Swami Keshvanand Instituteof Technology,

Management & Gramothan

(Accredited by NAAC with 'A^{++}' Grade)

Approved by AICTE, Ministry of Education, Government of India
Recognized by UGC under Section 2(f) of the UGC Act, 1956
Affiliated to Rajasthan Technical University, Kota

Point 4.1.1

Documents of CoE in Antenna Microwave and RF Engineering (2022-23)

: RAMNAGARIA (JAGATPURA), JAIPUR-302017 (RAJASTHAN), INDIA
: +91-141-3500300, 2752165, 2759609 | : 0141-2759555
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Approval Letter

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DR. FNA 30/5/23

OFFICE OF THE DEAN ACADEMIC AFFAIRS
RAJASTHAN TECHNICAL UNIVERSITY

AKELGARH, RAWATBHATA ROAD, KOTA-324010
Ph-0744- 2473015, website : www.rtu.ac.in, email : dean.academic@rtu.ac.in

RTU/Acad./F(17)14/2023/ 1042-43 **Date: 23.05.2023**

Principal/Director
Swami Keshvanand Institute of Technology Management & Gramothan
Ramnagaria, Jagatpura,
Jaipur-302017

Sub: Recognition of Centre of Excellence in **Antenna Microwave and RF Engineering.**
Ref.: Your proposal dtd. 11.03.2022.

With reference to University call for proposals for establishment of Centre of Excellence, your application for recognition of Centre of Excellence in the area of **Antenna Microwave and RF Engineering** was considered. On the recommendation of Expert Evaluation Team and subsequent approval of 75th Board of Inspection vide agenda no. 75.3.1, University recognised the Centre of Excellence in the area of **Antenna Microwave and RF Engineering** at your institute from session 2022-23.

Further, BOI has not approved the COE proposal for Solar and Biofuel Research for Sustainable Future.

The operation of Centre of Excellence would be governed under the Guidelines for Establishment, Recognition and Operation of COE approved in 74thBOI vide agenda no. 74.4 and subsequently amended time to time.

(**Prof. D.K. Palwalia**)
Dean, Academic Affairs

C.C.to:
PS to HVC

(**Diwakar Joshi**)
Dy. Registrar, A/A

Swami Keshvanand Institute of Technology, Management & Gramothan, Jaipur

Department of Electronics & Communication Engineering

A Proposal for

Centre of Excellence in

"Antenna, Microwave and RF Engineering"

Submitted to:

Rajasthan Technical University, Kota

March, 2022

Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur

TABLE OF CONTENTS

Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur

Proposal for Centre of Excellence in Part I: General Information

1	Name of the Institute submitting the Centre of Excellence Proposal	Swami Keshvanand Institute of Technology, Management and Gramothan
2	Address with pin code	Ramnagaria, Jagatpura, Jaipur-302017 (Rajasthan)
	Contact No.	0141-3500300, 2759609, 2752165
	Email id	info@skit.ac.in
3	Proposed name of Centre of Excellence	**Centre of Excellence in "Antenna, Microwave and RF Engineering"**
4	Fee Payment Detail	

5. Vision and Mission of proposed COE:

Vision:

To emerge as globally competitive center for training, research and product innovation and development in the field of RF, antennas and microwave to meet the socio-economic needs

Mission:

To empower undergraduates and postgraduates by imparting quality training, research, design & developments in the field of antennas and microwave and preparing them to be competent in dealing with industrial and societal challenges.

6. Objective and Relevance of the proposed Centre of excellence:

Objectives

The objective is to provide quality education with focus on practical knowledge and maintain a student support system for their professional growth to compete globally and also aims to promote an environment conductive for innovation, entrepreneurship development and research

- To enhance the skills of the students towards the RF circuits, Antenna and Microwave component development.

- To develop the skills required for the RF and microwave system design, fabrication, testing and measurement.
- To give the knowledge and skills necessary to participate as an effective team member or team leader in the development of RF systems covering a broad range of engineering and scientific applications.
- To provide a platform to students, researchers and academicians for research, innovation and product development in the field of RF, Microwave and Antenna.
- To organize short term & long term training programs at the COE.

Relevance

Antenna is used for radiating and receiving electromagnetic signal into space. It acts as a transition region between free space and guiding structure like a transmission line in order to communicate between two or more locations. In antennas, high gains with very narrow beam width in one or more planes are required. These can be achieved with antennas of reasonable size. The main purpose of this center of excellence is to help students, researchers and academicians to know many things about antennas and microwave components used in communication system.

Microwaves are widely used for point-to-point communications because their small wavelength allows conveniently-sized antennas to direct them in narrow beams, which can be pointed directly at the receiving antenna. This allows nearby microwave equipment to use the same frequencies without interfering with each other, as lower frequency radio waves do. Another advantage is that the high frequency of microwaves gives the microwave band a very large information-carrying capacity; the microwave band has a bandwidth 30 times that of all the rest of the radio spectrum below it.

