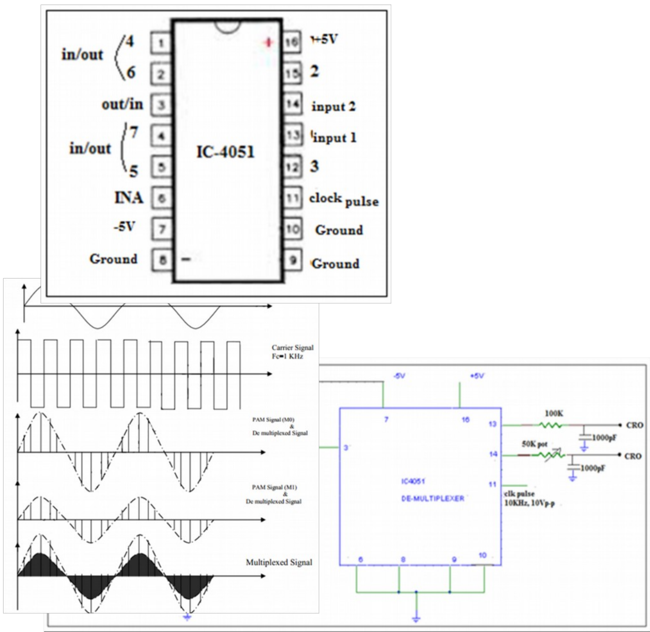
D. EXPERIMENTS

Experiment 01 : Time Division Multiplexing and Demultiplexing of two bandlimited signals

–	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Time Division Multiplexing and Demultiplexing of two bandlimited signals						
2	Course Outcomes	Explain the generation and multiplexing of signal in transmitter and the concept of demultiplexing in receiver						
3	Aim	Exercise on Time Division Multiplexing and Demultiplexing of two bandlimited signals						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula,	Time-division multiplexing (TDM) is a type of digital or (rarely) analog						

	Principle, Concept	multiplexing in which two or more signals or bit streams are transferred apparently simultaneously as sub-channels in one communication channel, but are physically taking turns on the channel. The time domain is divided into several recurrent timeslots of fixed length, one for each sub-channel. A sample byte or data block of sub-channel 1 is transmitted during timeslot 1, sub-channel 2 during timeslot 2, etc. One TDM frame consists of one timeslot per sub-channel. After the last sub-channel the cycle starts all over again with a new frame, starting with the second sample, byte or data block from sub-channel 1, etc. Application examples · The plesiochronous digital hierarchy (PDH) system, also known as the PCM system, for digital transmission of several telephone calls over the same four-wire copper cable (T-carrier or E-carrier) or fiber cable in the circuit switched digital telephone network · The SDH and synchronous optical networking (SONET) network transmission standards, that have surpassed PDH. · The RIFF (WAV) audio standard interleaves left and right stereo signals on a per-sample Basis. The left-right channel splitting in use for stereoscopic liquid crystal shutter glasses · TDM can be further extended into the time division multiple access (TDMA) scheme, where several stations connected to the same physical medium, for example sharing the same frequency channel to communicate the GSM telephone system.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) Connections are made as shown 2) Two signals with different frequencies but with same voltage are input to LPF 3) The waveforms in the CRO are observed 4) The sampling period of the signal is determined 5) The overall connections of TDM is shown in the block diagram 6) The demodulated output voltage is noted
7	Block, Circuit, Model Diagram,	

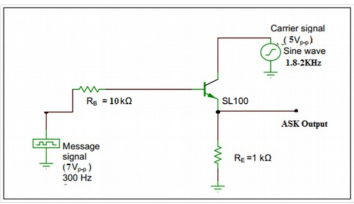
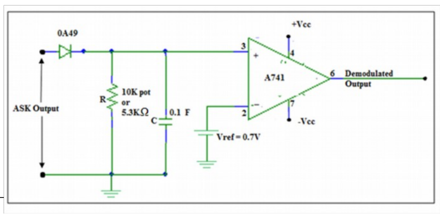


	Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	The circuit to demonstrate the working of TDM for PAM signals was designed and the output waveforms were verified.
12	Application Areas	
13	Remarks	

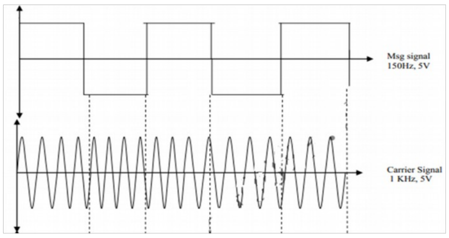
14	Faculty Signature with Date	

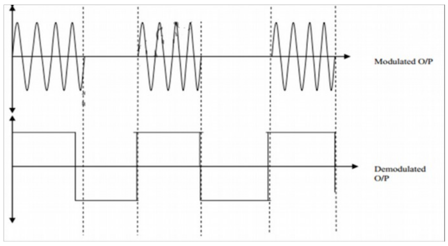
Experiment 02 : ASK generation and detection

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	ASK generation and detection						
2	Course Outcomes	Compare and modulate and demodulate the message signal using ASK						
3	Aim	Exercise on ASK generation and detection						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The transmission of digital signals is increasing at a rapid rate. Low-frequency analog signals are often converted to digital format (PAM) before transmission. The source signals are generally referred to as baseband signals. We can send analog and digital signals directly over a medium. From electro-magnetic theory, for efficient radiation of electrical energy from an antenna it must be at least in the order of magnitude of a wavelength in size; c = fλ, where c is the velocity of light, f is the signal frequency and λ is the wavelength. For a 1kHz audio signal, the wavelength is 300 km. An antenna of this size is not practical for efficient transmission. The low-frequency signal is often frequency-translated to a higher frequency range for efficient transmission. The process is called modulation. The use of a higher frequency range reduces antenna size. **ASK:** Amplitude shift keying - ASK - in the context of digital communications is a modulation process, which imparts to a sinusoid two or more discrete amplitude levels. These are related to the number of levels adopted by the digital message. For a binary message sequence there are two levels, one of which is typically zero. Thus the modulated waveform consists of bursts of a sinusoid. A binary ASK (BASK) wave is obtained by multiplying the message signal with the carrier. The B-ASK signal has two levels „1" and „0" representing the presence and absence of the sinusoid respectively. This can be shown in the waveform below. The message signal must be represented in NZR uni polar format only.							

