Design of Compact Implantable Microstrip antennas for Biomedical Applications

File Number : CRG/2022/003311

Submitted By : Dr. Gayatri Devi Gavalapu

Submission Date : 25-Apr-2022

PROPOSAL DETAILS

(CRG/2022/003311)

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Professor (ECE)

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Technical Details :

Scheme :	Core Research Grant		
Research Area :	Electrical Electronics & Computer Engineering (Engineering Sciences)		
Duration :	36 Months	**Contact No :**	+919490301962
Date of Birth :	27-Jun-1985		
Nationality :	INDIAN	**Total Cost (INR) :**	47,06,000

Is PI from National Laboratory/Research Institution ? No

Project Summary :

Health monitoring is increasingly gaining concern as it will avoid loss of and lives and to lead a better life. The present work focuses on design of implantable antenna which can be mounted inside the patient's body and used to communicate the health related issues with the health expert. In the present work focus is also given towards the simplicity and cost reduction to meet the requirement of the desired goal (i.e optimization of size and cost). Here in this work, design and development of patch base antennas which are operating in ISM band will be carried out for implanting in body tissues. The antenna is first designed using design equations and then simulated using EM simulation tools like ADS, HFSS,CST Microwave studio. Patch antennas are low profile, compact and light weight antennas which can be easily mounted on surfaces. The structure of patch antenna is as shown in below figure 1. It consists of a radiating patch on one side of a dielectric substrate and a conducting ground plane on other side of the substrate. The patch is usually made up of conducting material like gold or copper. It can act as a broadside radiator, with radiation pattern perpendicular to its surface, by proper selection of mode of excitation. The patch radiates along its radiating edges from fringing fields. The choice of patch design is affected by several factors such as compatibility with body tissues, size, operating frequency etc. The shape of the antenna may take several forms like rectangle, triangle, square etc. The main parameters of design concern are : 1. Width of the patch 2. Length of the patch 3. Substrate thickness 4. Substrate material 5. Shape of the patch 6. Excitation to the patch After the antenna is designed with proper selection of parameters, it will be simulated using HFSS software. The parameters like return loss, gain, VSWR, polarization will be computed and verified whether they are within the range or not. Specifications: VSWR:1:2 Gain: greater than 5dB Return loss: Less than-10dB Polarization: Linear and Circular 3-dB AR bandwidths Since the antenna design requires number of parameters to be optimized, optimization algorithms are to be used. Different optimization techniques like Genetic Algorithm, Particle Swarm Optimization (PSO) and DE (Differential Evolution) etc. will be used to find the optimum parameters. In this work DE will be used. Then it is simulated using electromagnetic simulators like HFSS, CST microwave studio etc. In this work, HFSS will be used. Then the antenna will be fabricated for further validation. To study how the antenna works after implanted in human body, various phantom models which replicate human body environment like heart phantom etc. will be used. The fabricated antenna will be then implanted in that phantom and studied for various parameters.

Objectives :

• The objective is to design and develop patch base antennas which are operating in ISM band for implanting in body tissues

Keywords :
Patch antenna, HFSS, DE algorithm, Directivity

Expected Output and Outcome of the proposal :

The following are the expected outcomes from the proposed system. 1. To check the continuous response of the pacemaker 2. To view the optimized patient response of the endoscopic capsule with respect to the stomach image. 3. To design low complexity algorithm to reduce the delay between end users.

Suitability of the proposed work in major national initiatives of the Government:

Swasth Bharat

Theme of Proposed Work:

Health

Collaboration Details for last 5 Years :

Planned Collaboration for the proposed work with any foreign scientist/ institution ? **No**

Other Technical Details

1. Origin of the Proposal:

Antenna design plays a crucial role in implantable biomedical applications. One of the most essential aspect concerning active implantable devices is biotelemetry which enables the healthcare professionals to continuously monitor patients. Recent years have seen a surge in the need for health monitoring systems which requires the need to design antennas which radiate efficiently and at the same time should not harm body tissues.

There are mainly three frequently used operating frequency bands for implantable antennas, namely the medical implantable communication service frequency band (MICS, 402–405 MHz), the wireless medical telemetry service frequency band (WMTS, 1.395–1.4 GHz), and the industrial, scientific, and medical frequency bands (ISM, 433–434 MHz, 902–908 MHz, 2.4–2.48 GHz, 5.715–5.875 GHz). In addition, some foreign regions have also authorized ultra-wideband frequency bands for high-quality transmission (UWB, 3.1–10.6 GHz).

Many researchers around the world have been carrying out research on optimum design of these implantable antennas operating in different frequency bands. Many works reported till now used antennas which are either large in size or consume more power. The purpose of this research work is to design an optimum implantable antenna in terms of size and power consumption for mounting inside implantable devices like an artificial pacemaker, endoscope capsules, retinal implants etc.