7. Technical novelty and utility:

Technical novelty: Institute has a strong team of faculties and staff members with extensive experience working on various areas related to design, simulation, analysis, fabrication, integration and testing of advanced microwave components and antennas for communication, navigation and sensor applications. Also institute is having well equipped laboratories which include required facilities for COE comprising of both

hardware and software. The microwave lab of the institute has got various MIC components to design a microwave circuit, microwave source S band (2-4 GHz) and USB power sensor to measure microwave power and other equipments to measure various microwave parameters.

Major equipments and facilities:

- 25 user HFSS software (Ansys Academic Teaching HF Package) version 13
- MATLAB & Simulink R2006a
- Lab View Academy standard suite
- PCB Fabrication Lab
- Automatic Spin Coating Machine Apex Instruments EZspin A1
- 14 GHz Two port Field Fox microwave Analyzer N9916A (VNA)
- 1 GHz spectrum analyzers, Caddo 8010, 150 kHz to 1050 MHz
- Advanced MIC trainer, NV 9008

Utility:

Due to rapid growth in the area of modern wireless communication systems, the demand for different types of novel, multi-functional and high-performance antennas and microwave components is increasing exponentially. As a crucial part of the future communication system, breakthrough in the development of antennas will obviously improve the performance of the whole communication system. That's why the Antenna, Microwave and RF Engineering are an exciting area for research, innovation and product development.

Also, antenna is playing a prominent role in biomedical engineering for improving health and quality of life. Pacemakers, deep neural implants, endoscopy, magnetic resonance imaging, microwave imaging and clinical instruments for thermal ablation are some examples of health care instruments which are taking advantage of antennas. Antennas can be implanted, placed on the body and swallowed to transfer diagnosis information from the human body to the external monitor and further to the doctor or concerned person through the internet. In addition, variation in the electrical parameters of antennas

like near field electromagnetic radiations, impedance and reflection coefficient can be analyzed to detect diseases. Microwaves are a highly utilized electromagnetic wave, used across a range of industries including food processing, communications, in the development of novel medical treatments and biosensor diagnostics. The microwave frequency of 2.45 GHz is used for biomedical applications.

8. Possible Patentability of the research under COE

Microwave components are basically metallic structures separated by dielectric materials. Their properties critically depend on the shape and size of the metal and the dielectric and properties of the dielectric material. Designs of microwave components (for achieving desired properties) are very special. As mentioned under point 12 below, the proposed research work (under COE) will develop many such designs. All these designs will be patentable.

The facilities and infrastructure are being continuously upgraded as per latest technological advancements. Various research projects and quality papers in SCI/SCOPUS indexed journals are a big testimony of the quality of facilities at the proposed centre.

9. List of mentor faculties with qualification details and expertise details in relevant COE

S.N.	Name of mentor faculty	Designation	Qualification	Expertise details in Relevant COE	Experience (in years) (Teaching and Industry)
1	Prof.(Dr.) Mukesh Arora	Professor	B.E, M. Tech, Ph.D	Wireless communication and Antennas	18
2	Prof. (Dr.) Satish Kumar Bhatnagar	Professor & Director (Research)	Ph.D	Wireless communication and Antennas	59
3	Mr. Satya Narayan Vijayvergiya (Industry person)	Professor & Dean (Research and Development	B.E, M. Tech	Instrumentation, industry related projects	45

4	Dr. Braj Raj Sharma	Professor and Head, Physics Department	M.Sc. (Physics), Ph.D.	Microstrip Patch Antennas	18
5	Dr. Monika Mathur	Associate Professor & PG Co-ordinator	B.E, M. Tech, Ph.D	Microstrip antenna designing	15
6	Dr. Shubhi Jain	Assistant Professor	B.E, M. Tech, Ph.D	Microstrip antennas, metamaterials	10
7	Dr. Komal Sharma	Associate Professor	M.Sc., Ph.D.	Microstrip Patch Antennas	20
8	Ms. Suman Sharma	Assistant Professor	B.E, M. Tech, PGDBA, PhD*	Wireless communication and Antennas	12
9	Ms. Rajni Idiwal	Assistant Professor	B.E, M. Tech, PhD*	Optical antenna	11
10	Mr. Pallav Rawal	Assistant Professor	B.Tech., M. Tech, PhD*	Reconfigurable Antennas	11
11	Mr. Harshal Nigam	Assistant Professor	B.E, M. Tech, PhD*	Phased array antennas	7
12	Mr. Pawan Kumar Jain	Assistant Professor	M.Sc.,PhD*	Microwave Electronics, Microstrip Patch Antenna	16
13	Ms. Gloria Joseph	Assistant Professor	B.Tech., M. Tech	Photonics, optical antenna	10
14	Mr. Sunil Lakhawat	Assistant Professor	B.Tech., M. Tech	Digital communication s	9

