

**Department of Electronics and Communication Engineering**  
**NATIONAL INSTITUTE OF TECHNOLOGY, TIRUCHIRAPPALLI**

<b>Course Title</b>	<b>Electromagnetic Metamaterials</b>		
<b>Course Code</b>	<b>EC615</b>	<b>No. of Credits</b>	<b>3</b>
<b>Department</b>	<b>ECE</b>	<b>Faculty</b>	<b>Dr. R. Pandeewari</b>
<b>Pre-requisites Course Code</b>	<b>MIC</b>		
<b>Course Coordinator(s) (if, applicable)</b>	<b>Dr. R. Pandeewari</b>		
<b>Other Course Teacher(s)/Tutor(s) E-mail</b>	-	<b>E-mail/Telephone No.</b>	<b><u>rpands@nitt.edu</u> 0431-2500133</b>
<b>Course Type</b>	<b>Elective course</b>		

**COURSE OVERVIEW**

- To understand the properties of metamaterials and MTM inspired structures for antenna performance improvement, microwave components.

**COURSE OUTCOMES (CO)**

<b>Course Outcomes</b>	<b>Aligned Programme Outcomes(PO)</b>
1. To learn and understand the properties of metamaterials and the effect of properties on fundamental phenomena	
2. To understand the theory of Transmission line theory of Metamaterials.	
3. To discuss different types of SRR and to derive equivalent circuit	
4. To discuss the metamaterial properties for performance enhancement of antenna.	
5. To learn the design of microwave components using metamaterials.	

**COURSE TEACHING AND LEARNING ACTIVITIES**

<b>S. No.</b>	<b>Week</b>	<b>Topic</b>	<b>Mode of Delivery</b>
<b>1.</b>	First week of January <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>• Introduction to Metamaterials</li> <li>• Definition, Theoretical speculation, Experimental demonstration</li> </ul>	

		<ul style="list-style-type: none"> <li>Conventional Backward Waves and Novelty of LH MTMs ,Terminology Left-handed metamaterials</li> </ul>	
2.	Second week of January <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>Transmission Line (TL) Approach , Composite Right/Left- Handed (CRLH) MTMs ,</li> <li>Left-Handedness from Maxwell's Equations , Boundary Conditions ,</li> <li>Reversal of Doppler Effect, Reversal of Snell's Law: Negative Refraction.</li> </ul>	Chalk &Talk, PPT or any suitable mode
3.	Third week of January <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>TL Theory of MTMs ,Ideal Homogeneous CRLH TLs: Fundamental TL Characteristics</li> <li>Equivalent MTM Constitutive Parameters Balanced and Unbalanced Resonances ,</li> <li>Lossy Case, LC Network Implementation</li> </ul>	
4.	Fourth week of January <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>Difference with Conventional Filters , Transmission Matrix Analysis</li> <li>Input Impedance, General Design Guidelines</li> <li>Microstrip Implementation</li> </ul>	
5.	First week of February <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>Parameters Extraction ,</li> <li>Conversion from Transmission Line to Constitutive Parameters.</li> </ul>	
6.	<b>ASSESSMENT –I</b>		
7.	Third week of February <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>An overview of different types of SRR and CSRR</li> <li>Equivalent circuit model for MSRR</li> </ul>	Chalk &Talk, PPT or any suitable mode
8.	Fourth week of February <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>Labyrinth and spiral resonator</li> <li>Parameters extraction using NRW approach.</li> </ul>	
9.	First week of March <b>(3 Contact Hours)</b>	<ul style="list-style-type: none"> <li>LH-TL loaded antenna, Electrically small antenna</li> <li>Thin wavelength resonator design , Partial metamaterial loading</li> </ul>	

