दिल्ली विश्वविद्यालय
University of Delhi

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CNC-II/093/1/EC-1275/25/07(iii)
Dated: 16.10.2026

NOTIFICATION

Sub: Amendment to Ordinance V

(ECR 07-10/ dated 23.05.2025)

Following addition be made to Appendix-II-A to the Ordinance V (2-A) of the Ordinances of the University;

Add the following:

The Syllabus of M.Tech in Microwaves and Communication for Semester-III/IV under the Faculty of Inter-Disciplinary & Applied Sciences based on PGCF-2024, is notified herewith for the information of all concerned as per *Annexure-1.*

16/10/26

REGISTRAR

Annexure-1

DEPARTMENT OF ELECTRONIC SCIENCE
UNIVERSITY OF DELHI SOUTH CAMPUS

FRAMEWORK FOR M.TECH.(MICROWAVE AND COMMUNICATION)

Part/ Semester	Unique code	Name of Course	L	P	C	Page no.
Part 1	**Semester I**					1
1/I	**MTC101**	Electromagnetic Theory and Transmission Lines	**4**	**-**	**4**	1
	MTCL102	Microwave Planar Lines and Passive Components	**4**	**2**	**6**	3
	Choose any one out of the following					
	MTEL101	Microwave Characterization and Measurement Techniques	**4**	**2**	**6**	6
	MTEL102	Optical Communication Systems	**4**	**2**	**6**	9
	Choose any one out of the following					
	MTE103	Microwave Devices	**4**	**-**	**4**	11
	MTE104	EMI and EMC Technology	**4**	**-**	**4**	13
	Total credit in Semester I				**20**	
Part 1	**Semester II**					15
1/II	**MTC201**	Advanced Communication Theory	**4**	**-**	**4**	15
	MTC202	Microwave Active Circuits	**4**	**-**	**4**	17
	MTCL203	Advanced Antenna Theory and Techniques	**4**	**2**	**6**	19
	Choose any one out of the following					
	MTEL201	Computational Electromagnetics	**4**	**2**	**6**	22
	MTEL202	Radar Technology	**4**	**2**	**6**	23
	Choose any one out of the following					
	MTE203	Metamaterials and Metasurfaces: Concepts and Applications	**4**	**-**	**4**	25
	MTE204	Satellite Communication System	**4**	**-**	**4**	29
	Total credit in Semester II				**24**	
Part 2	**Semester III**					29
2/III	**MTCL301**	Next-Generation Communication Systems	**4**	**2**	**6**	29
	MTCP302	Minor project	**-**	**6**	**6**	31
	Choose any one out of the following					
	MTE301	Terahertz, Nanophotonics and Plasmonics	**4**	**-**	**4**	32
	MTE302	Industrial Microwaves Technology	**4**	**-**	**4**	34
	MTE303	MEMS Design and Technology	**4**	**-**	**4**	36
	Total credit in Semester III				**16**	
Part 2	**Semester IV**					38
2/IV	**MTCP401**	Major project	**-**	**16**	**16**	38
	Total credit in Semester IV				**16**	
Total Credit in all semesters					**76**	

L-credits in lectures, P-credits in practicals, and C- total credits

SEMESTER III

MTCL301. Next-Generation Communication Systems

Lecture Credits: 4 **Total Lectures: 60**

Course Learning Objectives

This course delves into the design, analysis, and implementation of next-generation communication systems. It covers cutting-edge technologies such as 5G/6G, massive MIMO, millimeter-wave communications, software-defined networks, and quantum communication. The course emphasizes both theoretical foundations and practical applications, preparing students to contribute to the future of wireless communications.

Course Learning Outcomes

At the end of this course, students will have
CO1. Understand the architecture and key technologies driving next-generation communication systems.
CO2. Analyze the performance and limitations of current and future wireless communication systems.
CO3. Develop skills to design and evaluate next-generation communication protocols and systems.
CO4. Gain hands-on experience with modern communication tools and simulation environments.

Syllabus Contents

Unit-1 **12 lectures**
Introduction to mobile communication system, evolution from 1G to 5G (GSM, GPRS, LTE, LTA etc), Key requirements and use cases for next-generation systems; Overview of 5G New Radio (NR) and 6G vision.

Unit-2 **16 lectures**
5G Radio Access Network (RAN) architecture and components; 5G NR (New Radio) and core network architecture; deployment scenarios; Functional split options in 5G RAN; Network slicing and software-defined networking (SDN); Security challenges in 5G; Introduction to Open-RAN alliance.