10. Support staff dedicated deployed for proposed COE with qualification details:

S.No.	Name of support staff	Designation	Qualification	Expertise details in Relevant COE	Total Experience (in years)
1	Mr. Dhurendra Singh	Technical Assistant	B.Tech.	PCB designing, Software Handling	12
2	Mr. Prema Ram	Technical Assistant	B.Tech.	Project assistance, PCB designing and Software handling	12

11. Details of the National/ International Institutes/ Industries Involved in the proposed centre of excellence

- Malaviya National Institute of Technology, Jaipur
- CARE, IIT Delhi
- Manipal University, Jaipur
- RTU Kota
- Genus Innovation Ltd. Jaipur
- CEERI, Pilani
- Rajasthan University, Jaipur
- Government Women Engineering College, Ajmer

Part –II Technical Details of Center

12. Specific thematic focus:

Kindly refer Annexure-I

13. Previous experience in the field : Work already done by department/ institute in this field (supported by papers published, IPR/Patents held and grant received in the field)

Kindly refer Annexure-II

14. Strategy to provide scientific mentoring / Skill Development / startup of young Engineers / Professional student under the center

To mentor the research project and training programme, well qualified and experienced faculties are available in the institute. In addition, the relationship with various institutes and industries will also help in conduction of research projects under COE. We are in constant touch with professors of national and international institute/university for current ongoing academic and research activities.

Future Center of Excellence proposes the strategy to provide scientific mentoring/ Skill Development / startup of young Engineers / Professional student in following ways:

- Candidates' prior performance in area of antennas, background academic skills will be taken as an input so as to provide appropriate motivation, mentor in applied field and goal orientation to research further.
- To develop an advance mentee's academic and personal career during training, each mentee will be allotted mentor.
- Moreover, guided virtual mentoring for academic practice would be also provided to the mentee wherein, then he/she will be tailored all the reflections from the mentor through various digital platforms.
- Mentee productivity will be uplifted by scholarly activities, research dissemination, manuscript submissions, publications, grant submissions, presentations.
- Career development webinars/workshops will provide discernment, goal training and motivation for the mentee.

- For the Skill Development Enhancement, Candidate will be provided the needed Component & Software's Practices in COE and Regular Frequent Assessments and Sessions will be done by the mentors.
- For Entrepreneurship/Startup in the field of antennas COE will be help as needed by the Candidate to develop the product, with some defined MOU.

15. Proposed training programs schedule:

We will be going to conduct one week, two weeks, one month and two months training program .There will be training modules which will cover various lectures as well as hands on sessions including the assignments. This training aims at giving maximum exposure of Antenna and microwave propagation field to the students.

The details of the training modules are mentioned in Annexure-III.

PART –III Infrastructural facilities

1. Major equipment's, accessories exclusive for COE

S. N	Name of Equipment	Specification	Make	Research Application	Total Cost (Rs.)
1	Vector Network Analyzer	Two port handheld VNA from Keysight technologies, Range is 14 GHz	2017	To analyze cables and antennas, field strength measurement, Spectrogram analysis and stimulus response Measurement of fabricated RF and Microwave components, Antenna parameters measurement	14,60,000
2	Automatic Spin Coating machine	Apex Instruments EZspin A1	2022	To deposit photo resist coating for fabrication on substrate	1,89,991
3	Spectrum Analyzer	Caddo 8010, 150 kHz to 1050 MHz	2009	It can be used for measurement of spectrum, Circuit testing, and troubleshooting	1,19,500
4	Proto Cure PCB Curing Machine (Oven)	Maximum allowable PCB size: 250 X 300 mm (10" X 12"), finned	2007	Table top unit for curing of liquid photoresist	12,375

		heaters with thermostat controls			
5	Photoresist dip coating machine	Maximum allowable PCB size: 250 X 300 mm (10” X 12”), Rectangular tank 2 L capacity	2007	Coating of laminates with photoresist	19,923
6	PCB art work film maker	Working area: 250 X 300 mm (10” X 12”) with diffused light	2007	Negative making contact printer as well as an Illuminated art work table	15,675
7	PCB double sided UV exposure machine	Maximum size: 250 X 300 mm (10” X 12”), UV tubes: 2X4= 8 Watts	2007	Double sided UV exposure	29,452
8	Microwave USB Power Sensor	Keysight U2000A 10 MHz-18 GHz	2018	To measure microwave power through various microstrip components	2,86,946

2. Major software and IT structure for COE

S.N	Name of Software	Research Application	Total Cost (Rs.)
1	Ansys Academic Teaching HF Package , Version 13,(25users)	To compute basic electromagnetic field quantities, Simulation of high frequency RF and microwave components along with antenna design simulation	9,00,000
2	MATLAB & Simulink R2006a	To simulate different algorithms related to transmission and reception of signals for communication system.	2,15,500
3	Lab View Academy standard suite z	It is used for microwave measurements in simplified manner with appropriate step by step explanations of instrument capabilities.	2,76,000