2. Review of status of Research and Development in the subject

2.1 International Status:

Implantable devices have an increasingly great concern in the scientific community as they provide biomedical data with high efficiency than the traditional wired sensors which are mounted on exterior of the body. These devices find wide applications such as in neural recording, glucose monitoring , and intracranial pressure monitoring, etc.

The traditionally used method for communicating with external receiver is through near field magnetic coupling. The coils used have operating frequencies between low frequencies to KHz[1,2]. In 1999, as a reply to petition from Medtronic, the U.S. Federal Communications Commission (FCC) allotted the Medical Implant Communication Service (MICS) band (402 – 405 MHz) to allow the use of a mobile radio device for data communication for implantable devices [3]. The range required to set up a communication link with implantable devices can be significantly expanded [4]. The comparable isotropically radiated power (EIRP) of MICS devices is restricted to -16 dBm to control the interference to other medical devices [5]. In 2002, this band is later accepted by European Telecommunications Standards Institute (ETSI) and become the target band for implantable antenna designers [6].

The supervision of heart failure patients via the implantation of artificial pacemakers has become a well-known therapy. However, the traditional pacemakers have drawbacks like limited battery life, transvenous pacing leads and subcutaneous device pocket. The pacemakers are usually closed in a case made up of biocompatible conducting material. This case can attenuate electromagnetic RF signals.

A noteworthy amount of work has been carried out on designing RF antennas for implantable devices. Delavaud et. al. [7] proposed a loop antenna which works at MICS band and set inside the header of the pacemaker. Huang and Kishk proposed a spiral microstrip antenna which can be attached to pacemaker case resulting in an increased thickness [8].A brief introduction along with procedure for designing and testing of implantable antennas was presented by Kiourti et al. [9]. Zada and Yoo [10] presented a miniaturized triple band implantable antenna system for multiple biotelemetry applications, which

operates at the industrial, scientific, and medical (ISM) band (902-928 MHz and 2400-2483.5 MHz) and the midfield band (1824-1980 MHz).

Compared with a linearly polarized antenna, a circularly-polarized (CP) antenna is preferred for the implantable devices because it can reduce multipath distortion and provide flexible mobility. However, few works were reported on the miniaturized CP implantable antennas. Xia et.al[11] presented a novel compact broadband circularly polarized (CP) implantable patch antenna for biomedical applications in 2.4 GHz industrial, scientific, and medical (ISM) band by employing slots on the patch plane and shorting method. The entire size (including the superstrate) of the designed antenna can be extremely reduced to $9.8 \times 9.8 \times 1.27$ mm ^{3}. Liu et.al [12] designed a capacitive loaded single-fed small circularly polarized microstrip patch antenna and experimentally demonstrated for industrial-scientific-medical (2.4-2.48 GHz) biomedical applications. The proposed antenna is designed by utilizing the capacitive loading on the radiator.

1. P. Arzuaga, "Cardiac Pacemakers: Past, Present and Future," Ieee Instrumentation & Measurement Magazine, vol. 17, pp. 21-27, Jun 2014.
2. A. J. Shah, J. D. Brunett, J. P. Thaker, M. B. Patel, V. V. Liepa, K. Jongnarangsin, et al., "Characteristics of telemetry interference with pacemakers caused by digital media players," Pacing and Clinical Electrophysiology, vol. 33, pp. 712-720, 2010.
3. H. D. Marlene, "FCC-03-32A1," Federal Communications Commission Office of Engineering & Technology, 2003.
4. K. S. Nikita, Handbook of biomedical telemetry: John Wiley & Sons, 2014.
5. H. S. Savci, A. Sula, Z. Wang, N. S. Dogan, and E. Arvas, "MICS transceivers: Regulatory standards and applications," Proceedings of the IEEE SoutheastCon 2004, pp. 179-182, 2005.
6. E. T. S. Institute, "Ultra Low Power Active Medical Implants (ULPAMI) and Peripherals (ULP-AMI-P) operating in the frequency range 402 MHz to 405 MHz," 2009.
7. F. C. W. Po, C. Delavaud, E. de Foucauld, J.-B. David, and P. Ciais, An Efficient Adaptive Antenna-Impedance Tuning Unit Designed for Wireless Pacemaker Telemetry: INTECH Open Access Publisher, 2011.
8. W. Huang and A. A. Kishk, "Embedded Spiral Microstrip Implantable Antenna," International Journal of Antennas and Propagation, 2011.
9. A. Kiourti and K. S. Nikita, “A review of implantable patch antennas for biomedical telemetry: Challenges and solutions [wireless corner],” IEEE Antennas and Propagation Magazine, vol. 54, no. 3, pp. 210–228, Jun. 2012.
10. M. Zada and H. Yoo, “A miniaturized triple-band implantable antenna system for bio-telemetry applications,” IEEE Transactions on Antennas and Propagation, vol. 66, no. 12, pp. 7378–7382, Oct. 2018.
11. Z. Xia, H. Li, Z. Lee, S. Xiao, W. Shao, X. Ding, and X. Yang, “A wideband circularly polarized implantable patch antenna for ISM band biomedical applications,” IEEE Transactions on Antennas and Propagation, pp. 1–1, Oct. 2019.
12. Liu, C.R.; Guo, Y.X.; Xiao, S.Q., “Capacitively loaded circularly polarized implantable patch antenna for ISM band biomedical applications”, IEEE Trans. Antennas Propag. 2014, Vol.62,No.5, pp.2407–2417, May 2014.
13. Li, R.; Guo, Y.X.; Zhang, B.;, “Du, G.H. A miniaturized circularly polarized implantable annular-ring antenna”, IEEE Antennas Wirel. Propag. Lett. 2017, vol.16, pp.2566–2569.

