Certificate course on

Electromagnetic Metamaterials and Their Applications

Offered by

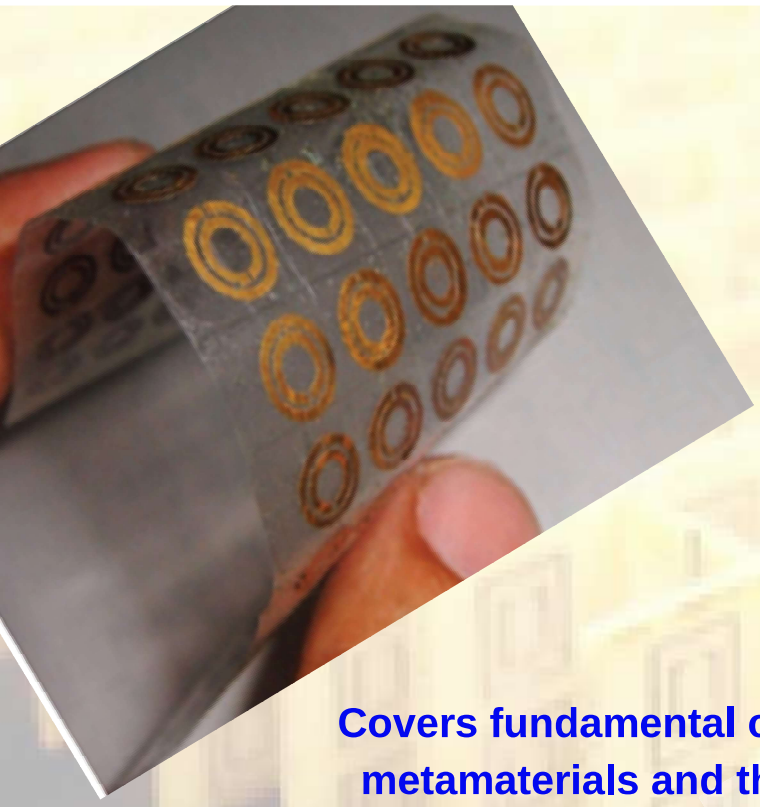
DEPARTMENT OF PHYSICS
(UNAIDED)
CHRIST COLLEGE
(AUTONOMOUS) IRINJALAKUDA

Come...

Let's Learn something META...

INAUGURATION

On
11 March 2024
10 AM
Room No. SC 08



Course Highlights :

- Introduction to Metamaterials
- Physics of Metamaterials
- Electromagnetic Metamaterials
- Metamaterials design, Fabrication & measurement techniques
- Metamaterials Applications
  Current research and future trends
- Hands - on training

LOGO HERE

Covers fundamental concepts of electromagnetic metamaterials and their applications in various fields.

Contact Us

physicsself@christcollegeijk.edu.in,
emmetchrist@gmail.com

Course Duration

30 Hours

Course Co-ordinators

Dr. V. P Joseph
Ms. Anju Sebastian
Ms. Aswathi P V

Electromagnetic Metamaterials and Their Applications - CPCC63

Value Added Certificate Course

Teacher Coordinator Report 2023-24

Number of students	10
Date of examination	12/07/2024
Total students who passed exam	10
Total course duration	30 Hrs.

Feedback analysis:

- ✓ Students appreciated the initiative to introduce advanced topics and techniques, especially the hands-on training sessions.
- ✓ The practical training was highly valued for its applicability to future research endeavors.
- ✓ Teamwork during the sessions enhanced collaborative learning and engagement.
- ✓ 100% of the students reported enjoying the course and found the classes informative and interactive.
- ✓ There is a strong demand for similar courses to further develop practical and research-oriented skills.

Course Coordinators : Dr. V. P Joseph, Professor, Department of Physics (Self)
Ms. Anju Sebastian (Asst. Professor, Department of Physics (SF)
Ms. Aswathi P V (Asst. Professor, Department of Physics (SF)

Model Question Paper

Value Added Certificate Course

Department of Physics (Self- Financing)

Electromagnetic Metamaterials and Their Applications

Section A: Short Answer Questions *(2 Marks Each)*

(Answer any five questions)

1. Define metamaterials and explain their classification with examples.
2. What are the unique properties of electromagnetic metamaterials?
3. Describe the significance of effective medium theory in the study of metamaterials.
4. Explain the role of split ring resonators (SRRs) in achieving negative refractive index.
5. Outline the steps involved in the fabrication of metamaterials using photochemical etching.
6. Mention two applications of metamaterials in antenna and communication systems.

(5 × 2 = 10 Marks)

Section B: Descriptive Questions *(15 Marks Each)*

(Answer any one questions)

7. Describe the design and measurement techniques used for characterizing metamaterials using a Vector Network Analyzer (VNA).
8. Illustrate the role of metamaterials in vibration damping and noise reduction, highlighting practical examples.