		Binary ASK system has the largest probability of bit error when compared to FSK and PSK systems. There are sharp discontinuities shown at the transition points. These result in the signal having an unnecessarily wide bandwidth. Band limiting is generally introduced before transmission, in which case these discontinuities would be „rounded off". The band limiting may be applied to the digital message, or the modulated signal itself. One of the disadvantages of ASK, compared with FSK and PSK, for example, is that it has not got a constant envelope. This makes its processing (eg, power amplification) more difficult, since linearity becomes an important factor. However, it does make for ease of demodulation with an envelope detector.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) The circuit connections are made as per the circuit diagram. 2) A message signal with frequency about _______ Hz and amplitude of about _______ volts is fed to the transistor and carrier is fed to the collector (nearly ______ volts and ______Hz). 3) ASK output is now drawn at the emitter. 4)The amplitude of ASK is noted from the CRO. 5) This ASK output is fed to the demodulator circuit and a reference voltage of Vref =0.7volts is set. 7) The message signal at the output is obtained. Note the values of the detected output. 8) The modulated and the modulating signal are drawn on a graph.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	 

8	Observation Table, Look-up Table, Output	
9	Sample Calculations	**For Generation:** Choose R_b=600bits/sec è$T_b=1/R_b$ = 1.67ms Fm= $1/2T_b = R_b/2$ =300Hz **Therefore F_m = 300Hz** Choose m(t) with 300Hz and $7V_{p-p}$ $F_c=n_c/T_b = n_c/R_b$ =3*600 = 1.8KHz Choose c(t) =1.8KHz and $5V_{p-p}$ Let β=100; I_C=2.5mA=I_E **Therefore V_{RE}=2.5V** $R_E= V_{RE}/I_E$ = 2.5/2.5m =1KΩ **Therefore R_E=1KΩ** $V_{RB}=V_{m(p-p)}/2 - V_{RE} - V_{BE}$ = 7/2-2.5-0.7 =0.3V β = I_C/I_B èI_B = 25μA Choose $I_{B(sat)}$ = 1.2 * 25μ = 30μA $R_B = V_{RB}/I_{B(sat)}$ = 0.3/30μ =10KΩ **Therefore R_B=10KΩ** **For Detection:** Given F_m = 300Hz èF_m = 1/(2πRC) è R=1/(2π*0.1μ*300) = 5.3KΩ
10	Graphs, Outputs	





11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 03 : FSK Generation and detection

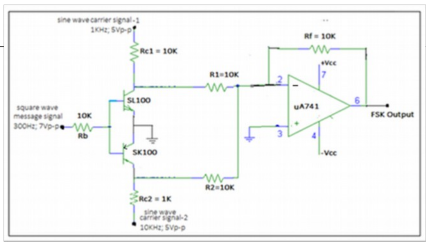
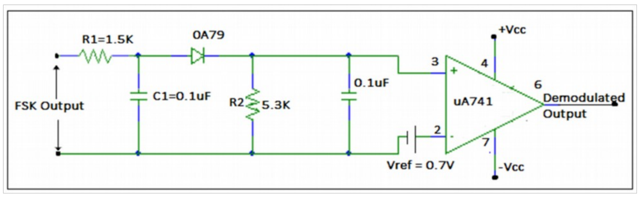
-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	FSK generation and detection						
2	Course Outcomes	Compare and modulate and demodulate the message signal using FSK						
3	Aim	Exercise on FSK generation and detection						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	As its name suggests, a frequency shift keyed transmitter has its frequency shifted by the message. Although there could be more than two frequencies involved in an FSK signal, in this experiment the message will be a binary bit stream, and so only two frequencies will be involved. The word „keyed" suggests that the message is of the „on-off" (mark-space) variety, such as one (historically) generated by a morse key, or more likely in the present context, a binary sequence. Conceptually, and in fact, the transmitter could consist of two oscillators (on frequencies f1 and f2), with only one being						

connected to the output at any one time. Unless there are special relationships between the two oscillator frequencies and the bit clock there will be abrupt phase discontinuities of the output waveform during transitions of the message.

Bandwidth: Practice is for the tones f1 and f2 to bear special inter-relationships, and to be integer multiples of the bit rate. This leads to the possibility of continuous phase, which offers advantages, especially with respect to bandwidth control.

