To
The Principal
Amritsar group of Colleges, Amritsar

Subject: Request for Seed Money to Support Research on Microwave Cladding

Respected Sir/Madam,

I, Dr. Gurbhej Singh, Assistant Professor at AGC Amritsar, I am currently engaged in pioneering research on microwave cladding of materials. This study explores the use of advanced materials, such as Inconel 625 powder and alumina plates as separators, to enhance surface engineering techniques.

To progress in this research, I require financial assistance to procure essential materials and consumables. Below is a summary of the items and estimated costs:

Sr. No.	Item Name	Cost of Item in Rs.
1	Inconel 625 Powder	70,000/ Rs
2	Alumina Plates (Separators	20,000/Rs
3	Other Consumables and Accessories	30.000/Rs
Total Amount		**1,20,000/Rs**

Total Amount Requested: ₹1,20,000/Rs

The outcomes of this research are expected to be highly impactful, including:

1. Development of cost-effective and efficient microwave cladding methods.
2. Enhanced surface properties of industrial components, leading to improved wear and corrosion resistance.
3. Increase in the number of high-quality publications in reputed journals, enhancing the institution's academic profile.
4. Contribution to the institution's research metrics, fostering a culture of innovation and excellence.
5. Potential for patentable innovations and opportunities for industrial collaborations, further strengthening the institution's reputation.

I kindly request your approval for the seed funding of 1, 20,000/Rs to support this project. This initiative aligns with our institution's commitment to fostering cutting-edge research and innovation.

Thank you for considering my request. I look forward to your positive response.

Yours sincerely,
29/08/24

Dr. Gurbhej Singh
Assistant Professor
AGC Amritsar

Principal
Amritsar Group of Colleges
Amritsar.

To

The Principal,

AGC, Amritsar

Subject: Request to grant the Seed Money

Dear Sir,

Please provide the seed Money for Project on Triple-Tuned Antenna for Metamaterials /EBG/PBG structures and Antennas using Metamaterials, and detail of project is as mentioned below:

ABSTRACT:

Metamaterials have emerged as a revolutionary class of engineered materials that possess unique properties not found in nature, particularly in the electromagnetic spectrum. In the realm of antenna technology, metamaterials offer the potential to dramatically enhance performance, increase bandwidth, and reduce size. Metamaterials enable the design of antennas with improved radiation patterns and efficiencies through manipulation of their effective permittivity and permeability. By utilizing structures such as split-ring resonators or complementary split-ring resonators, antennas can achieve characteristics like negative refraction, leading to novel antenna configurations that challenge traditional limits. These properties facilitate compact antennas that operate across a wide range of frequencies, making them ideal for applications in telecommunications, satellite communication, and sensing. Recent research has demonstrated the successful integration of metamaterial structures into various antenna forms, including patch antennas, dipole antennas, and phased array systems. The use of metamaterials not only enhances the gain and directivity of antennas but also contributes to the miniaturization of designs, making them more suitable for modern devices requiring portability. The integration of metamaterials in antenna technology represents a significant advancement with the potential to revolutionize the field. As research continues, further exploration of metamaterial properties will likely lead to the development of antennas that are more efficient, versatile, and capable of supporting the ever-growing demands of wireless communication systems. The transition of communication technologies has significantly impacted human beings, with researchers finding that Ultra-Wideband (UWB) is ideal for wideband applications. Antennas with UWB and directed gain are in high demand for tasks such as high-speed data downloading and creating high-resolution images. Metamaterials in microstrip patch antennas can address challenges like narrow bandwidth, low gain, and long simulation times. These issues can be resolved by incorporating metamaterials into the antenna design.

This research advances patch antenna studies using metamaterials and serves as a pilot project to tackle various challenges in antenna research, potentially inspiring future multidisciplinary projects. It explores the use of metamaterials in antenna design. Various objectives for analysis and designing of Metamaterial based Microstrip Patch Antenna are as follows:

Analyze Existing MPA:

The study focuses on improving Microstrip Patch Antennas (MPAs) for Ultra-Wideband (UWB) applications using metamaterials such as EBG/PBG/Photonic Structures by evaluating existing designs, optimizing periodic and non-periodic structures, and studying their combined effects on performance metrics like reflection coefficient, VSWR, and gain. Enhancements using Defected Ground Structures (DGS) and metamaterials are explored to boost antenna efficiency. Finally, an optimized design is fabricated and compared with simulation results to address discrepancies and refine real-world performance.