		<ul style="list-style-type: none"> <li>Sub-wavelength antenna, Metamaterial substrate</li> </ul>	
		<b>ASSESSMENT –II</b>	
10.	Second week of March (3 Contact Hours)	<ul style="list-style-type: none"> <li>Metamaterial superstrate ,</li> <li>CSRR loaded antenna</li> <li>OCSRR loaded monopole antenna, Bandwidth enhancement</li> </ul>	Chalk &Talk, PPT or any suitable mode
11.	Third week of March (3 Contact Hours)	<ul style="list-style-type: none"> <li>Notch function using SRR in UWB antenna , MTM inspired antenna</li> <li>Guided-Wave Applications - Dual-Band Components</li> </ul>	
12.	<b>ASSESSMENT-III</b>		<b>Written exam</b>
13.	First week of April (3 Contact Hours)	<ul style="list-style-type: none"> <li>Dual-Band Property of CRLH TLs</li> <li>Quarter- Wavelength TL and Stubs</li> </ul>	Chalk &Talk, PPT or any suitable mode.
14.	Second week of April (3 Contact Hours)	<ul style="list-style-type: none"> <li>Quadrature Hybrid and Wilkinson Power Divider</li> <li>Enhanced-Bandwidth Components: Principle of Bandwidth Enhancement -</li> </ul>	
15.	Third week of April (3 Contact Hours)	<ul style="list-style-type: none"> <li>Rat-Race Coupler Example</li> <li>Revision.</li> </ul>	
		<b>COMPENSATION ASSESSMENT</b>	<b>Written exam</b>
16.	<b>FINAL ASSESSMENT</b>		<b>Descriptive type of exam</b>

#### COURSE ASSESSMENT METHODS

S.No.	Mode of Assessment	Week/Date	Duration	% Weightage
1.	ASSESSMENT-I (Descriptive)	2 <sup>nd</sup> week of February'2017	60minutes	20



2.	ASSESSMENT-II (Seminar )	1 <sup>st</sup> week of March'2017	-	10
4.	ASSESSMENT-III (Descriptive)	4 <sup>th</sup> week of March'2017	60minutes	20
5.	COMPENSATION ASSESSMENT (CPA)	3 <sup>rd</sup> week of April'2017	60 minutes	Refer course policy
6.	FINAL ASSESSMENT (Descriptive type of exam)	First week of May'2017	180 minutes	50

#### ESSENTIAL READINGS :

##### Text Books:

1.Christophe Caloz, Tatsuo Itoh, " Electromagnetic Metamaterials: Transmission Line Theory and Microwave Applications " by John Wiley & Sons , Inc ., Hoboken, New Jersey, 2006.

##### Reference Books:

2. Ricardo Marqués, Ferran Martín, Mario Sorolla, Metamaterials with Negative Parameters: Theory, Design, and Microwave Applications, Wiley, Inc.,2008

3. Filippo Capolin, Theory and Phenomena of Metamaterials, CRC Press, 2009

#### COURSE EXIT SURVEY

1. Feedback from the students during class committee meeting.
2. Queries through questionnaire.
3. Course Attainment is calculated through Direct tools (Exams)

#### COURSE POLICY

##### Correspondence:

1. All the students are advised to come to class regularly. All the correspondence (schedule of classes/ schedule of assessment/ course material/ any other information regarding this course) will be intimated in the class / over phone.
2. Queries (if required) to the course teacher shall be emailed to the email id specified.

**Attendance:**

1. Attendance will be taken by the faculty in all the contact hours. Every student should maintain minimum 75 % physical attendance (on other duty will not be considered) in these contact hours to attend the end semester examination.
2. Any student, who fails to maintain the minimum 75% attendance but has attendance between 50% and 75%, will be eligible for attending the end semester examination provided if he/she appears for the compensation assessment (CPA) and scores more than 60 % marks in the CPA. Otherwise, they will have to REDO the course.
3. Students having attendance less than 50% at the end of the semester will have to RE DO the course.

**Assessment:**

1. Attending all the assessments is MANDATORY for every student.
2. If any student is not able to attend either one or both of the continuous assessments I & III due to genuine reason, student is permitted to attend the compensation assessment (CPA) with only 20 % weightage for both the cases.
3. At any case, CPA will not be considered as an improvement test.
4. If any student is not able to attend the End semester due to genuine reason with valid attestation, student is permitted to take up FORMATIVE ASSESSMENT.
5. Finally, every student is expected to score minimum 35% of the mark of the class in the total assessment (1, 2, 3 and end semester) to pass the course. Otherwise the student would be declared fail and 'F' grade will be awarded. Further the student can take up only FORMATIVE ASSESSMENT.

**ADDITIONAL COURSE INFORMATION**

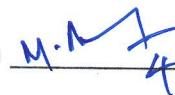
Queries and feedback may also be emailed to the Course Faculty directly at [rpands@nitt.edu](mailto:rpands@nitt.edu)

**FOR SENATE'S CONSIDERATION**

Course Faculty



CC-Chairperson



4/11/2020 HOD