FSK signals can be generated at baseband, and transmitted over telephone lines (for example). In this case, both f1 and f2 (of Figure 2) would be audio frequencies. Alternatively, this signal could be translated to a higher frequency. Yet again, it may be generated directly at „carrier" frequencies. Other forms of FSK **Minimum frequency-shift keying or minimum-shift keying (MSK)** is a particularly spectrally efficient form of coherent FSK. In MSK the difference betweenthe higher and lower frequency is identical to half the bit rate. Consequently, the waveforms used to represent a 0 and a 1 bit differ by exactly half a carrier period. This is the smallest FSK modulation index that can be chosen such that the waveforms for 0 and 1 are orthogonal. A variant of MSK called GMSK is used in the GSM mobile phone standard. FSK is commonly used in Caller ID and remote metering applications

Audio frequency-shift keying (AFSK) is a modulation technique by which digital data is represented by changes in the frequency (pitch) of an audio tone, yielding an encoded signal suitable for transmission via radio or telephone. Normally, the transmitted audio alternates between two tones: one, the "mark", represents a binary one; the other, the "space", represents a binary zero. AFSK differs from regular frequency-shift keying in performing the modulation at baseband frequencies. In radio applications, the AFSK-modulated signal normally is being used to modulate an RF carrier (using a conventional technique, such as AM or FM) for transmission. AFSK is not always used for high-speed data communications, since it is far

		less efficient in both power and bandwidth than most other modulation modes. In addition to its simplicity, however, AFSK has the advantage that encoded signals will pass through AC-coupled links, including most equipment originally designed to carry music or speech.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) The connections are made as per the circuit diagram. 2) Message signal of amplitude 7v and frequency 300 Hz is applied to the base of the transistor 3) Carrier C1(t) of 1KHz and 5v is applied at the collector of the NPN transistor. 4) Another carrier C2(t) of 10 kHz and 5v is applied at the Collector of the PNP transistor. 5) Get the FSK output waveform at the summer. 6) The frequency of the FSK output is noted from the CRO. 7) Then apply the FSK output to the input of the Demodulation circuits 8) Set the reference voltage to 0.7 volts and note the values of the detected output
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	 
8	Observation Table, Look-up Table, Output	
9	Sample Calculations	**For Generation:**

Choose R_b=600bits/sec è$T_b=1/R_b$ = 1.67ms

Fm= $1/2T_b = R_b/2$ =300Hz

Therefore F_m = 300Hz

Choose m(t) with 300Hz and $7V_{p-p}$

$F_c=n_c/T_b = n_c/R_b$ =3*600 = 1.8KHz

Let β=100; I_C=2.5mA=I_E, V_{RE}=2.5V

$R_C= V_{RE}/I_C$ = 2.5/2.5m =1KΩ

$V_{RB}=V_{m(p-p)}/2 - V_{RE} - V_{BE}$ = 7/2-2.5-0.7 =0.3V

$I_B = I_C /\beta = I_C/I_B$ = 2.5mA/100 èI_B = 25μA

Choose $I_{B(sat)}$ =1.2 * I_B = 1.2 * 25μ = 30μA

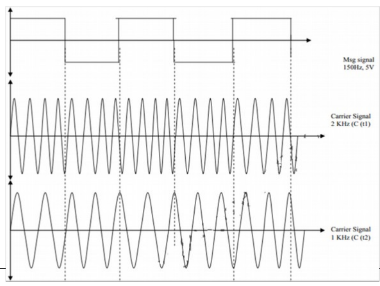
$R_B = V_{RB}/I_{B(sat)}$ = 0.3/30μ =10KΩ **Therefore R_B=10KΩ**

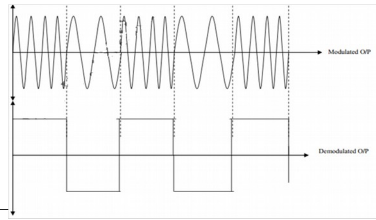
For Detection:

Assume $C_1 = C_2$= 0.1μF; F_1 =1 KHz and F_2 = 300Hz

$F_1 = 1/(2\pi R_1C_1)$ è R_1=1/(2π*0.1μ*1K) = 1.5KΩ

$F_2 = 1/(2\pi R_2C_2)$ è R_2=1/(2π*0.1μ*300) = 5.3KΩ

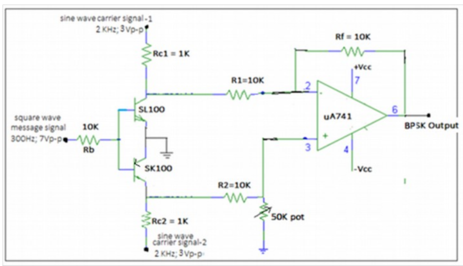
10	Graphs, Outputs	

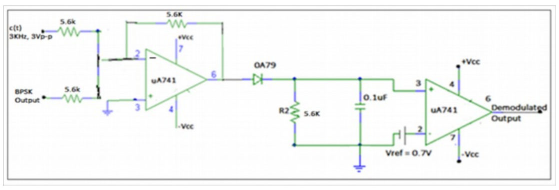
		
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 04 : BPSK generation and detection

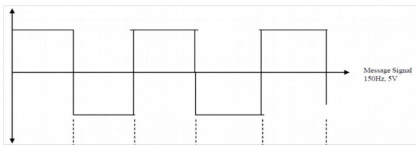
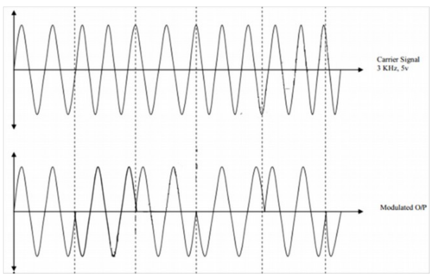
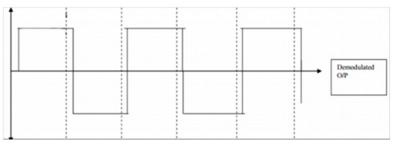
-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	BPSK generation and detection						
2	Course Outcomes	Compare and modulate and demodulate the message signal using BPSK						
3	Aim	Exercise on BPSK generation and detection						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Phase shift keying is one of the most efficient digital modulation techniques. It is used for very high bit rates. In PSK, the phase of the carrier is modulated to represent Binary values. In BPSK, the carrier phase is used to switch the phase between 0^0 and180^0 by digital polar Format. Hence it is also known as phase reversal keying. The modulated carrier is given by: Binary 1: S (t) = Ac $_{max.}$ cos. (2πfct) Binary 0: S (t) = Ac $_{max.}$ cos. (2πfct + 180) = - Ac $_{max.}$ cos. (2πfct)						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) The connections are made as per the circuit diagram. 2) A sine wave of amplitude 3v and 2kHz is fed to the Collector of the transistor as carrier.						