OUTCOMES:

Antennas using metamaterials offer a range of innovative applications due to their unique ability to control and manipulate electromagnetic waves. Here are various applications of antennas using metamaterials:

Metamaterial Based Patch Antennas are applicable for automotive applications and defensive applications. Metamaterial structures can enhance the gain of antennas, allowing for improved signal reception and transmission. This is beneficial in communication systems where a strong and reliable signal is crucial.

MTM based antennas are used in RADAR and SONAR applications as metamaterials can be employed to design antennas with highly directional radiation patterns. This is useful in point-to-point communication systems, satellite communication, and radar applications where precise beam control is required.

However in satellite communication MTM based antennas can enhance the performance of satellite communication systems by improving signal quality, reducing interference, and optimizing the overall efficiency of satellite antennas.

Metamaterial based antenna structure easy to understand and comprehend because it gives physical insight into the antenna structure.

Such type of antennas are useful to track objects or vehicles due to their high gain and large bandwidth. Metamaterial-based antennas can be engineered to operate over a broader range of frequencies, leading to wideband capabilities. This is advantageous in communication systems that require coverage across multiple frequency bands.

To enhance radiative cooling in antennas and communication devices MTM based antennas are used. By manipulating the thermal properties of materials, metamaterials can facilitate more efficient heat dissipation, leading to improved device performance and longevity.

#Metamaterial based antennas are miniaturized antennas and are very useful in biomedical industry. Metamaterial antennas can be used in medical imaging devices and sensing applications. Their ability to control electromagnetic waves allows for improved resolution and sensitivity in imaging and sensing technologies

This project of using MTM based antennas gives satisfactory and reliable antenna performance of wearable antennas for a long period. Metamaterials can be designed to shrink the size of antennas while

maintaining or even improving their performance. This is particularly useful in applications where space is limited, such as in small electronic devices or wearable technology.

Metamaterials can be used to design antennas with stealth capabilities by controlling electromagnetic waves to minimize radar cross-section. This is valuable in military applications for creating stealth aircraft or other covert platforms such as stealth technology

Smart antennas using Metamaterials can be used to enhance the capabilities of 5G and future communication networks. This includes improving beamforming, increasing data rates, and mitigating interference.

Terahertz communications by making use of MTM based antennas as metamaterials are well-suited for applications in the terahertz frequency range. Antennas designed with metamaterials can play a key role in terahertz communication systems, offering high data rates and potential applications in imaging and spectroscopy.

Another type of MTM that is used in antennas is Frquency selective surfaces as FSS applications to selectively filter or transmit specific frequencies. This is beneficial in designing antennas for communication systems that require frequency filtering or interference mitigation.

Metamaterial-based antennas can be integrated into wireless power transfer systems, enabling efficient energy transmission over longer distances. This is relevant in applications such as wireless charging for electric vehicles or powering remote sensors in WIRELESS POWER TRANSFER SYSTEM.

Designing and analyzing metamaterial-based antennas requires a combination of hardware and software tools. Here's a list of equipment commonly used for the analysis and design of metamaterial-based antennas:

EQUIPMENT REQUIRED:

Designing and analyzing metamaterial-based antennas requires a combination of hardware and FDTD/MOM based simulation software tools. Here's a list of equipment commonly used for the analysis and design of metamaterial-based antennas:

HARDWARE EQUIPMENTS:

1) Computer:
   High-performance smart computer systems are essential for running electromagnetic simulation software (such as FDTD and MOM based simulation software) and conducting complex numerical analyses.
2) Fabrication Tools:
   Tools for building prototypes of antennas, which may include PCB fabrication equipment, soldering stations, and other materials for constructing physical prototypes.