2.2 National Status:

Design of antennas for implantable devices like pacemaker is a research topic of great concern for antenna design community. It allows the healthcare professionals to monitor patients

and save lives. Significant amount of work had been carried out previously on antenna design for implantable devices.

An implantable antenna [1] appropriate for wireless medical telemetry services (WMTS) band (1.39-1.42 GHz) and ISM band (2.4-2.48 GHz) biotelemetry application is presented by Valanarasi and Dhanasekaran. The measured -10 dB bandwidth ranges from 1.395 to 1.44 GHz at WMTS band and 2.3905 to 2.4512 GHz at ISM band. A return loss of -25.78 and -39.95 dB at WMTS and ISM bands is obtained. In [2] Singhwal et al. proposed a dielectric resonator antenna (DRA) resonating at 2.45 GHz as an implantable antenna with no metallic losses, varied implant depth performance and bio-compatibility.

An implantable antenna [3] providing dual band characteristics at ISM band of 2.5 GHz and location application for emergency services (LAES) band at 4.2 GHz is designed for body area network, industrial scientific and medical applications with low specific absorption rate (SAR). An implantable antenna for short range biomedical applications operating in Industrial, Scientific and Medical (ISM) (2.4 GHz-2.48 GHz) bands is proposed in [4]. A novel and small — shaped implantable antenna [5] has been proposed by Narmada et al. for scientific industrial & medical (ISM) band applications. The proposed antenna is operated at 2.45 GHz and has been structured by using ROGER 3010 substrate which has the thickness of 1.6 mm and dielectric permittivity of 10.2. Ghosh et al. [6] proposed an implantable antenna operating in 2.45 GHz ISM band has been developed based on different types of slot structures. This antenna is tuned at 2.49 GHz and is capable of radiating over a bandwidth of 200 MHz between 2.36 GHz and 2.56 GHz. Perumalla and Muthusamy [7] proposed a Circular Miniaturized Implantable (CMI) antenna in the Industrial, Scientific, and Medical (ISM) (2.4 to 2.5 GHz) band. The simulated design is validated in with and without cylindrical three-layered human arm model.

1. A. Valanarasi and R. Dhanasekaran, "Optimum Band ε Shaped Miniature Implantable Antennas for Telemetry Applications," in *IEEE Transactions on Antennas and Propagation*, vol. 69, no. 1, pp. 55-63, Jan. 2021, doi: 10.1109/TAP.2020.3008622.

2. S. S. Singhwal, L. Matekovits, I. Peter and B. K. Kanaujia, "A Study on Application of Dielectric Resonator Antenna in Implantable Medical Devices," in *IEEE Access*, vol. 10, pp. 11846-11857, 2022, doi: 10.1109/ACCESS.2022.3144664.

3. Nadh, B.P., Madhav, B.T.P. & Kumar, M.S. “Design and analysis of dual band implantable DGS antenna for medical applications”, *Sādhanā* , Vol.44, No.131, May 2019.

4. S. Dinesh, R. V. Priyan and R. Jothichitra, "Design of implantable patch antenna for biomedical application," 2015 International Conference on Innovations in Information, Embedded and Communication Systems (ICIIECS), 2015, pp. 1-6, doi: 10.1109/ICIIECS.2015.7192861.

5. G. Narmadha , M. Malathi, Srinivasan Ashok Kumar, T. Shanmuganantham, S. Deivasigamani, “ Performance of implantable antenna at ISM band characteristics for biomedical base”, ICT Express,2021, https://doi.org/10.1016/j.icte.2021.05.009.

6. S. Ghosh, A. Kundu and B. Gupta, "Design and Performance of a Slot Based Implantable Antenna in 2.45 GHz ISM Band," *2021 IEEE Indian Conference on*

Antennas and Propagation (InCAP), 2021, pp. 129-132, doi: 10.1109/InCAP52216.2021.9726260.
7. K. C. Perumalla and P. Muthusamy, "SAR Analysis of Circular Miniaturized Implantable Antenna for Bio-Telemetry Applications," *2021 IEEE Indian Conference on Antennas and Propagation (InCAP)*, 2021, pp. 681-684, doi: 10.1109/InCAP52216.2021.9726182.