(3 × 5 = 15 Marks)

Section C: Practical-Oriented Question *(5 Marks)*

11. Describe the process of SRR unit cell fabrication. How would you measure its transmission characteristics using HFSS?

(1 × 5 = 5 Marks)

Certificate of Achievement

This certificate is proudly awarded to ANJANA.A of M Sc. Physics 2023-2025 batch for successfully completing the certificate course in *Electromagnetic Metamaterials and their Applications* offered by the Department of Physics (Unaided), Christ College (Autonomous), Irinjalakuda with A grade.

Ms. Anju Sebastian
Course Coordinator

Prof. Dr. V P Joseph
HOD
Department of Physics (Unaided)

Certificate course on 'Electromagnetic Metamaterials and Their App				
Course Name	**Reg.No.**	**User Name**	**Class**	**Department**
Electromagnetic Metamaterials and Their Applications'	CCAXMPH014	ADITHYA V.JAYADEVAN	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH015	ANJANA A	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH016	ANUSHREE T A	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH017	DHEERA K.S.	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH018	KRISHNA RAJAN	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH019	LAKSHMI PRIYA C S	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH020	MEGHNA MARIYA K B	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH021	NISIN M JUSTIN	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH022	NUHA SAVAD NALAKATH	MSc. Physics	Physics Self
Electromagnetic Metamaterials and Their Applications'	CCAXMPH023	SANIDYA E D	MSc. Physics	Physics Self

lications' for MSc. Batch 2023- 2025

Commencement Date	Duration	Certificate	Year	Date of exam	Grade
11th March 2024	30 Hrs	Yes	2023 - 2024	18th May 2024	A
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Certificate Course

Offered by the

Department of Physics (Self- Financing)

Electromagnetic Metamaterials and Their Applications

Course Description

This course covers the fundamental concepts of electromagnetic metamaterials and their applications in various fields. Students will gain an understanding of engineered structures with tailored electromagnetic properties and their practical use in devices and systems.

Course Outcomes

CO 1: Explain the basic concepts and properties of metamaterials, including their historical perspective and development.

CO 2:Understand the Physics of metamaterials, including the interaction of waves with metamaterials, effective medium theory, and unique properties such as negative refractive index and cloaking

CO 3: Design and fabricate metamaterials and carry out measurements based on techniques such as resonant and non-resonant methods, VNA, and cavity perturbation techniques.

CO 4: Identify and describe various applications of metamaterials, antenna and communication systems, sensors, and vibration damping and noise reduction.

CO 5: Familiarize with current research and future trends in the field of metamaterials, including major research groups and industries.

CO 6: Gain hands-on experience in SRR unit cell fabrication and measurement of transmission characteristics using TL coupled SRR, antenna and SRR unit cell, and cavity perturbation technique and co-axial probe method.

Course Outline

- **Introduction to Metamaterials**
- **Physics of Metamaterials**
- **Electromagnetic Metamaterials**
- **Metamaterials Design, Fabrication and measurement techniques**
- **Metamaterials Applications**
- **Current research and future trends**
- **Hands-on training**

Course Delivery: The course will be delivered through a combination of lectures, discussions, and practical demonstrations

Assessment: A final assessment may be conducted to evaluate the understanding and application of concepts covered in the course.

This may include a written exam, project presentation, or a combination of both.

Certificate Course : Syllabus

Electromagnetic Metamaterials and Their Applications [30 Hours]

Module I : Introduction to Metamaterials (2 hours)

Historical perspective and development of metamaterials

Basic concepts and properties

Overview of metamaterial classifications : Electromagnetic metamaterials, Acoustic Metamaterials, Thermal Metamaterials, Seismic Metamaterials

Module II : Physics of Metamaterials(4 hours)

Interaction of waves with metamaterials

Effective medium theory and homogenization concepts

Unique Properties- dispersion, negative refractive index, backward propagation, Electromagnetic shielding, perfect lens - Transformation optics and cloaking

Module III: Electromagnetic Metamaterials(4 hours)

Epsilon - Mu diagram

SNG and DNG materials

Wire media and split ring resonators

Realization of negative refractive index

Module IV : Metamaterials Design, Fabrication and measurement techniques (6 hours)

Design of metamaterials

Micro-/nano-fabrication methodologies: Photochemical etching,3D printing
Measurement methods: resonant and non- resonant methods, Cavity perturbation techniques, co-axial probe method, transmission line method ,

Vector Network Analyser

Module V :Metamaterials Applications (6 hours)