The fabrication of antenna prototypes involves various processes, and different machines and equipment are used depending on the specific requirements of the antenna design and the materials used. Here are some key machines and equipment commonly used in the prototype development of antennas:

PCB Prototyping Machines
CNC (Computer Numerical Control) Milling Machines
Laser Cutting Machines
Soldering Stations: (attaching the antenna elements, feedlines, and any matching networks.)

3) Antenna substrate:
Substrate of antenna significantly influences the antenna's performance, radiation characteristics, and overall efficiency. Different substrates have varying dielectric properties, thermal characteristics, and mechanical strengths. Here are some common antenna substrates and their characteristics:

FR-4 (Flame Retardant 4):

- Dielectric Constant (εr): Typically around 4.4.
- Advantages: Cost-effective, widely used in PCB (Printed Circuit Board) technology, readily available, good mechanical strength.
- Disadvantages: Moderate dielectric constant can limit bandwidth, especially for high-frequency applications.

Rogers RO4003 or RO4350 Series:

- Dielectric Constant (εr): Depends on the specific series (e.g., RO4003C is around 3.38, RO4350B is around 3.48).
- Advantages: Low loss, suitable for high-frequency applications, excellent dimensional stability.
- Disadvantages: Higher cost compared to FR-4.

Polytetrafluoroethylene (PTFE) or Teflon:

- Dielectric Constant (εr): Varies (e.g., PTFE-based materials like Teflon have εr around 2.1).
- Advantages: Low loss, excellent electrical stability, high-temperature resistance.
- Disadvantages: Expensive, may require specialized fabrication techniques.

Ceramic Substrates (Alumina or Aluminum Nitride):

- Dielectric Constant (εr): Depends on the specific ceramic material (e.g., Alumina has εr around 9-10, Aluminum Nitride around 8-9).
- Advantages: High thermal conductivity, suitable for high-power applications, good mechanical stability.
- Disadvantages: Relatively higher cost, limited flexibility.

Liquid Crystal Polymer (LCP):

- Dielectric Constant (εr): Around 3.

- Advantages: Low dielectric loss, good high-frequency performance, lightweight, suitable for flexible antennas.
- Disadvantages: Limited availability, higher cost compared to FR-4.

Duroid:

- Dielectric Constant (εr): Varies with specific types (e.g., Duroid 5880 has εr around 2.2).
- Advantages: Low loss, suitable for high-frequency and microwave applications.
- Disadvantages: Higher cost, less common compared to standard PCB materials.

Liquid Crystal Elastomer (LCE):

- Dielectric Constant (εr): Varies.
- Advantages: Flexible and stretchable, suitable for conformal antennas.
- Disadvantages: Limited availability, specialized applications.

Glass-Reinforced Hydrocarbon (G10):

- Dielectric Constant (εr): Around 4.4.
- Advantages: Good mechanical strength, thermal stability, and low cost.
- Disadvantages: Moderate dielectric constant, limited to lower frequency applications.

Gallium Arsenide (GaAs):

- Used in high-frequency and high-power microwave applications.
- Excellent electrical properties

Ceramic Substrates: (Aluminum Nitride (AlN) or Beryllium Oxide (BeO))

- High thermal conductivity, low loss, and excellent dielectric properties.
- Particularly used in military or aerospace applications

Quartz:

- Used in some high-precision antennas,
- High dielectric constant and low loss tangent

Single-Crystal Substrates:

- Used in field of high-frequency and phased-array antennas
- Single-crystal materials that have excellent uniformity and performance characteristics.

When selecting a substrate, factors such as operating frequency, bandwidth requirements, mechanical constraints, and cost considerations play a crucial role. It's common for designers to perform simulations and optimizations using different substrate materials to determine the most suitable one for the specific antenna application. Additionally, advancements in material science continue to introduce new substrate options, further expanding the possibilities for antenna design.

SOFTWARE TOOLS:

Electromagnetic Simulation Software like CST Microwave Studio, ANSYS HFSS (High-Frequency Structure Simulator), and FEKO are commonly used for simulating electromagnetic fields and analyzing antenna performance, as these software's take less computational time as compared to other software's and also give more accurate data.

It's important to note that the specific tools and equipment required may vary based on the complexity of the metamaterial-based antenna design and the goals of the project.