2.3 Importance of the proposed project in the context of current status

Health monitoring is increasingly gaining concern as it will avoid loss of and lives and to lead a better life. Continuous monitoring of patient's vital health aspects like heart rate etc. requires proper communication between the patient and the medical centre. Last decade saw a rise in research on design of implantable antennas which provide this facility. Although many designs have been proposed but still there is requirement of antenna size reduction and increase in gain of the antenna. The present work focuses on design of such implantable antenna which can be mounted inside the patient's body and used for communication with health practitioners.

2.4 If the project is location specific, basis for selection of location be highlighted:

Not applicable

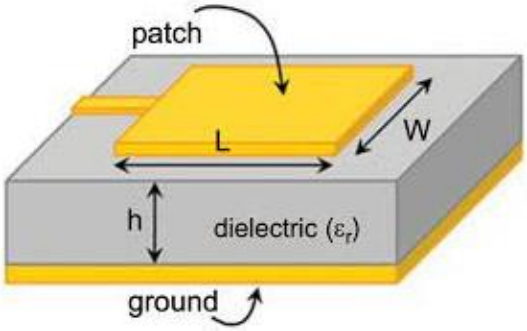
3. Work Plan:

3.1 Methodology: *(Maximum of 5 pages)*

The research works aims at designing and developing patch antennas operating in ISM band for implanting in body tissues. The antenna is first designed using design equations and then simulated using EM simulation tools like ADS, HFSS,CST Microwave studio.

Patch antennas are low profile, compact and light weight antennas which can be easily mounted on surfaces.

The structure of patch antenna is as shown in below figure 1.



It consists of a radiating patch on one side of a dielectric substrate and a conducting ground plane on other side of the substrate. The patch is usually made up of conducting material like gold or copper. It can act as a broadside radiator, with radiation pattern perpendicular to its surface, by proper selection of mode of excitation. The patch radiates along its radiating edges from fringing fields.

The choice of patch design is affected by several factors such as compatibility with body tissues, size, operating frequency etc.

The shape of the antenna may take several forms like rectangle, triangle, square etc. The main parameters of design concern are :

1. Width of the patch
2. Length of the patch
3. Substrate thickness
4. Substrate material
5. Shape of the patch
6. Excitation to the patch

After the antenna is designed with proper selection of parameters, it will be simulated using HFSS software. The parameters like return loss, gain, VSWR, polarization will be computed and verified whether they are within the range or not.

Specifications:

VSWR:1:2

Gain: >5dB

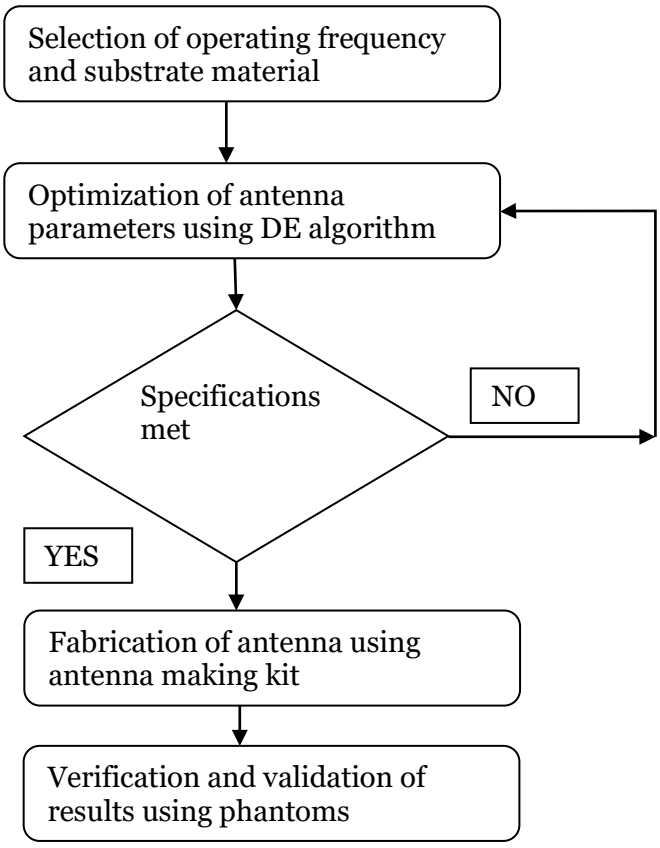
Return loss: <-10dB

Polarization: Linear and Circular 3-dB AR bandwidths

Since the antenna design requires number of parameters to be optimized, optimization algorithms are to be used. Different optimization techniques like Genetic Algorithm, Particle Swarm Optimization (PSO) and DE (Differential Evolution) etc. will be used to find the optimum parameters. In this work DE will be used. Then it is simulated using electromagnetic simulators like HFSS, CST microwave studio etc. In this work, HFSS will be used.

Then the antenna will be fabricated for further validation. To study how the antenna works after implanted in human body, various phantom models which replicate human body environment like heart phantom etc. will be used. The fabricated antenna will be then implanted in that phantom and studied for various parameters.