Unit-3 **16 lectures**
Fundamentals of URLLC, Techniques for achieving low latency and high reliability; Applications: Autonomous vehicles, industrial automation, Massive Machine-Type Communication (mMTC) and Internet of Things (IoT); Characteristics of mMTC, IoT protocols and standards, Challenges and solutions for massive connectivity.

Unit-4 **16 lectures**

Fundamentals of millimeter-wave communication; Challenges: Propagation, beamforming, hardware design, Concept of Massive Multiple-Input Multiple-Output (MIMO) and spatial multiplexing; Introduction to Li-Fi; AI and Machine Learning in Communication Systems; Role of AI in network management and optimization; Machine learning techniques for communication networks; AI-driven wireless resource allocation.

Suggested Books:

1. Dahlman, E., Parkvall, S., & Skold, J. 5G NR: The Next Generation Wireless Access Technology. Academic Press, 2018
2. Huang, K. C., & Wang, Z., Millimeter wave communication systems. John Wiley & Sons, 2011.
3. Milovanovic, D. A., Bojkovic, Z. S., & Fowdur, T. P. (Eds.). Driving 5G Mobile Communications with Artificial Intelligence Towards 6G. CRC Press, 2023
4. Chen, W., Gaal, P., Montojo, J., & Zisimopoulos, H. Fundamentals of 5G communications: Connectivity for enhanced mobile broadband and beyond. McGraw-Hill Education, 2021.
5. Milovanovic, D. A., Bojkovic, Z. S., & Fowdur, T. P. (Eds.). (2023). Driving 5G Mobile Communications with Artificial Intelligence Towards 6G. CRC Press.

Next-Generation Communication Systems Laboratory

Practical Credits: 2 **Total Lectures: 60**

List of Experiments:

1. To study and analyze the 5G NR waveforms using 5G toolbox in MATLAB.
2. To study and simulate 5G NR end-to-end wireless communication links in MATLAB.
3. To study the multiple-input multiple-output (MIMO) system in MATLAB
4. To study the Orthogonal Frequency Division Multiplexing (OFDM) in MATLAB.
5. To study the role of AI in network management and optimization using MATLAB.
6. To capture and study the Live RF Signals using Software defined radio (SDR) kit.
7. To design a communication system by implementing 8,16 QAM using SDR kit.
8. To design a MIMO system with multiple antennas in SDR and evaluate its performance.
9. To study 5G NR Waveform Generation and Testing using 5G testbed.
10. To study the End-to-End 5G Network and Performance Analysis using 5G testbed.
11. To study the generation and capture of live 5G Signals using antenna and RF instruments.

MTCP302. Minor-Project

Practical Credits: 6

Each student has to take up a mini-project based on the hardware and/or software in III semester which will be of 6 credits i.e. 150 marks. The project evaluation will be based on the project report submitted by the student and a presentation to a panel of three examiners from the Department faculty as decided by the PG Committee of Courses of the Department every year. The 50% of the marks will be based on continuous internal assessment evaluation throughout the semester.

MTE301. Terahertz, Nanophotonics and Plasmonics

Lecture Credits: 4 **Total Lectures: 60**

Course Learning Objectives

The main objective of this course is to give a comprehensive understanding and hands-on exposure to the various processes, industrial tools, protocols, and design specifics which are involved in Nano Photonics and Plasmonics so that the students can understand the interaction of Light frequencies and THz frequencies with metal and dielectrics. This is most needed for future communication systems largely envisaged for extreme high frequencies.

Course Learning Outcomes

At the end of this course, students will have

CO1 Familiarization of the various types of Nano photonic devices/components

CO2 Understanding of the Nano photonics and plasmonic components, their characteristics and their applications.

CO3 Pre-requisite knowledge to perform design of these nano photonic and plasmonic components

CO4 Understanding of the current trends and scope of the THz communication industry

Syllabus Content

Unit-1 **14 Lectures**

Motivation, brief introduction to nanophotonics, plasmonics and metamaterials; Overview of current status of research in academia and industry in the fields of nanophotonics, plasmonics, and metamaterials; Electromagnetic theory of light; Electromagnetic properties of material; Constitutive relationships and material parameters; Electromagnetic waves in dielectric media; Polarization of light; Reflection and refraction; Fresnel equations; Absorption, dispersion, and scattering of electromagnetic waves.