Artificial magnetic conductors and absorbers

Antenna and communication systems

Sensors

Vibration damping and noise reduction

Metamaterials in food and Agriculture

ISM applications

Module VI: Current research and future trends (2 hours)

Major research groups & industries

Metamaterials research in EMRL

Hands-on training (6 hours)

SRR unit cell fabrication

Measurement of transmission characteristics using TL coupled SRR

Antenna and SRR unit cell

Familiarization with Cavity perturbation technique and co axial probe method

References:

1. *Waves in Metamaterials*- Laszlo Solymar & Ekaterina Shamonina
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3. Ricardo Marqu´es, Ferran Martin, and Mario Sorolla. *Metamaterials with negative parameters:theory, design, and microwave applications*. John Wiley & Sons, 2011.
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13. W. Rotman, "*Plasma simulation by artificial dielectrics and parallel-plate media*," IRE Trans. on Ant. and Propag., vol. 10, no. 1, pp. 82–95, Jan. 1962.
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16. R.A. Shelby, D.R. Smith, and S. Schultz, "*Experimental verification of a negative index of refraction*," Science Magazine, vol. 292, pp. 77–79,Apr. 2001.

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GPS Map Camera

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Electromagnetic Metamaterials and Their Applications

Value Added Certificate Course

Summary Report 2023-24

The course started on March 11, 2024. There were 10 students and all of them completed the course. The course was of 30 Hrs. duration, which combined lectures, discussions, and hands-on training sessions. Students actively participated in the sessions and appreciated the opportunity to work collaboratively during hands-on activities. The practical sessions, in particular, were highlighted as a valuable and enjoyable part of the course.

Course Outcome:

The course provided students with:

- A thorough understanding of the fundamental concepts and properties of electromagnetic metamaterials.
- Practical expertise in SRR unit cell fabrication and measurement techniques using advanced methodologies.
- Hands-on training with HFSS software was also appreciated.
- Awareness of current research trends and applications of metamaterials in various fields.

The students were highly satisfied with the course structure and delivery. They found the hands-on training sessions highly beneficial for future research purposes. All participants enjoyed the course and expressed interest in attending more such skill-oriented programs to enhance their practical knowledge.

Conclusion:
The course achieved its objectives, successfully blending theory with practical application. Based on student feedback, similar courses should be organized to promote advanced learning and research skill development.

Course Coordinators: : Prof. Dr. V. P Joseph, Professor, Department of Physics (Self)
Ms. Anju Sebastian (Asst. Professor, Department of Physics (SF)
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Anju Sebastian (You, presenting)

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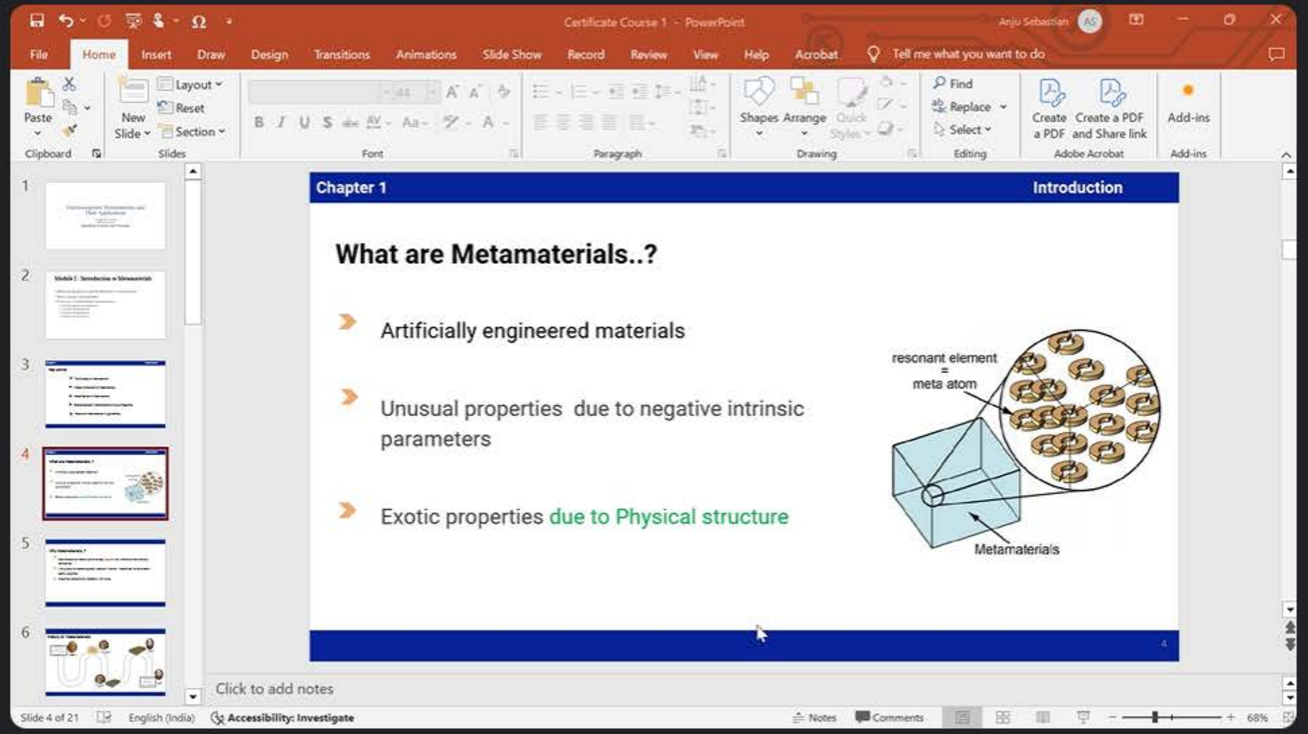