(ANSYS HFSS/CST Microwave Studio/FEKO) Software Approx Cost : Rs 3,00,000/-

FINANCIAL PROJECTIONS:

Detailed budget of project includes:

HARDWARE such as High Performance Computer System with good configuration: Rs 30,000/-

Antenna substrates: Rs 1,00,000/- (PTFE /Quartz /TEFLON/GaAs/Ceramic Substrates /LCP /Rogers /FR4 /LCE)

Antenna Prototype Machine: (LPKF PROTOMAT) Antenna/PCB Prototype Machine/ Parshwanath Robotics Standard Nano Engrave PCB Prototyping Machine, Automatic Grade: Automatic, 1 Kw)

Application	PCB Prototyping , Enclosure Prototyping
Design	Standard
Automatic Grade	Automatic
Power Consumption	1 kW
Brand	Parshwanath Robotics
Max Speed (rpm)	24000
Voltage	230 V
Frequency	50 Hz
Model	bseries

Cost: Rs 2,00,000/-
Total Amount Required = 6,30,000/-
I will be obliged for the Consideration.

With Regards,

22/08/23

Dr. Narinder Sharma
Dean (R & D)
AGC, Amritsar

Principal
Amritsar Group of Colleges
Amritsar.

To

The Principal,

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Subject: Regarding Seed Money

Dear Sir,

Please provide me the Seed Money for Project on Microstrip patch Antenna/ Metamaterials, and detail of project is as mentioned below:

ABSTRACT:

The transition of communication technologies has significantly impacted human beings, with researchers finding that Ultra-Wideband (UWB) is ideal for wideband applications. Antennas with UWB and directed gain are in high demand for tasks such as high-speed data downloading and creating high-resolution images. Metamaterials in microstrip patch antennas can address challenges like narrow bandwidth, low gain, and long simulation times. These issues can be resolved by incorporating metamaterials into the antenna design.

This research advances patch antenna studies and serves as a pilot project to tackle various challenges in antenna research, potentially inspiring future multidisciplinary projects. It explores the use of metamaterials in antenna design, addresses practical considerations for real-world applications, and provides insights into the challenges and opportunities of bringing innovative antenna designs to market.Various objectives for analysis and designing of MTM based MPA are as follows:

Analyze Existing MPA:

For analyzing existing Microstrip Patch Antenna (MPA)/Metamaterials for Ultra-Wideband (UWB) applications:

1. Evaluation of Existing MPAs: Assess the performance of MPAs with various slits and slots, focusing on parameters like reflection coefficient, Voltage Standing Wave Ratio (VSWR), gain, and reflectivity.
2. Design for UWB Applications: Explore both periodic and non-periodic structures in MPA design, optimizing based on parameters such as reflection coefficient, VSWR, gain, and reflectivity to meet UWB application requirements.
3. Study of Combined Effects: Investigate how the selected structures impact antenna parameters and compare these effects to traditional antenna designs.
4. Enhancement with DGS/Metamaterials: Explore the integration of Defected Ground Structures (DGS) and metamaterial structures to improve antenna performance. Evaluate their impact on reflection coefficient, VSWR, gain, and other performance parameters.
5. Fabrication of Optimized Design: Fabricate the antenna based on optimized simulation results, ensuring the fabrication process aligns with design specifications.

6. Comparison with Simulated Design: Compare the performance of the fabricated antenna with the simulated design, analyzing discrepancies and identifying factors that affect real-world performance.

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FINANCIAL PROJECTIONS:

Detailed budget of project includes:

HARDWARE such as High Performance Computer System with good configuration: Rs 50,000/-

Antenna substrates: Rs 1,00,000/- (PTFE /Quartz /TEFLON/GaAs/Ceramic Substrates /LCP /Rogers /FR4 /LCE)

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Total Amount Required = 3,50,000/-

I will be obliged for the Consideration.

With Regards,

31/08/24

Dr. Navdeep Singh
Dy. Dean (R & D)
AGC, Amritsar

Forwarded to Dean R&D for consideration, please

Principal
Amritsar Group of Colleges
Amritsar.