<table>
<tr><td></td><td></td><td>
3) The message signal, a square wave of amplitude 7V and 300Hz is fed to the base of the transistor.
4) The BPSK wave is observed at pin 6 of the op-amp IC 741.
5) The demodulation circuit is also connected.
6) BPSK wave obtained is fed as input to the demodulation circuit.
7) The demodulated waveform is observed
8) All the required waveform to be plotted.
9) The phase shift of the BPSK output is noted from the CRO and the values of the detected output is noted
</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>



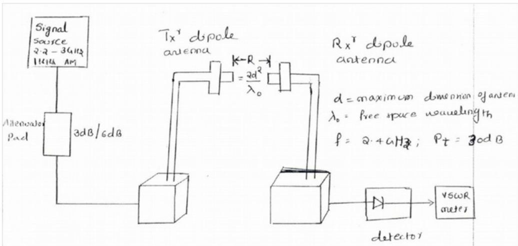


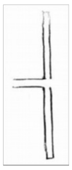
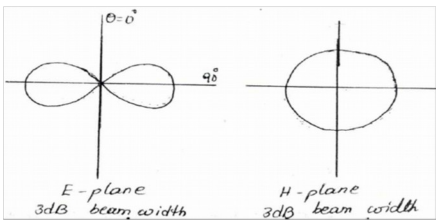
</td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>
For Generation:
Let $\beta=100$; $I_C=2.5mA=I_E$, $V_{RC}=2.5V$
$R_C= V_{RC}/I_C = 2.5/2.5m =1K\Omega$
Choose m(t) with 300Hz and $7V_{p-p}$
$V_{RB}=V_{m(p-p)}/2 - V_{BE(SAT)} = 7/2-0.7 = 2.8V$
During Positive half cycle
</td></tr>
</table>

		SL-100 - closed switch, SK-100 - open switch VO=-RF/R1 *c(t) è VO = -c(t) [Assume RF = R1 =10K] During Negative half cycle SL-100 - open switch, SK-100 - closed switch Voltage at non-inverting terminal is c(t)/2 VO=[RF/R1+1] *c(t)/2 = [1+10K/10K]*c(t)/2 è VO = c(t) **For Detection:** Given F_m = 300Hz èF_m = 1/(2πRC) è R=1/(2π*0.1μ*300) = 5.3KΩ but use 5.6KΩ
10	Graphs, Outputs	  
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 05 : Measurement of directivity and gain of microstrip dipole antennas

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Measurement of directivity and gain of microstrip dipole antennas						
2	Course Outcomes	Evaluate performance of dipole antenna using directivity and gain						
3	Aim	Exercise on Measurement of directivity and gain of microstrip dipole antennas						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The simplest practical antenna is the half wave dipole. In its original form it consists of two thin straight wires, each λ/4 in lengths, by a small gap. For this simple antenna, under fairly realistic approximations, closed form expressions are available for radiated fields, power, directivity etc. The important feature of Yagi antenna is that it is an end-fire antenna, ie the direction of maximum radiation is tangential to the plane formed by the parallel antenna elements. The design of a rectangular microstrip patch antenna begins with (a) choice of a substrate, (b) selecting the feed mechanism, (c) determining patch length L, (d) determining patch width w and (e) selecting the feed location.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	· Connect the 3dB/6dB attenuator to the signal source, the other end of which is connected to the transmitting antenna. · RF power level knob is kept at minimum position, measure transmitted power Pt. · Connect recieving antenna to the VSWR meter and then to the detector. · Maintain the distance greater than R between the two antennas. · Switch on the RF power switch. Set modulation frequency to I KHz. · Switch on the VSWR meter. · Place the antennas in E-Plane. Set the frequency to 2.4GHz. Note the						

<table>
<tr><td></td><td></td><td>VSWR readings at different angles. Note the corrected values from chart.
· Repeat the above steps with the reciever antenna in H-Plane.
· Repeat the above steps for the other types of antennas.
· Draw the graph and calculate the beam width of each antenna in E-Plane and H-Plane.
· Calculate the directivity and gain in dB of all antennas.</td></tr>
<tr><td>7</td><td>Block, Circuit, Model Diagram, Reaction Equation, Expected Graph</td><td>

</td></tr>
<tr><td>8</td><td>Observation Table, Look-up Table, Output</td><td><table>
<tr><td colspan="4">E-plane horizontal</td><td colspan="4"></td></tr>
<tr><td>Angle</td><td>VSWR meter reading</td><td>Corrected values</td><td>Normalized values</td><td>Angle</td><td>VSW read</td><td></td><td></td></tr>
<tr><td colspan="8">Clockwise</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td colspan="8">Anti-clockwise</td></tr>
<tr><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
</table></td></tr>
<tr><td>9</td><td>Sample Calculations</td><td>$Directivity = \frac{32,L}{\Delta\theta^{\circ}}$
$Directivity\ in\ dB; = 10\log$
$Gain\ in\ dB = \frac{1}{2}\{P_r(dB) - P_t(dB) + 20\log$
$\lambda_0 = \frac{c}{f}$ $R = \frac{2d}{\lambda}$</td></tr>
<tr><td>10</td><td>Graphs, Outputs</td><td>
</td></tr>
</table>