Process flowchart:



3.2 Time Schedule of activities giving milestones through BAR diagram.
(Maximum 1 page)

S.No	Contents	Period						
		1-3 months	4-8months	9-12 months	13-20 months	20-24	25-30	31-36
1	Literature survey							
2	JRF Recruitment							
3	Procurement of equipment and experimental set up							
4	Simulation of proposed antennas							
5	Design and development of Microstrip antennas							
6	Experimentation and data collection for different proposed antennas							
7	Validation and comparison of results							
8	Preparation and submission of report							

3.3 Suggested Plan of action for utilization of research outcome expected from the project. *(Maximum ½ page)*

The advances in wireless communication system have led to the development sophisticated patient monitoring systems in biomedical field. Health care monitoring has seen a surge in designing new equipment which changes the lifestyle of the patients. One of the important aspects concerning the fabrication of implantable devices is the design of antenna for wireless communication. The developed antennas from this proposal can be used for implanting in various implantable devices such as in artificial pacemaker, endoscopy capsules etc. The equipment and facilities created will be used for training of students. The findings and project outcomes will be shared with research community. Other interested faculty and students may utilize the facilities for further research.

3.4 Environmental impact assessment and risk analysis. *(Maximum ½ page)*

The antennas designed may result in radiation problem but since the power is very low the effect will be very low.

4. Expertise:

4.1 Expertise available with the investigators in executing the project: *(Maximum 1 page)*

PI has completed her Ph.D in the area of antenna array thinning and also published various papers in Microwave and biomedical applications area in reputed national/international journals and conferences. She guided UG projects in the field of antenna design for wireless applications. Her contributions include design and simulation of thinned antenna arrays for wireless applications, design of patch antennas for body area networks, and several other applications. PI has expertise in using modern design tools like MATLAB, HFSS and NI LABVIEW.

4.2 Summary of roles/responsibilities for all Investigators:

S. No.	Name of the Investigators	Roles/Responsibilities
1.	-	-
2.	-	-
3.	-	-

4.3 Key publications published by the Investigators pertaining to the theme of the proposal during the last 5 years

1. G. S. K. Gayatri Devi, G. S. N. Raju, P. V. Sridevi, “Application of Genetic Algorithm for Reduction of Sidelobes”, AMSE JOURNALS–2015-Series: Advances B, vol. 58; No. 1, pp. 35-52, April 2015.

2. G. S. K. Gayatri Devi, G. S. N. Raju, P. V. Sridevi, "Design of Concentric Circular Antenna Arrays for Sidelobe Reduction using Differential Evolution Algorithm", AMSE JOURNALS–2016-Series: Modelling A, vol. 89; No. 1, pp. 45-57, March 2016.
3. G. S. K. Gayatri Devi, G. S. N. Raju, P. V. Sridevi, "Generation of Narrow Beams using Differential Evolution Algorithm from Circular Arrays", International Journal of Computer Applications, vol. 112, No. 3, pp. 20-27, 2015.
4. G. S. K. Gayatri Devi, S. Krishnaveni, "Pattern Synthesis Using Particle Swarm Optimization", International Journal of Modern Trends in Engineering and Research, vol. 3, No. 2, pp. 309-316, Feb 2016.
5. G. S. K. Gayatri Devi, "Synthesis Of Optimized Patterns from Thinned Arrays", International Journal of Innovative Technology and Exploring Engineering, vol. 8, No. 4S2, pp. 282-286, March 2019.
6. S. Krishnaveni, G. S. K. Gayatri Devi, "Design and Comparison of Microstrip Patch Antennas for Wireless Body Area Network", International Journal of Engineering and Technology (UAE), vol. 7, No. 4.7, pp. 167-170, Sep 2018.
7. Dr.S.Krishnaveni, Dr.G.S.K.Gayatridevi, Dr.P.A.Nageswara Rao, N.Sowmya, "Defected Ground Structure (DGS) based microstrip patch Antenna for C-Band Applications", Solid State Technology, vol.63, no. 6, pp. 20596-20603, 2020.
8. Dr.S.Krishnaveni, Mahesh Babu A., Dr.G.S.K.Gayatridevi, Surisetty Prathyusha, T Sneha Nikhita " COVID-SAFE: IoT Based Health Monitoring System using RFID in Pandemic Life", 2021 IEEE International Conference on RFID Technology and Applications (RFID-TA), 2021, DOI: 10.1109/RFID-TA53372.2021.9617312.

4.4 Bibliography: covered under review of status of research

5. List of Projects submitted/implemented by the Investigators: NIL

(All the Investigators should list out details of the Projects submitted, implementing and completed by them. The list should start with the Projects implemented by the Principal Investigator, followed by Co-PI1, Co-PI 2 etc.)