Unit-2 **14 Lectures**

Electromagnetic waves in periodic structures-Matrix theory of dielectric layered media; Fabry–Perot Etalon; Bragg Grating; 1D Photonic crystals — Bloch modes, Dispersion relation and photonic band structure; Real and reciprocal lattices; 2D and 3D Photonic crystals; Bandgap engineering; Devices based on photonic crystals; Emerging Applications of Photonic Crystals.

Unit-3 **16 Lectures**

Optical properties of metals; Surface Plasmon Polaritons (SPP) on planar interfaces; SPP modes for shape resonances, gratings, and light scattering from rough surfaces; Applications of SPPs: Surface Enhanced Raman Spectroscopy (SERS), Sensing, Subwavelength properties in light-guiding and plasmonic circuitry, plasmonic subwavelength enhanced transmission of light; Plasmonic nanoparticles; Localized plasmon resonances; Chain of plasmonic nanoparticles; Applications of localized plasmon resonances.

Unit-4 **16 Lectures**

Metamaterials concept; Effective medium theories; Negative-permittivity and negative-permeability metamaterials; Double-Negative Materials; Perfect absorbers; Super lens, Hyperbolic metamaterials and application in high-resolution imaging; Introduction to Metasurfaces; Perfect control over transmission and reflection using metasurfaces; Introduction to Transformation Optics; Transformation optics and metamaterials, Introduction to alternative materials; Nanofabrication: Thin films —Physical methods; Chemical methods; Epitaxy; Photolithography, Non-optical lithography; Pattern transfer; Nanophotonic characterization.

Suggested Books:

1. Plasmonics: Fundamentals and Applications, S. Maier, Springer (2007)
2. Fundamentals of Photonics, 3rd Edition. by Bahaa E. A. Saleh, Malvin Carl Teich.(2019)
3. Fundamentals and Applications of Nanophotonics. by Joseph W. Haus (2016)
4. Optical Metamaterials: Fundamentals and Applications, W. Cai and V. Shalaev Springer (2010)

MTE302. Industrial Microwaves Technology

Lecture Credits: 4 **Total Lectures: 60**

Course Learning Objectives

This subject provides a comprehensive understanding of microwave heating principles, technology, and applications. It will explore the physics behind microwave heating, including dielectric properties, permeability, and frequency effects. The course will cover the technical aspects of microwave heating systems, such as components, generators, waveguides, applicators, and materials processing. Furthermore, students will gain insights into the principles and applications of microwave medical applications and plasma systems.

Course Learning Outcomes

At the end of this course, students will have
CO1. Understand the fundamentals of microwave heating.
CO2. Explain the dielectric properties and permeability of materials and microwave heating.
CO3. Understand the components and systems used in microwave heating and its regulations.
CO4. Analyse the applications of microwave medical application.

Syllabus Contents

Unit-1 **12 lectures**
Microwave as a Heat Source, Microwave Heating of Substrates in Solutions, Microwave Heating of a Solid Substance, Difference between Microwave Heating and Conventional Heating. Heating Methods: Direct Heating, Selective Heating, and Hotspots or Local Heating. Stages of Superheating, and its applications.

Unit-2 **18 lectures**
Parameters in Microwave Heating: Dielectric constant, electric and magnetic permeability. Mechanism of microwave heating, including dipole rotation, conduction loss, and dielectric and magnetic loss heating. Penetration depth, Skin depth, and Frequency effects. Overview of electromagnetic and thermodynamics simulations. Basics of Microwave oven concepts. Microwave Chemistry in Liquid Media. Microwave Materials Processing in Solid Media. Hybrid cooking system.

Unit-3 **14 lectures**
Components in Microwave Heating Equipment: Microwave Generators, Waveguides, Isolators, Power Monitors, Tuners, Iris, and Short Plungers. Single-mode versus Multimode Applicators and Temperature Measurements. Interaction between electromagnetic waves and biological materials. Microwave cancer diagnosis and thermal ablation. Mathematical Models for the Complex Permittivity of Biological Tissue.

Unit-4 **16 lectures**
Common Techniques for Microwave Cancer Diagnosis. Antennas and wearable sensors for biomedical diagnostics and therapeutic applications. Microwave Plasma Systems for Plasma

Processing at Reduced Pressures, Microwave-assisted Plasma generation. Hybrid Microwave Plasma System with Magnetized Hollow Cathode. RF High-Power Sources. LINAC Basic Concepts and Constituents. Role of Linear Accelerators in Health Care. Accelerator-Based Radiation Therapy.