3. Other available infrastructure facilities

S.N	Description of the Infrastructure		Use in Research Center	Total
1	MT 9000	Micowave test bench (Klystron based)	Used for performing measurements of different Microwave parameters	4
2	MT 9001	Micowave test bench (Gunn based)	Used for performing measurements of different Microwave parameters	2
3	NV 9008	MIC Trainer kit	Contains different Microstrip components for measuring their characteristics	1
4	U2000A	Microwave Power sensor	To measure microwave power through various microstrip components	1
5	VS411	VSWR meter	To measure Microwave power and VSWR	2
6	Nvis104	Microwave generator S band	Microwave source to excite microstrip components	2

7	NV102	Klystron power supply	Microwave source for test bench	1
8	NV101A	Gunn power supply	Microwave source for test bench	2
9	HM 5012-2, 150 kHz to 1 GHz	Spectrum Analyzer	It can be used for measurement of spectrum, Circuit testing, and troubleshooting	1
10	Model No. 401-DSO-Scientech 50 MHz, 500 ms/s, Channel-2	DSO	Circuit testing, measurement and troubleshooting	2
11	1. Model No. HM1507-3, 150 MHz, 200 ms/s, Channel -2 (Analog and digital) 2. Keysight DSO 1012 A/ 100 MHz/ two channel	DSO	Circuit testing, measurement and troubleshooting	2
12	Digital microscope	Digital microscope	USB digital microscope magnifier	1
13	Caddo 803/Scientech ST251/ 30 MHz/ Two Channel	CRO	Circuit testing, measurement and troubleshooting	4
14	ScientiFic SM 5081	Milli ohm meter		3
15	ScientiFic SM 5051/ 1 GHz	Frequency counter		5
16	ScientiFic SM 5027	Distortion meter		1
17	Caddo 9302	Digital LCR meter		4
18	ScientiFic SM 5035/ 20 MHz	Pulse generator		1
19	ScientiFic SM 7022/metravi 19 F/Agilent U-1252 A	Digital Multimeter		14
20	ScientiFic SM 5070/caddo 4061/ 3 MHz	Function generator		3
21	VPL –VICT	Universal IC tester		1

22	TI	Project interfacing board	Designing and developing of electronics and embedded systems	5
23	Dynalog/NVIS NV 5001, NV 5002,	Microcontroller development board		6
24	ScientiFic SM 5015	Programmable multiplier		4
25	ScientiFic SM 901/ 30 MHz	Power scope		1
26	Scientech ST-4070, ST-4077	Power Supply		3
27	Scientech ST-2610	Project Board		5
28	TI/ AD58364M-EVM	ADC interfacing kit		1
29	TI	DAC interfacing kit		1
30	TI	GSM modem interface kit		1

4. List of Consumables

S.N	**Item**	**Quantity**	**Total Cost (Rs.)**
1	Klystron tube 2k25 (2)	2	10400X2= 20800
2	Gunn diode tube (2)	2	10000X2=20000
3	RF Microwave amplifier BXHF1084 Bandwidth 2-20 GHz, high gain: 26dB (1)	1	9000
4	Microwave power detector (1)	1	8000
5	SMA M/M cable (10)	10	1000X10=10000
6	SMA M/M connector (10)	10	1200X10=12000
7	SMA female connector (10)	10	1000X10=10000

Kindly refer **Annexure IV** for visual of facilities.

5. Other funded activities organized in the past in the present area of COE

S.N	Dates (from-to)	Title of the Events organized	Total Cost (Rs.)
1	24-26 Feb, 2022	3rd International Conference on Advancements in Nanoelectronics and Communication Technologies	1,85,000/-
2	5-11 Jan, 2022	FIP on recent trends in robotics and automation (Sponsored by AICTE-ISTE)	93000/-
3	4-6 Feb, 2021	2nd International Conference on Advancements in Nanoelectronics and Communication Technologies	1,68,000/-
4	14-18 September, 2020	FDP on Emerging tools and techniques in communication systems, ETTCS-2020 (Sponsored by RTU TEQIP)	93,000/-
5	17-18 Jan, 2020	International Conference on Advancements in Nanoelectronics and Communication Technologies	1,96,000/-
6	19-21 September, 2019	National Workshop on "PCB Design and Fabrication (PDF-2k19) (Sponsored by IEEE Rajasthan Subsection)	80,000/-
7	April 21, 2018	IETE Zonal Seminar and ISF Zonal Congress on "Advances in Electronic Circuits and Systems"	10,000/-
8	01-16 December, 2017	Faculty Development Program on Project Planning Management and Development	10,000/-
9	09-11 Feb, 2017	National Conference on "Advancements in Nano electronics and Communication Technologies" (ANCT-2017)	80,000/-
10	22-23 December, 2016	Workshop on "Introduction to Robotics" through the e-Yantra Lab Setup Initiative (eLSI) (Sponsored by e yantra)	72,000/-
11	17-19 March, 2016	National Conference on "Advancements in Nano electronics and Communication Technologies" (ANCT-2016)	75,000/-