Details of Projects submitted to various funding agencies:

S. No	Title	Cost in Lakh	Month of submission	Role as PI/Co-PI	Agency	Status
	----------					

Details of Projects under implementation:

S. No	Title	Cost in Lakh	Start Date	End Date	Role as PI/Co-PI	Agency
	----------					

Details of Projects completed during the last 5 years:

S. No	Title	Cost in Lakh	Start Date	End Date	Role as PI/Co-PI	Agency
	----------					

6. List of facilities being extended by parent institution(s) for the project implementation.

Infrastructural Facilities

Sr. No.	**Infrastructural Facility**	**Yes/No/ Not required Full or sharing basis**
1.	Workshop Facility	YES
2.	Water & Electricity	YES
3.	Laboratory Space/ Furniture	YES
4.	Power Generator	YES
5.	AC Room or AC	YES

6.	Telecommunication including e-mail & fax	YES
7.	Transportation	YES
8.	Administrative/ Secretarial support	YES
9.	Information facilities like Internet/Library	YES
10.	Computational facilities	Not Applicable
11.	Animal/Glass House	Not Applicable
12.	Any other special facility being provided	Not Applicable

Equipment available with the Institute/ Group/ Department/Other Institutes for the project:

Equipment available with	**Generic Name of Equipment**	**Model, Make & year of purchase**	**Remarks including accessories available and current usage of equipment**
PI & his group	--	--	--
PI's Department	Xilinx Vivado System Edition	Version 20, Apply VOLT, Aug/2021	50%
Other Institute(s) in the region	--	--	--

7. Name and address of experts/ institution interested in the subject / outcome of the project.

NIL

Budget Details

Institution wise Budget Breakup :

Budget Head	Malla Reddy Engineering College	Total
Manpower	14,76,000	**14,76,000**
Consumables	1,00,000	**1,00,000**
Travel	1,00,000	**1,00,000**
Equipment	28,70,000	**28,70,000**
Contingencies	80,000	**80,000**
Other cost	30,000	**30,000**
Overhead	50,000	**50,000**
Total	**47,06,000**	**47,06,000**

Institute Name : ***Malla Reddy Engineering College***

Year Wise Budget Summary (Amount in INR) :

Budget Head	Year-1	Year-2	Year-3	Total
Manpower	4,92,000	4,92,000	4,92,000	**14,76,000**
Consumables	30,000	35,000	35,000	**1,00,000**
Travel	30,000	35,000	35,000	**1,00,000**
Equipments	28,70,000	0	0	**28,70,000**
Contingencies	30,000	25,000	25,000	**80,000**
Other cost	10,000	10,000	10,000	**30,000**
Overhead	10,000	20,000	20,000	**50,000**
Grand Total	**34,72,000**	**6,17,000**	**6,17,000**	**47,06,000**

Manpower Budget Detail(Amount in INR) :

Designation	Year-1	Year-2	Year-3	Total
Attender *One attender is required to clean up the lab and equipment, move the papers from one table to another in the campus*	1,20,000	1,20,000	1,20,000	**3,60,000**
Junior Research Fellow *One Junior research fellow is required to help the experimental set up and simultaneously simulate the results to validate the proposed work.*	3,72,000	3,72,000	3,72,000	**11,16,000**

Consumable Budget Detail (Amount in INR) :

Justification	Year-1	Year-2	Year-3	Total
For conducting experiments and fabricating antennas, materials like RT duroid, AD1000, coaxial and SMA connectors, cables, electronic components etc. are required. In addition, printer cartridges, pen drives, DVDs etc. are also needed.	30,000	35,000	35,000	**1,00,000**

Travel Budget Detail (Amount in INR) :

Justification (Inland Travel)	Year-1	Year-2	Year-3	Total
This is required to visit industries for interacting with industry people, research community, to visit various organizations having the required infrastructural facilities, to attend workshops, conferences and seminars organized in related areas.	30,000	35,000	35,000	**1,00,000**

Equipment Budget Detail (Amount in INR) :

Generic Name ,Model No. , (Make)/ Justification	Quantity	Spare time	Estimated Cost
Advanced Design System (EM simulation Software) EEsof EDA (Keysight(Agilent)) *1. ADS: It is the design software required for design and simulation of all types of high frequency and high speed RF/Microwave components like antennas, waveguides, RF connectors etc.* *2. Ansoft Designer (RF&SI): It is electromagnetic simulation software used for designing and simulating RF and microwave devices like RFICs, System-on-Chips, MMICs, antenna arrays etc. like Gunn diode, IMPATT diode, VCOs, Network Analysers, Mixers etc.*	1	50 %	**5,70,000**
Antenna fabrication Machine MITS (pcb and Entuple Technologies) *Antenna fabrication machine: Used for fabricating various types of microstrip antennas with different shapes and materials.*	1	60 %	**12,00,000**
Vector network analyzer E5071C (Keysight(A gilent)) *Vector Network Analyzer: Various antenna design parameters like Return loss, S-parameters, VSWR can be tested using this device*	1	50 %	**10,00,000**
Data Acquisition system with peripherals (hp) *Data Acquisition system with peripherals: For Sortware simulation and taking necessary printouts related to results.*	1	100 %	**1,00,000**

Contingency Budget Detail (Amount in INR) :