Prepared by Checked by Approved

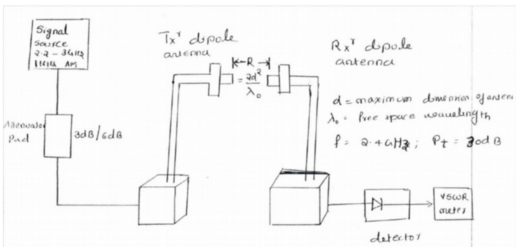
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

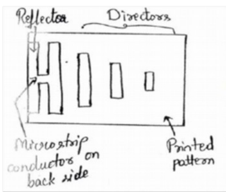
Experiment 06 : Measurement of directivity and gain of microstrip yagi antennas

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Measurement of directivity and gain of microstrip yagi antennas						
2	Course Outcomes	Evaluate performance of yagi antenna using directivity and gain						
3	Aim	Exercise on Measurement of directivity and gain of microstrip yagi antennas						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The simplest practical antenna is the half wave dipole. In its original form it consists of two thin straight wires, each λ/4 in lengths, by a small gap. For this simple antenna, under fairly realistic approximations, closed form expressions are available for radiated fields, power, directivity etc. The important feature of Yagi antenna is that it is an end-fire antenna, ie the direction of maximum radiation is tangential to the plane formed by the parallel antenna elements. The design of a rectangular microstrip patch antenna begins with (a) choice of a substrate, (b) selecting the feed mechanism, (c) determining patch length L, (d) determining patch width w and (e) selecting the feed location.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	· Connect the 3dB/6dB attenuator to the signal source, the other end of which is connected to the transmitting antenna. · RF power level knob is kept at minimum position, measure transmitted power Pt. · Connect recieving antenna to the VSWR meter and then to the detector. · Maintain the distance greater than R between the two antennas.						

- Switch on the RF power switch. Set modulation frequency to I KHz.
- Switch on the VSWR meter.
- Place the antennas in E-Plane. Set the frequency to 2.4GHz. Note the VSWR readings at different angles. Note the corrected values from chart.
- Repeat the above steps with the reciever antenna in H-Plane.
- Repeat the above steps for the other types of antennas.
- Draw the graph and calculate the beam width of each antenna in E-Plane and H-Plane.
- Calculate the directivity and gain in dB of all antennas.

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph





8 Observation Table, Look-up Table, Output

E-planc horizontal							
Angle	VSWR meter reading	Corrected values	Normalized values	*A*			
Clockv							
Anti-cloc							

9 Sample Calculations

Directivity $= \frac{32,4}{\Delta\theta^\circ}$

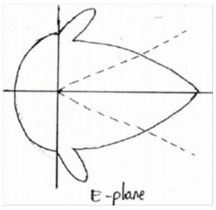
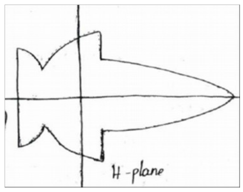
Directivity in dB; $= 10\log$

Gain in dB $= \frac{1}{2}\{P_r(dB) - P_t(dB) + 20\log$

$\lambda_0 = \frac{c}{f}$ $R = \frac{2d}{\lambda}$

EC

Prepared by Checked by Approved

10	Graphs, Outputs	 
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 07 : Coupling and isolation characteristics of microstrip directional coupler

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Coupling and isolation characteristics of microstrip directional coupler						
2	Course Outcomes	Determintion of Coupling and isolation characteristics of microstrip directional coupler						
3	Aim	Exercise on Coupling and isolation characteristics of microstrip directional coupler						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	A two stub branch line coupler is a fundamental direct coupled structure in which the main line is directly bridged To the secondary line by means of two shunt branches. The length of each branch and their spacing are all quarter Wavelength in the transmission medium at the center frequency f0. In a parallel coupled directional coupler the main length “l” of the coupled line section is quarter wavelength in the transmission medium at the center frequency f0 . All inputs and outputs lines have the same characteristic impedance						
6	Procedure, Program, Activity,	1) Set up the system as shown in the block diagram 2) Before switching on the signal source, rotate the RF power level knob						

Algorithm, Pseudo Code

in the first front panel anticlockwise to minimum position and the attenuation pad at the RF output port of the source.

3) Keep the range switch in the 40dB range position and the variable gain knob to maximum

4) First measure reference power level key connecting the cable directly.

5) Set the frequency of the source to 2.3GHz.

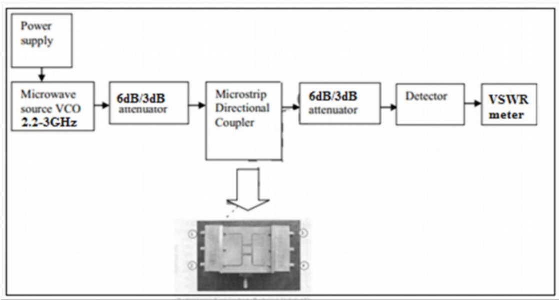
6) Increase the RF power output of the source till VSWR meter shows the reading in 50dB range

7) Next insert the coupler. Record the readings 2 and 4 of the coupler in 50 Ω matched loads

8) The value of isolation is generally much greater than coupling

9) Same procedure is followed for measuring isolation except that, port 4 is connected to the output port.