MEGHNA Mariya

A S

9 others

Anju Sebastian

Anju Sebastian

People

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Contributors 12

Anju Sebastian (You)
Meeting host

Anju Sebastian
Your presentation

Adithya Jayadevan

Anjana A

Anuhsree T .A.

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Krishna Rajan

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Anju Sebastian (You, presenting)

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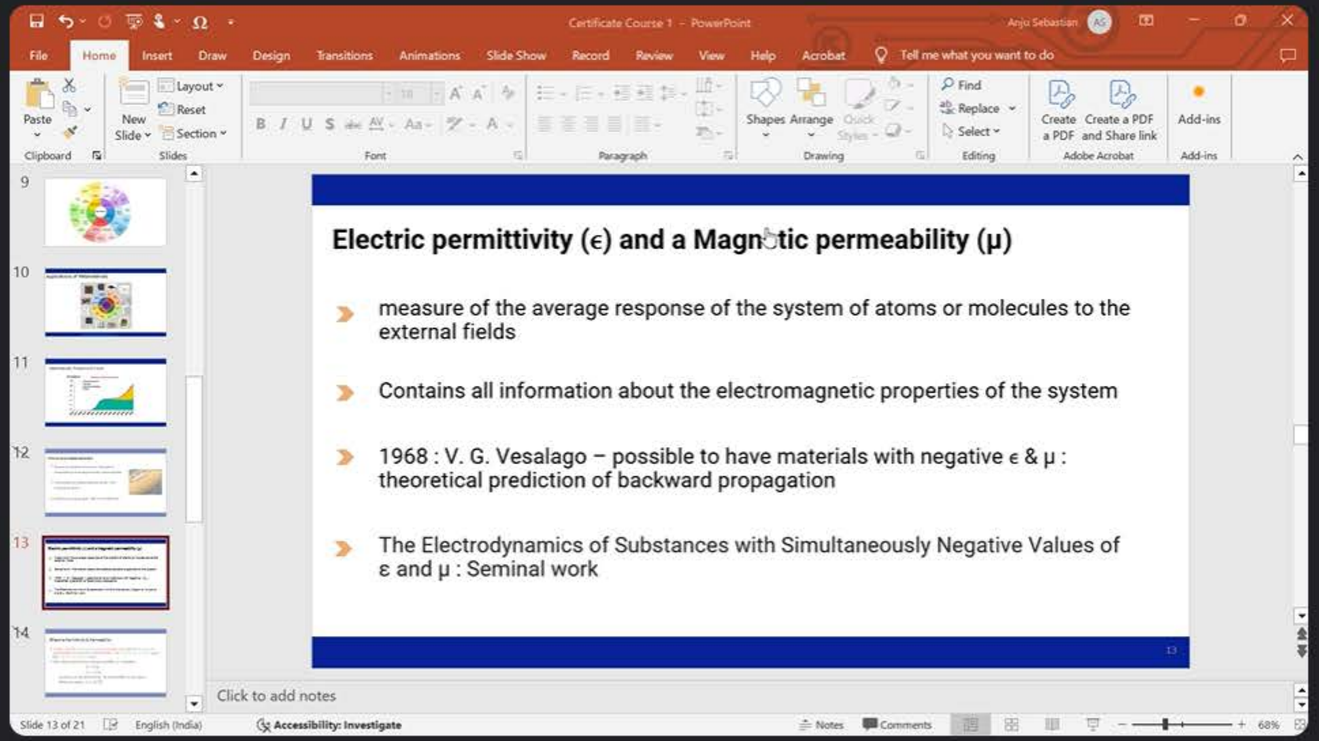

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Anuhsree T .A.

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8 others

Anju Sebastian

People

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Contributors 11

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Krishna Rajan