Swami Keshvanand Institute of Technology, Management and Gramothan, Jaipur

SKIT/2022/ **10.03.2022**

DECLARATION/CERTIFICATION

It is certified that

(a) The institute assume to undertake the financial and other management responsibilities of the Centre of Excellence

(b) The institute provide the necessary facilities and infrastructure for the Centre of Excellence

Dr. Ramesh Kumar Pachar
Principal

Annexure-I

Conceptual framework and scientific strategies of the above thematic focus supported by citations

Simulation of the antenna / MIC components on HFSS software

The Institute is having 25 user HFSS software (Ansys Academic Teaching HF Package) version 13 with which different types of antennas and Microwave components like planar and non-planar antennas, reconfigurable antennas, microwave components and RF circuits can be designed and simulated. The analysis of following can be done but not limited.

- Square patch microstrip antenna with notches and curved edges.
- Concentric circular patch microstrip antenna with an elliptical slot.
- Parasitically coupled semi-circular elliptical ring antenna surrounding elliptical patch geometry.
- Concentric elliptical patch microstrip antenna with a circular slot.
- Reconfigurable antennas.
- Microwave components like couplers, dividers, filters etc.
- Simulation of RF circuits like amplifiers, oscillators, impedance matching networks etc.
- Overall analysis of various parameters including return loss, VSWR, Far field patterns, axial ratio, polarization of antennas, return loss, insertion loss, phase delay, transmission losses for various components.

Fabrication

The above antenna designs and components can be fabricated with the existing facilities in the Institute, for further research and product development the Institute can attain Industrial and Institutional Tie-ups.

Testing

The Institute is having 14 GHz Two port Field Fox microwave Analyzer N9916A (VNA) with which various parameters of antenna and Microwave components like S parameter, VSWR, Smith Chart can be analyzed.

The far field measurement and radiation measurements can be carried out with Anechoic Chamber.

Measurement of parameters for MIC components

The facilities available in the Institute is capable to measure transmission line losses, input output powers, for waveguide components using the microwave test bench and for MIC components using Microwave USB power sensors.

Current status of Research and Development (National and International)

The global mobile data traffic has been increased dramatically in recent years due to high demand in secure, fast, and large data transmission rates in many recent and advanced applications, including broadcasting, Internet of Things (IoT), automobiles, smart cities, energy, emergencies communication, and wearable devices. This has put a lot of pressure on the current 3G/4G/WiFi wireless communication systems to upgrade their capacity and performance. Each generation of mobile and wireless communication systems has been established to meet those demands. Nevertheless, the data hungry devices used in the above-mentioned applications have increased a lot and require huge data rates [1,2]. One potential way of enhancing capacity and data rates in the current and future mobile and wireless generations is the bandwidth [3,4]. The data rates are directly proportional to the bandwidth. The higher bandwidth provides higher data rates [5,6]. However, current frequency bands, i.e., 1.7 GHz GSM band, 1.8 GHz 4G/LTE band, 2.0 GHz 4G/LTE band, 2.1 LTE band, and 2.6 GHz band, provide limited bandwidth. Recently, high-frequency bands including 24 GHz (n258), 28 GHz (n257 and n261), 37 GHz (n260), and 39 GHz (n260) in addition to some future recommended bands, i.e., 47 and 60 GHz, have been considered for 5G applications [7–16]. Those high-frequency bands, also called mm-wave bands, can provide significantly large bandwidth (more than 500 MHz). Nevertheless, the current 5G communication still uses the sub-6 GHz band, i.e., 3.3 GHz to 4.2 GHz (n77 and n78), and 4.4 GHz to 5 GHz (n79). Although some advancements have been accomplished, i.e., use of a more advanced and larger number of multiple-input multiple-output (MIMO) antennas [17–19] to improve the wireless Electronics. Although some advancements have been accomplished, i.e., use of a more advanced and larger number of multiple-input multiple-output (MIMO) antennas [17–19] to improve the wireless communication system, the data rates are still limited due to the narrow bandwidth at sub-6 GHz [6].. 5G allocated bands, the concept has been obtained from

[20]. In the last few years, substantial work has been presented by considering massive MIMO and mm-wave bands for 5G. In massive-MIMO technology, the implementation of a large number of antennas at both the base station (1000′s of antennas) and handheld devices (10′s of antennas) is required [19,21–23]