7 Block, Circuit, Model Diagram, Reaction Equation, Expected Graph



8 Observation Table, Look-up Table, Output

Freq. in GHz	VSWR Readings		Corr		
	Pli in dB	P3s in dB	Pli in dB		

9 Sample Calculations

WITH OSCILLOSCOPE:-

Insertion loss (dB) = 20 log V1 /V2

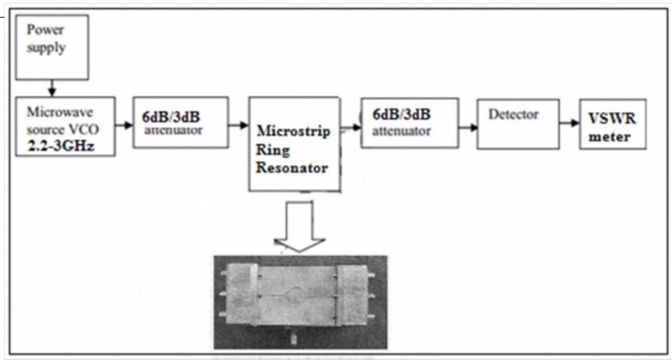
Coupling factor (dB) at port 2= 20 log 10 V1/ V3

Isolation (dB) = 20 log 10 V1 / V4

		WITH VSWR METER: Coupling factor (dB) =power at port 1 P1- power at port 3 P3 Isolation (dB) = power at port 3 P3- power at port 4 P4 Directivity (dB) = power at port 1 P1- power at port 4 P4 Insertion Loss (dB) = power at port 1P1- power at port 2 P2
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 08 : Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate						
2	Course Outcomes	Determintion of Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate						
3	Aim	Exercise on Resonance characteristics of microstrip ring resonator and computation of dielectric constant of the substrate						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	The ring resonator is known as a simple printed resonator that is useful for making approximate measurement of dielectric constant. It is also used in filters, and in antennas. Ring resonators can be analyzed in two ways. Looking at a ring resonator in isolation, it may appear that the field would be in the form of a wave circulating around either direction, but in reality, the coupling structure						

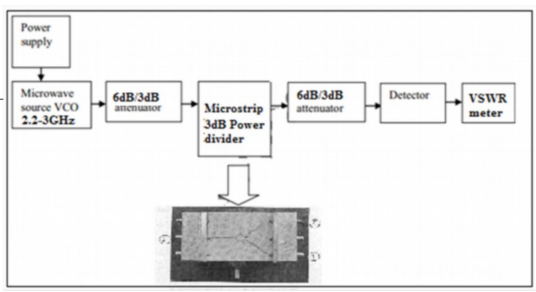
		plays an important role.
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) Set up the system as shown in the block diagram 2) Before switching on the signal source, rotate the RF power level knob in the first front panel anticlockwise to minimum position and the attenuation pad at the RF output port of the source. 3) Keep the range switch in the 40dB range position and the variable gain knob to maximum 4) First connect the 3dB attenuator pad at the output pad. The VSWR meter is to be used in conjunction with the coaxial detector 5) Set the frequency of the source to 2.2GHz. 6) Keep the range in 40dB and increase the RF power output of the source till VSWR meter shows the reading in 45dB range 7) Next insert the ring. Vary the frequency of the source slowly from 2.3GHz to 2.8GHz and observe the frequency at which VSWR meter shows a sharp peak. If no peak is observed, increase the power output of the source and vary frequency gain. Note the frequency at which the VSWR meter shows the peak. 8) This is first order resonant frequency for the resonator.
7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	

9	Sample Calculations	**Given parameters** Strip conductor width (in rising)= w= Height of the substrate = h= Mean radius of the ring = R = Vo = ; n = Measured resonant frequency = fr = Power in dB = **Formulae** $$2\pi R = \frac{n\ Vo}{fr\sqrt{\in ef}}$$ $$\in r = \frac{2 \in ef + [(1 + \frac{10h}{w})^{-\frac{1}{2}}] - 1}{[(1 + \frac{10h}{w})^{-\frac{1}{2}}] + 1}$$
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 09 : Power division and isolation of microstrip power divider.

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Power division and isolation of microstrip power divider.						
2	Course Outcomes	Determintion of Power division and isolation of microstrip power divider.						
3	Aim	Exercise on Power division and isolation of microstrip power divider.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Power divider is a 3 port device in which one input port and two output ports. When the power is fed at input port 1, power will emerge from the other two ports 2 and 3. It is impossible to match all the ports of power divider. In order to match all the three ports, an isolation resistance of 2Z0 is added between ports 2 and 3.With this, the proper isolation is provided						

		between ports 2 and 3
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) Set up the system as shown in the block diagram 2) Before switching on the signal source, rotate the RF power level knob in the first front panel anticlockwise to minimum position and the attenuation pad at the RF output port of the source. 3) Keep the range switch in the 40dB range position and the variable gain knob to maximum 4) To measure the reference power level, connect the cable directly. 5) Set the frequency of the source to 2.3GHz. 6) Increase the RF power output of the source till VSWR meter shows the reading in 50dB range 7) Vary the frequency of the source slowly from 0.1GHz to 2.8GHz and note the corresponding VSWR to measure the power divider division properly, insert the power divider in between and terminate the port 3 with matched load 8) Set the frequency of the source to 2.3GHz. Record the readings of VSWR meter. Next interchange the connections at port 2 and 3 i.e terminate the port 2 with matched load . 9) Record the readings of VSWR meter. Increase the frequency in steps of 0.1GHz upto 2.8GHz. 10) To measure the isolation property, remove the power divider from setup. Measure the reference power level at the same procedure by keeping reference level slightly higher. 11) Insert the power divider with port 2 as input port and port 3 as output port. 12) Record the readings of VSWR meter at the same frequency
7	Block, Circuit, Model Diagram, Reaction Equation,	