Suggested Books:

1. S. Horikoshi, R. F. Schiffmann, J. Fukushima, and N. Serpone, Microwave Chemical and Materials Processing. Springer, First Edition, 2017.
2. G. B. Awuah, H. S. Ramaswamy, and J. Tang, Radio-Frequency Heating in Food Processing. CRC Press, First Edition, 2014.
3. C. Li, M.-R. Tofighi, D. Schreurs, and T.-S. J. Horng, Principles and Applications of RF/Microwave in Healthcare and Biosensing, Academic Press, First Edition, 2016.
4. L. Wang, Electromagnetic Waves and Antennas for Biomedical Applications, IET, 2021.
5. L. Bardos and H. Barankova, Microwave Plasma Sources and Methods in Processing Technology. John Wiley & Sons, First Edition, 2022.

MTE303. MEMS Design and Technology

Lecture Credits: 4 **Total Lectures: 60**

Course Learning Objectives

In this course, students explore Radio-Frequency Microelectromechanical System (RF MEMS) technology and its use in microwave systems. They learn about MEMS fabrication techniques and key materials used in RF MEMS devices. The course focuses on developing mechanical modelling skills for MEMS devices like switches, filters, and antennas to improve performance through analysis. Students gain knowledge of various MEMS switches, such as capacitive shunt and series switches, including their physical properties and electromagnetic behaviour. The course covers modelling principles for mechanical filters, micromachined filters, surface acoustic wave filters and phase shifters. Designing and fabricating MEMS switches with packaging considerations and ensuring device reliability. Students also study micromachined transmission lines, coplanar transmission lines, and micromachined waveguide components, learning techniques to optimize antenna performance and integrate MEMS devices effectively in practical applications.

Course Learning Outcomes

At the end of this course, students will have
CO1. Understanding of RF MEMS Fundamentals and Fabrication
CO2. Knowledge about mechanical modeling of MEMS Devices
CO3. Exposure to design and fabrication of MEMS Switches
CO4. Concepts of MEMS Transmission line, Filters, Phase Shifters, antennas and their integration

Syllabus Contents

Unit-1 **12 lectures**
RF MEMS for microwave applications, MEMS technology and fabrication, mechanical modelling of MEMS devices, MEMS materials; BioMEMS; VLSI and Micro-electromechanical Technologies for MEMS.

Unit-2 **16 lectures**
Introduction to MEMS switches; Capacitive shunt and series switches: Physical description, circuit model and electromagnetic modelling; Design of MEMS switches; Techniques of MEMS switch fabrication and packaging. Micromachined filters, surface acoustic wave filters,Various types of MEMS phase shifters; Ferroelectric phase shifters.

Unit-3 **18 lectures**
Introduction to Electrostatic Sensors and Actuators, Interdigitated Finger Capacitors, Applications of Comb Drive Devices. Thermal Sensing and Actuation: Introduction, Sensors and Actuators Based on Thermal Expansion, Thermal Couples, Thermal Resistors, Applications. Magnetic Actuation: Essential Concepts and Principles, Fabrication of Micromagnetic Components, Case Studies of MEMS Magnetic Actuators.

Unit-4 **14 lectures**

Role of MEMS packages, types of MEMS packages, module packaging, packaging materials and reliability issues.

Suggested Books:

1. V. K.Varadan, K. J. Vinoy, and K.J. Jose, RF MEMS and their Applications, John Wiley & Sons. 2002.
2. G.M. Rebeiz, MEMS: Theory Design and Technology, John Wiley & Sons. 1999.
3. H. J. De Los Santos, RF MEMS Circuit Design for Wireless Communications, Artech House. 1999.
4. W. Trimmer, Micromechanics & MEMS, IEEE Press. 1996.
5. M. Madou, Fundamentals of Microfabrication, CRC Press. 1997
6. S. M. Sze, Semiconductor Sensors, John Wiley & Sons. 1994

SEMESTER IV

MTCP401. Major Project

Practical Credits: 16

Students will be required to work on the major project in Semester IV which will be of 16 credits i.e. 400 marks and can be carried out in collaboration with an R& D Organization or industry of repute in the related areas of microwave and communication. The collaboration is to be established by the project coordinator.

All students will have to go through a mid-semester project evaluation which will be of 30% of total marks i.e. 120 marks and will be facilitated by the project coordinator and internal supervisor of the student either through online or offline mode.