Multiple antennas of wireless communication systems especially at mmWave and THz provide the ability to considerably improve service quality. However, because acquiring accurate instantaneous channel state information (CSI) can use a significant fraction of bandwidth, the systems that depend on statistical CSI are preferred [24-31]

The current research is primarily going on design of following types of antennas

- Antenna design techniques and measurement for 5G systems
- Multiple antennas for advanced 5G transceivers
- Multiband 5G antenna
- 5G Dielectric Resonator antennas
- Antennas on flexible substrates for medical applications
- Wearable and implantable antennas
- RFID antennas
- Antennas for wireless power transmission and harvesting
- Beamforming antenna designs
- Reconfigurable antennas and devices
- Mutual coupling and isolation techniques between antenna elements
- Antennas integration in/on vehicles
- UWB antennas
- Phased array antennas

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Annexure II

Work already done by department/ institute in this field

(i) Publications

1. Monika Mathur, Harshal Nigam, D. Mathur, G. Singh, S.K. Bhatnagar, Mukesh Arora (2021)," Design of Wearable UWB Microstrip Patch Antenna for Breast Cancer Tumor Detection" Annals of the Romanian Society for Cell Biology, Vol 25, Issue 3,2021 , pp: 7751-7759
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(ii) **Grant received of Rs. 2,40,000 :** One Collaborative Research Project under the TEQIP III,RTU(ATU),Kota, **PI-Monika Mathur** has been completed on the title "**Dual band Implantable and Wearable Antenna for Breast Cancer Detection**"

(iii) Patent

Kiran Rathi , Pooja Choudhry, Ankit Agarwal, Dr. S.K. Bhatnagar, Anil Verma (STA), Deepak Dhakad (TA), A Device For Soldering Electronic Components By Reflow Soldering Technique and the Process Thereof. Patent No.: 202011044614. Published and under examine from 23/10/2020, Received FER (First Examination report) on January 4, 2022.

(iv) Dissertation completed in the related field

S. No.	University Roll No.	Name of Student	Dissertation Topic	Dissertation Supervisor
1	15ESKDC603	Neelam Kumari	Investigations of the Annular Ring Patch Antenna Using Bhatnagar's Postulate and Equivalence of Design's concept	Dr. Monika Mathur
2	15ESKDC604	Nidhi Sharma	Some Investigation of Bhatnagar's Postulate and Transformation of Design for Circular and Elliptical Patch Microstrip Antennas	Prof. S. K. Bhatnagar
3	16ESKDC600	Ankita Sharma	Investigation of Meta material inspired antenna for Wimax/Bluetooth applications	Prof. S. K. Bhatnagar

4	16ESKDC602	Kajal	Miniaturized structure of Microstrip Antenna for Breast Cancer Application	Dr. Monika Mathur
5	16ESKDC608	Ranu Singh Yadav	Designing technique of circular ring microstrip antenna by using transformation design formule	Prof. S. K. Bhatnagar
6	17ESKDC601	Shreya Bhandia	Dual Band Antenna array on Single Substrate for IOT Application	Dr. Monika Mathur

(v) Registered research supervisors in related field

S. No.	Name of Research Supervisor	Area of Specialization	Teaching Experience (in years)	No. of registered Research Scholars
1	Dr. Mukesh Arora	Wireless Millimeter Wave Antennas, Microstrip Patch Antennas, Reconfigurable Antennas, UWB Antennas	18	2
2	Dr. Monika Mathur	Antennas for biomedical applications, Antenna for energy harvesting and phased array antennas, antennas for 5G applications	15	3
3	Dr. Shubhi Jain	Broadband planar antennas and metamaterials	10	NIL
4	Dr. Komal Sharma	Microstrip Patch Antennas	20	1

Annexure-III: Training Programs

Schedule of different training programs:

1.Training Plan (One week)

Training Module: 1 (7 days)

In this training module, students will be able to design, simulate and fabricate planar antennas and basic microwave transmission line using HFSS software.

The objective of this 7 days training program is to:

1. Study about transmission line and Antennas basics
2. Describe and demonstrate how to use *HFSS software* for simulation
3. Design patch antennas and transmission lines for a given frequency
4. Fabricate basic patch antennas and planar transmission lines.

Duration: one week

S.No.	Topics to be covered
Day-1	Introduction to Transmission Lines, Antenna and its parameters
Day-2	Microstrip Patch Introduction and Design Procedure for 2.4 GHz applications
Day-3	Introduction to HFSS simulation software and Simulation of planar transmission lines
Day-4	Simulation of Patch Antenna for 2.4 GHz applications and Analysis of various parameters
Day-5	Fabrication process above simulated antennas
Day-6	Fabrication process of above simulated transmission lines
Day-7	Assignments and Queries

2. Training Plan (Two weeks)

In this training module, students will be able to design planar and non planer antennas, basic microwave components, fabrication and testing.