	Expected Graph	
8	Observation Table, Look-up Table, Output	

Freq. in GHz	VSWR Readings			Corrected Values			Power Division	
	Pli in dB	P2s in dB	P3s in dB	Pli in dB	P2s in dB	P3s in dB	Port1-2	Port1-3

Freq. in GHz	VSWR Readings			Corrected Values			Isolation from Port 2-3
	Pli in dB	P2s in dB	P3s in dB	Pli in dB	P2s in dB	P3s in dB	

Freq. in GHz	VSWR Readings			Corrected Values			Isolation from Port 3-2
	Pli in dB	P2s in dB	P3s in dB	Pli in dB	P2s in dB	P3s in dB	

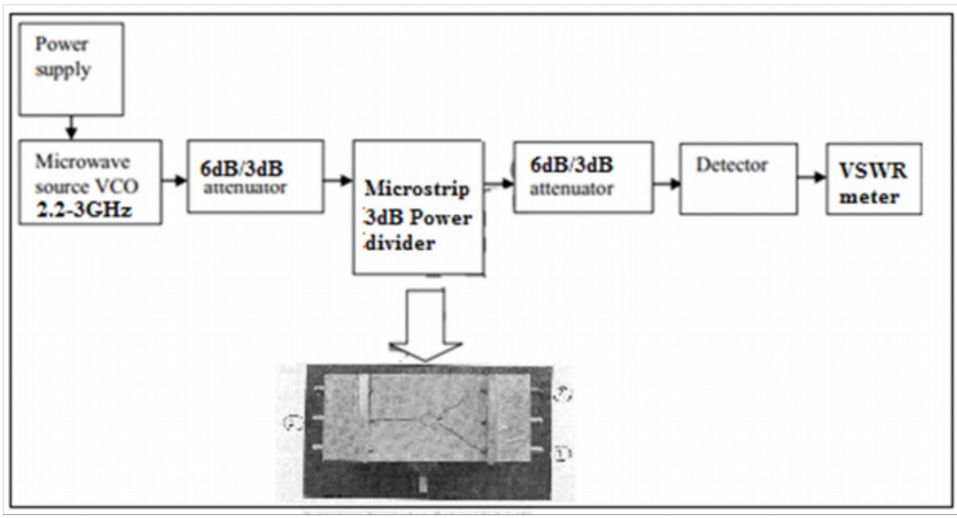
9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 10 : Power division and isolation of microstrip power divider.

-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducted**	
1	Title	Power division and isolation of microstrip power divider.						
2	Course Outcomes	Determintion of Power division and isolation of microstrip power divider.						
3	Aim	Exercise on Power division and isolation of microstrip power divider.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Power divider is a 3 port device in which one input port and two output ports. When the power is fed at input port 1, power will emerge from the other two ports 2 and 3. It is impossible to match all the ports of power divider. In order to match all the three ports, an isolation resistance of 2Z0						

		is added between ports 2 and 3.With this, the proper isolation is provided between ports 2 and 3
6	Procedure, Program, Activity, Algorithm, Pseudo Code	1) Set up the system as shown in the block diagram 2) Before switching on the signal source, rotate the RF power level knob in the first front panel anticlockwise to minimum position and the attenuation pad at the RF output port of the source. 3) Keep the range switch in the 40dB range position and the variable gain knob to maximum 4) To measure the reference power level, connect the cable directly. 5) Set the frequency of the source to 2.3GHz. 6) Increase the RF power output of the source till VSWR meter shows the reading in 50dB range 7) Vary the frequency of the source slowly from 0.1GHz to 2.8GHz and note the corresponding VSWR to measure the power divider division properly, insert the power divider in between and terminate the port 3 with matched load 8) Set the frequency of the source to 2.3GHz. Record the readings of VSWR meter. Next interchange the connections at port 2 and 3 i.e terminate the port 2 with matched load . 9) Record the readings of VSWR meter. Increase the frequency in steps of 0.1GHz upto 2.8GHz. 10) To measure the isolation property, remove the power divider from setup. Measure the reference power level at the same procedure by keeping reference level slightly higher. 11) Insert the power divider with port 2 as input port and port 3 as output port. 12) Record the readings of VSWR meter at the same frequency

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	



8	Observation Table, Look-up Table, Output	

Freq. in GHz	VSWR Readings			Corrected Values			Power Division	
	P1i in dB	P2s in dB	P3s in dB	P1i in dB	P2s in dB	P3s in dB	Port1-2	Port1-3

Freq. in GHz	VSWR Readings			Corrected Values			Isolation from
	P1i in dB	P2s in dB	P3s in dB	P1i in dB	P2s in dB	P3s in dB	Port 2-3

Freq. in GHz	VSWR Readings			Corrected Values			Isolation from
	P1i in dB	P2s in dB	P3s in dB	P1i in dB	P2s in dB	P3s in dB	Port 3-2

9	Sample Calculations	
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

Experiment 11 : Measurement of propagation loss, bending loss and numerical aperture of an optical fiber. .