Justification	Year-1	Year-2	Year-3	Total
This is required to purchase books, handbooks and to subscribe to journals in the related field, towards registration fee for attending workshops, seminars, for patent filing etc.	30,000	25,000	25,000	**80,000**

Overhead Budget Detail (Amount in INR) :

Justification	Year-1	Year-2	Year-3	Total
Up gradation of lab to meet the project requirements	10,000	20,000	20,000	**50,000**

Other Budget Detail (Amount in INR) :

Description/Justification	Year-1	Year-2	Year-3	Total
Miscellaneous required to purchase miscellaneous things like A4 Sheets etc.	10,000	10,000	10,000	**30,000**

PROFORMA FOR BIO-DATA (to be uploaded)

1. Name and full correspondence address : Flat No.401, TSR ICON apartments, Near Mithila Nagar Circle, Mithila Nagar, Hyderabad-500055.

2. Email(s) and contact number(s) : gayatrigavalapu@gmail.com, 9490301962

3. Institution : MALA REDDY ENGINEERING COLLEGE

4. Date of Birth : 27-05-1985

5. Gender (M/F/T) :F

6. Category Gen/SC/ST/OBC : General

7. Whether differently abled (Yes/No) : No

8. Academic Qualification (Undergraduate Onwards)

	Degree	Year	Subject	University/Institution	% of marks
1.	UG	2006	ECE	JNTUH/Sarada Institute of Technology and Management	79.78
2.	PG	2008	ELECTRONIC INSTRUMENTATION (ECE)	ANDHRA UNIVERSITY	75.2
3.					
4.					

9. Ph.D thesis title, Guide's Name, Institute/Organization/University, Year of Award.
Thesis title : "INTENSIVE STUDIES ON THE OPTIMIZATION OF RADIATION PATTERNS FROM THINNED ARRAYS USING GENETIC ALGORITHM AND DIFFERENTIAL EVOLUTION ALGORITHM"
Guide's Name: PROF. Dr. G.S.N.RAJU, FORMER VICE-CHANCELLOR, ANDHRA UNIVERSITY
Institute/Organization/University: AU COLLEGE OF ENFINEERING,ANDHRA UNIVERSITY
Year of Award: 2016

10. Work experience (in chronological order).

S.No.	Positions held	Name of the Institute	From	To	Pay Scale
1	ASSISTANT PROFESSOR	VITAM	11-09-2008	20-10-2010	12,675+4,436+1,268
2	ASSISTANT PROFESSOR, ASSOCIATE PROFESSOR, PROFESSOR	MREC	01-08-2015	TILL DATE	6TH PAY

11. Professional Recognition/ Award/ Prize/ Certificate, Fellowship received by the applicant.

S.No	Name of Award	Awarding Agency	Year

12. Publications *(List of papers published in SCI Journals, in year wise descending order).*

S.No.	Author(s)	Title	Name of Journal	Volume	Page	Year
1.	G. S. K. Gayatri Devi	Synthesis Of Optimized Patterns from Thinned Arrays	International Journal of Innovative Technology and Exploring Engineering	8	282-286	March 2019
2.	S. Krishnaveni, G. S. K. Gayatri Devi	Design and Comparison of Microstrip Patch Antennas for Wireless Body Area Network	International Journal of Engineering and Technology (UAE)	7	167-170	Sep 2018
3.	Dr.S.Krishnaveni, Dr.G.S.K.Gayatri devi, Dr.P.A.Nageswara Rao, N.Sowmya	Defected Ground Structure (DGS) based microstrip patch Antenna for C-Band Applications	Solid State Technology	63	20596-20603	2020

13. Detail of patents.

S.No	Patent Title	Name of Applicant(s)	Patent No.	Award Date	Agency/Country	Status
1	AN EMPLOYEE MANAGEMENT SYSTEM	1. Dr. T. Srinivas Reddy 2. Mrs. P. S. Indrani 3. Dr. C. Annal Palgan 4. Dr. Subbalakshmi 5. Dr. A. Pradeep Kumar 6. Dr. G.S.K.Gayatri Devi 7. Dr. K. Rajendra Prasad	201841044752	11/27/2018	INDIA	Awaiting Request for Examination
2	AN AUTOMATED IOT BASED BLOOD GLUCOSE MEASUREMENT DEVICE ALONG WITH LED INDICATION	1. Dr.Sikha Madhu Babu 2. Dr.T Swapna 3. Dr.GSK Gayatri Devi 4. Dr.Ammangi Pradeep Kumar 5. Dr.N.Subbu Lakshmi 6. Dr.Tumu Srinivas Reddy 7. Dr.KanaparthyRajender Prasad	202041004245	1/31/2020	INDIA	Awaiting Request for Examination
3	A 20-180MHZ FREQUENCY BAND ELECTRICALLY TUNEABLE ANTENNA FOR RADIATION IMMUNITY TESTING	1. Mr.Durga Prasad Tumula 2. Mrs.A.Gayatri 3. Dr.G.S.K.Gayatri Devi 4. Dr.Sravana Kumar Bali 5. Mr.M.V.S.Ramprasad 6. Ms.Nupur Biswas 7. Mr.Y.Madhu Babu 8. Mr.K.V.S.N.Sai Krishna Mohan 9. Mr.Pradeep Vinaik Kodavanti 10. Mr.Ramesh Manikonda	202041049820 A	11/15/2020	INDIA	Awaiting Request for Examination

14. Books/Reports/Chapters/General articles etc.

S.No	Title	Author's Name	Publisher	Year of Publication

15. Any other Information (maximum 500 words)
The PI has been working on antenna design area for 10 years. She has published many papers in reputed national and international journals.