The objective of this 15 days training program is to:

1. Study about planar and non-planar transmission lines and Antennas basics
2. Describe and demonstrate how to use *HFSS software* for simulation
3. Fabricate and Testing of patch antennas
4. Design and fabricate array antennas

Training Module: 1
Duration: 5 days

S.No	Topics to be covered
Day-1	Introduction to planar Transmission Lines, Antenna and its parameters
Day-2	Microstrip Patch Introduction and Design Procedure
Day-3	Introduction to HFSS simulation software
Day-4	Simulation of basic Patch Antenna for 2.4 GHz applications and Analysis of various parameters
Day-5	Introduction to waveguides and non planar transmission lines

Training Module: 2
Duration: 10 days

S.No	Topics to be covered
Day-6	Simulation of Rectangular waveguide and analysis of results
Day-7	Simulation of Circular waveguide and analysis of results
Day-8	Simulation of Planar transmission lines and analysis of results
Day-9	Design a Slot, Ring and circular microstrip patch antenna using HFSS software at a frequency of 2.4 GHz
Day-10	Fabricate the patch antenna in the dark room and measurement
Day-11	Design and simulation of a Horn antenna at 5.5 GHz

Day-12	Introduction to antenna Array and its advantages
Day-13	Directional Antenna array (Simulation)
Day-14	Directional Antenna array (Fabrication and Testing)
Day-15	Summarize, conclusion and feedback

3. Training Plan (One month)

In this training module, students will be able to design UWB antennas, fractal antennas and reconfigurable antenna, fabrication and testing.

The objective of this 30 days training program is to:

1. Identify all antenna array types and different transmission lines
2. Identify performance parameters and selection of antenna designs for various applications
3. Demonstrate the process of antenna measurements
4. Fabricate and test the various microwave components and antennas.

Training Module: 1
Duration: 3 days

S.No	**Topics to be covered**
Day-1	Introduction to planar Transmission Lines, Antenna and its parameters
Day-2	Microstrip Patch Introduction and Design Procedure
Day-3	Introduction to HFSS simulation software

Training Module: 2
Duration: 7 days

S.No	**Topics to be covered**
Day-4	UWB Antennas (Theory, Simulation)
Day-5	Fractal Antennas (Theory, Simulation)
Day-6	Frequency Reconfigurable Antennas (Theory, Simulation)

Day-7	Reconfigurable Antennas (Theory, Simulation)
Day-8	UWB Directional Antenna array (Theory, Simulation)
Day-9	Power divider (Theory, Simulation)
Day-10	Hybrid coupler (Theory, Simulation)

Training Module: 3
Duration: 20 days

S.No	**Topics to be covered**
Day-11	Fabrication procedure for antenna in the dark room
Day-12	Introduction to VNA and measurement of different parameters from VNA, Testing of the above fabricated patch antenna
Day-13	UWB Antennas (Fabrication, Testing)
Day-14	Fractal Antennas (Fabrication, Testing)
Day-15	Frequency Reconfigurable Antennas (Fabrication, Testing)
Day-16	Pattern Reconfigurable Antennas (Fabrication, Testing)
Day-17	UWB Directional Antenna array (Fabrication, Testing)
Day-18	Power divider (Fabrication, Testing)
Day-19	Hybrid coupler (Fabrication, Testing)
Day-20	Introduction to Microwave Test Bench and its components
Day-21	Measurement of Guide wavelength, frequency and VSWR for Microwaves
Day-22	Introduction to USB Power sensor and measurement of transmission loss for MIC components
Day-23	Antennas for Medical systems (Simulation, Fabrication and Testing)
Day-24	Co planar line (Simulation and Fabrication)
Day-25	Slot line (Simulation and Fabrication)
Day-26	Rectangular Waveguide Simulation and its analysis
Day-27	Circular Waveguide Simulation and its analysis

Day-28	Discussion on projects in this field and recent researches
Day-29	Allotment of mini projects to students groups and completion of projects
Day-30	Summarize, conclusion and feedback

4. Training Plan (Two months)

In this training module, students will be able to design UWB antennas, smart antennas, MIMO antennas, Antenna arrays, bio medical antennas, fabrication and testing.

Identify all antenna array types and different transmission lines

1. Design and Fabricate UWB antennas
2. Design and Fabricate smart antennas
3. Design and Fabricate wearable antennas

The details of the training modules are mentioned below:

Training Module: 1
Duration: 3 days

S.No	Topics to be covered
Day-1	Introduction to planar Transmission Lines, Antenna and its parameters
Day-2	Microstrip Patch Introduction and Design Procedure
Day-3	Introduction to HFSS simulation software

Training Module: 2
Duration: 7 days

S.No	Topics to be covered
Day-4	UWB Antennas (Theory, Simulation)
Day-5	Fractal Antennas (Theory, Simulation)
Day-6	Frequency Reconfigurable Antennas (Theory, Simulation)
Day-7	Pattern Reconfigurable Antennas (Theory, Simulation)
Day-8	UWB Directional Antenna array (Theory, Simulation)