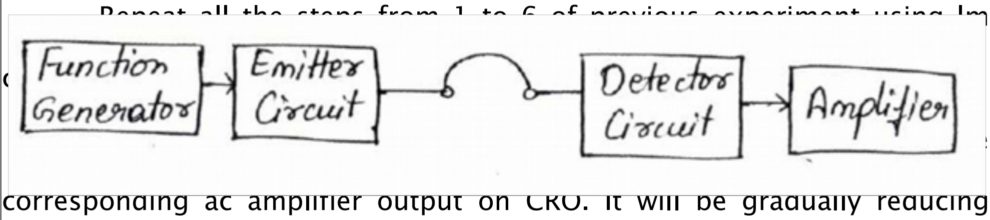
-	**Experiment No.:**	1	**Marks**		**Date Planned**		**Date Conducte**	

							d	
1	Title	Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.						
2	Course Outcomes	Determintion of Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.						
3	Aim	Exercise on Measurement of propagation loss, bending loss and numerical aperture of an optical fiber.						
4	Material / Equipment Required	Lab Manual						
5	Theory, Formula, Principle, Concept	Fiber optic links can be used for transmission of digital as well as analog signals. Basically a fiber optic link contains three main elements transmitter and optical fiber & a receiver. The transmitter module takes the input signal in electrical form and then transforms it into optical (light) energy containing the same information. The optical fiber is the medium, which carries this energy to the receiver. At the receiver, Light is converted back into electrical form with the same pattern as originally fed to the transmitter.						
6	Procedure, Program, Activity, Algorithm, Pseudo Code	**Propagation Loss** · Connect power supply to the board. · Make the following connections. · A function generator of 1KHz sine wave output and input socket of emitter-I circuit via 4mm load. · Connect 0.5m optic fiber between emitter output and detector-I's input and detector-I's output to amplifier-1 input socket via 4mm load. · Switch on the power supply. · Set the oscilloscope channel-1 to 0.5 v/div and adjust 4-6 div amplitude by using X1 probe with the help of variable pot in function generator block at the input of emitter-1. · Observe the output signal from detector on CRO. · Adjust the amplitude of the received signal as that of the transmitted one with the help of gain adjusts pot in ac amplifier block. Note this amplitude and name it as VI. · Now replace the fibre optic cable with 1 m cable without disturbing other settings.						

· Measure the amplitude at the receiver end again at the output of amplifier V2. Calculate the propagation loss

Bending Loss

Repeat all the steps from 1 to 6 of previous experiment using 1m



corresponding ac amplifier output on CRO. It will be gradually reducing showing the loss due to the bends.

Numerical Aperture

· Connect the power supply to board.

· Connect the frequency generators 1 KHz sine wave output to input of emitter- I circuit. Adjust the amplitude at 5Vp-p.

· Connect one end of fibre cable to output socket of emitter-1 circuit and other end to numerical aperture measurement jig. Hold the white screen facing the fibre such that its cut face is perpendicular to the axis of fibre.

· Hold the white screen with 4-concentric circles vertically at a suitable distance to make the red spot from the fibre coincide with 10mm circle.

· Record the distance of screen from the fibre end L and note the diameter W of the spot.

· Compute NA and Acceptance angle

7	Block, Circuit, Model Diagram, Reaction Equation, Expected Graph	
8	Observation Table, Look-up Table, Output	
9	Sample Calculations	

$$\frac{V_1}{V_2} = e^{-\alpha(l_1 + l_2)}$$

$\alpha \Rightarrow$ loss in neper/m

1 neper = 8.686 dB.

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		$$NA = \frac{\omega}{\sqrt{4L^2 + \omega^2}} = \sin\theta_{max}$$
10	Graphs, Outputs	
11	Results & Analysis	
12	Application Areas	
13	Remarks	
14	Faculty Signature with Date	

VIVA QUESTIONS

State different types of Digital modulation techniques?

2. What is shift keying?

3. What is a binary modulation technique?

4. Define ASK?

5. Define FSK?

6. Define PSK?

7. Define QPSK and DPSK?

8. Why QPSK is called quadrature shift keying?

9. Define TDMA?

10. What are applications of shift keying?

11. Define FDM?

12. State the applications of multiplexing?

13. State the principle of PLL?

14. State coherent detection?

15. State non-coherent detection?
16. Differentiate between DPSK and QPSK?
17. What is an M-Array data transmission?
18. What is a standing wave?
19. Define reflection and transmission co-efficient?
20. State different types of losses in transmission lines?
21. State some applications of smith chart?
22. Define modes?
23. Differentiate between TE and TM waves?
24. What is the range of microwaves?
25. What is the advantage of waveguides?
26. State the principle of quarter wave transformer?
27. Define VSWR?
28. Define properties of S-Matrix?
29. What are waveguide tees?
30. State properties of E-plane tees and H-plane tees?
31. State the properties of magic tee?
32. Define Isolator?
33. What is the principle of Directional coupler?
34. State different types of Directional couplers?
35. What is a Klystron?
36. State the classification of microwave tubes?
37. What are O-type and M-type tubes?
38. State application of klystron?
39. State the mechanism of oscillation in klystron?
40. How modulation occurs in reflex klystron?
41. State the principle of operation of TWT?
42. State the principle of operation of Magnetron?
43. State the applications of Magnetron?

44. What is PIN diode?

45. State some application of PIN diode?

46. State different modes of operation of GUNN diode?

47. What is an IMPATT, BARITT, TRAPATT diodes?

48. State two methods to find VSWR?

49. Define the principle of tuneable detector?

50. Define the principle of slotted line carriage?

51. Differentiate between normal and expanded SWR?

52. What type of frequency meter is used in Laboratory?

53. Define directivity, radiation efficiency, beamwidth and bandwidth of an antenna?

54. What are the radiation patterns for Horn antenna, parabolic antenna?

55. State the formula to find directivity for an antenna?

56. What are the advantages of using optical fibres?

57. What is the principle of operation of OFC?

58. State the difference between step-index and graded index fibre?

59. State the formula to find the numerical Aperture?

60. What are the different types of losses in OFCS?