Undertaking by the Principal Investigator

To

The Secretary
SERB, New Delhi

Sir

I G.S.K. Gayatri Devi herby certify that the research proposal titled Design of Compact Implantable Microstrip antennas for Biomedical Applications submitted for possible funding by SERB, New Delhi is my original idea and has not been copied/taken verbatim from anyone or from any other sources. I further certify that this proposal has been checked for plagiarism through a plagiarism detection tool i.e. Urkund approved by the Institute and the contents are original and not copied/taken from any one or many other sources. I am aware of the UGCs Regulations on prevention of Plagiarism i.e. University Grant Commission (Promotion of Academic Integrity and Prevention of Plagiarism in Higher Educational Institutions) Regulation, 2018. I also declare that there are no plagiarism charges established or pending against me in the last five years. If the funding agency notices any plagiarism or any other discrepancies in the above proposal of mine, I would abide by whatsoever action taken against me by SERB, as deemed necessary.

G.S.K. Gayatri Devi, 25/04/22

Signature of PI with date

Name / designation

Dr. G.S.K. Gayatri Devi
Professor

Endorsement from the Head of the Institution of PI

This is to certify that:

1. Institute welcomes participation of Name : **Dr.G.S.K.Gayatri Devi** Designation : **Professor** as the Principal Investigator for the project titled **"Design of Compact Implantable Microstrip antennas for Biomedical Applications"** and that in the unforeseen event of discontinuance by the Principal Investigator, the Co-Investigator will assume the responsibility of the fruitful completion of the project with the approval of SERB.

2. The PI, **Dr.G.S.K.Gayatri Devi** is a permanent or regular employee of this Institute/University/Organization and has **22** years of regular service left before superannuation

3. The project starts from the date on which the University/Institute/ Organization/College receives the grant from SCIENCE & ENGINEERING RESEARCH BOARD (SERB), New Delhi.

4. The investigator will be governed by the rules and regulations of University/ Institute/Organization/College and will be under administrative control of the University/ Institute/Organization/College for the duration of the project.

5. The grant-in-aid by the SCIENCE & ENGINEERING RESEARCH BOARD (SERB), New Delhi will be used to meet the expenditure on the project and for the period for which the project has been sanctioned as mentioned in the sanction order.

6. No administrative or other liability will be attached to SCIENCE & ENGINEERING RESEARCH BOARD (SERB), New Delhi at the end of the project.

7. The University/Institute/Organization/College will provide basic infrastructure and other required facilities to the investigator for undertaking the research project.

8. The University/ Institute/Organization/College will take into its books all assets created in the above project and its disposal would be at the discretion of SCIENCE & ENGINEERING RESEARCH BOARD (SERB), New Delhi.

9. The University/ Institute/Organization/College assumes to undertake the financial and other management responsibilities of the project.

Seal of

University/Institute/Organization/College

Date:

Malla Reddy Engg. College 500 100 Hyderabad

Signature

Registrar of University/Head of the Institute/
Head of organization / Principal of College

Principal
Malla Reddy Engineering College
Maisammaguda, Dhulapally,
(Post Via Kompally), Sec'bad-500100.

Certificate from the Investigator

Project Title: Design of Compact Implantable Microstrip Antennas for BioMedical Applications

It is certified that

1. The same project proposal has not been submitted elsewhere for financial support.

2. We/I undertake that spare time on equipment procured in the project will be made available to other users.

3. We/I agree to submit a certificate from Institutional Biosafety Committee, if the project involves the utilization of genetically engineered organisms. We/I also declare that while conducting experiments, the Biosafety Guidelines of Department of Biotechnology, Department of Health Research, GOI would be followed in toto.

4. We/I agree to submit ethical clearance certificate from the concerned ethical committee, if the project involves field trails/experiments/exchange of specimens, human & animal materials etc.

5. The research work proposed in the scheme/project does not in any way duplicate the work already done or being carried out elsewhere on the subject.

6. We/I agree to abide by the terms and conditions of SERB grant.

Name and signature of Principal Investigator: Dr. G.S.K. Gayatri Devi, G.S.K. Gayatri Devi
Date: 25/4/2022
Place: Hyderabad

Name and signature of Co-PI (s) (if any):
Date: 25/4/2022
Place: Hyderabad