Day-9	Power divider (Theory, Simulation)
Day-10	Hybrid coupler (Theory, Simulation)

Training Module: 3

Duration: 19 days

Day-11	Fabrication procedure for antenna in the dark room
Day-12	Introduction to VNA and measurement of different parameters from VNA, testing of the above fabricated patch antenna
Day-13	UWB Antennas (Fabrication, Testing)
Day-14	Fractal Antennas (Fabrication, Testing)
Day-15	Frequency Reconfigurable Antennas (Fabrication, Testing)
Day-16	Pattern Reconfigurable Antennas (Fabrication, Testing)
Day-17	UWB Directional Antenna array (Fabrication, Testing)
Day-18	Power divider (Fabrication, Testing)
Day-19	Hybrid coupler (Fabrication, Testing)
Day-20	Introduction to Microwave Test Bench and its components
Day-21	Measurement of Guide wavelength, frequency and VSWR for Microwaves
Day-22	Introduction to USB Power sensor and measurement of transmission loss for MIC components
Day-23	Antennas for Medical systems (Simulation, Fabrication and Testing)
Day-24	Co planar line (Simulation and Fabrication)
Day-25	Slot line (Simulation and Fabrication)
Day-26	Rectangular Waveguide Simulation and its analysis
Day-27	Circular Waveguide Simulation and its analysis
Day-28	Discussion on projects in this field and recent researches
Day-29	Allotment of mini projects to students groups and completion of projects

Training Module: 3
Duration: 11 days

S.No	Topics to be covered
Day-30	Complimentary Split Ring Resonator (Simulation, Fabrication and Testing)
Day-31	Design of MIMO Patch Antenna (Simulation, Fabrication and Testing)
Day-32	Design Smart Antennas (Simulation, Fabrication and Testing)
Day-33	Design of Bowtie Antenna (Simulation, Fabrication and Testing)
Day-34	Wearable Antennas For Body worn Applications (Simulation, Fabrication and Testing)
Day-35	6G RF Technology (Simulation, Fabrication and Testing)
Day-36	Multiband Antenna (Simulation, Fabrication and Testing)
Day-37	Directive Antenna (Simulation, Fabrication and Testing)
Day-38	Antennas for Medical systems (Simulation, Fabrication and Testing)
Day-39	Textile Antennas (Simulation, Fabrication and Testing)
Day-40	Phased array antennas (Simulation, Fabrication and Testing)

Training Module: 4 (Day 41 to Day 60)

Duration: 20 days

Below listed topics are displayed to the students. Each student should choose one topic of their own interest. They have to perform the Designing calculations, Simulation, Fabrication, and Testing/Measurement of the chosen design topic and make a full report on that. All the students should complete the allotted project (Hands on practice) in 19 days (4 hrs. in one day each). Students can make a team of 4 students only.

S.No.	Topics
1	Slot Antenna for 2.4 GHz on the Rogers substrate having dielectric constant 2.2.
2	Band pass Filters for the frequency range of 4-10 GHz.
3	Reconfigurable Antennas for working on the dual band 2.4 GHz and 10 GHz
4	Antenna working on 5G range.
5	Fractal Antenna for Dual Band applications.
6	UWB Antenna Designing.
7	2X2 Array Antenna for gain more than 6 dB
8	4X4 Array Antenna for gain more than 8 dB
13	Semiconductor Technologies for Milimeter Wave Frequency
14	High Power Microwaves for strategic applications
15	RF MEMS Switch for Defense Applications
16	Multimode Phenomena for optical waveguide structures
17	Coplanar Waveguides
18	Coaxial Balun Transformer for mobile communication systems
Summarize, conclusion and feedback	

Annexure-IV: Visuals of facilities

Vector Network Analyzer

Automatic Spin Coating Machine

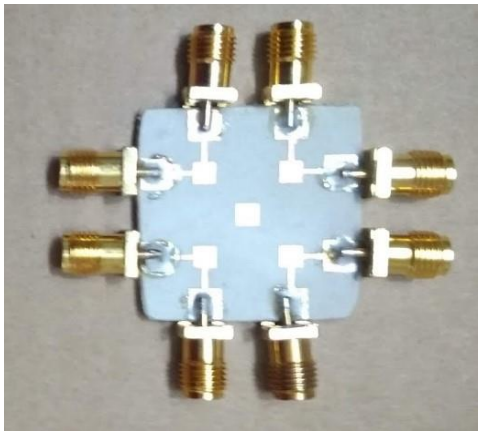
Proto cure PCB Curing machine (oven)

Photoresist dip coating machine

PCB double sided UV exposure machine

PCB art work film maker

Microwave USB Power Sensor



Samples PCB made in lab by mentor faculty

(Phased array antenna)

Spectrum Analyzer