GUJARAT TECHNOLOGICAL UNIVERSITY

Program Name: Master of Engineering
Level: PG
Branch: Electronics And Communication (VLSI Design)
Subject Code: ME02096041
Subject Name: Organic Electronics

WEF Academic Year	2025-26
Semester	02
Category of the Course	PEC-04

Prerequisite:	Fundamentals of digital electronics and VLSI circuits
Rationale:	Due to various limitations, issues of silicon-based electronics devices, organic materials-based electronics emerged and offer structural versatility, low-temperature, mechanical flexibility, lightweight, and energy-efficient devices. In this course, the students will learn the fundamentals of organic materials, organic photo physics with their characteristics and properties. The course also includes physics, working operation, characteristics and applications of organics LEDs, organic FETs, organic photovoltaic devices, and organic semiconductor lasers.

Course Outcome:

After Completion of the Course, Student will be able to:

No	Course Outcomes	RBT Level*
01	Understand organic semiconductor materials, photo physics and photochemistry.	UN
02	Analyze operation of organic LEDs (OLEDs).	AN
03	Analyze operation of OTFT and other organic devices.	AN
04	Analyze operation of organic semiconductor laser.	AN
05	Evaluate performance of OECT for sensor applications.	EL

*RM: Remember, UN: Understand, AP: Apply, AN: Analyze, EL: Evaluate, CR: Create

Course Scheme:

Teaching Scheme			**Total Credits**	**Assessment Pattern and Marks**				**Total Marks**
				Theory		**Practical**		
L	**T**	**PR**	**C**	**ESE (E)**	**PA(M)**	**ESE (V)**	**PA (I)**	
03	00	02	04	70	30	30	20	150

Course Content:

U. No	Course Content	No of Hours	% weightage
1	**Electronic Process in Organic Semiconductor Materials:** semiconductor property of conjugated polymers, semiconductor property of conjugated molecules, small molecular semiconductor materials.	02	05
2	**The Fundamentals of Organic Photo Physics and Photochemistry:** singlet and triplet states, quantized energy levels of molecule vibration, frontier molecular orbitals, optical transitions in organic materials, energy transfer, excitation and exciton dynamics, the photophysical properties of organotransition metal compounds (OTMC), photochemical reaction.	06	15
3	**Organic Light-Emitting Diodes (OLEDs):** Introduction to OLED devices: principle of OLED devices, OLED materials: fluorescent OLED materials, phosphorescent OLED materials, TADF OLED materials, next-generation OLED materials, charge transport/injection materials, charge blocking materials, OLED application status and prospects: overview of OLED industry, OLED for flexible applications.	06	15
4	**Organic Field-Effect Transistors:** Introduction, working principles of OFET: device architecture, charge transport in OFET, characterization of OFET device, Organic semiconductors for OFETs: small molecule organic semiconductors, polymer organic semiconductors, Strategies for better performance of OFET: material design for high-performance OFETS, fabrication strategy, interface engineering.	06	15
5	**Organic Photovoltaic Devices:** Advantages of organic semiconductor for photovoltaic applications, working principes of OPVs: characteristics of OPV devices, light absorption and exciton generation, charge transport and collection, development of OPV materials: homopolymer MEH-PPV, P3HT, Fullerene derivatives, D-A copolymer, non-Fullerene accepters, wide-bandgap donors, Novel concepts for better device performance: upper limit for efficiency, development of active layer structure, improving the morphology of active layers, vertical phase segregation, surface recombination, and device architecture, methodology for active layer preparation, multicomponent active layers, all-polymer solar cells.	8	20

6	**Organic Semiconductor Laser:** brief history, background for laser, laser materials, characteristics of laser, organic laser, amplifying spontaneous emission, materials for organic lasers: organic dyes, organic semiconductors, other organic lasing materials, comparing analog organic lasing materials, the photophysical properties of organic laser materials: gain effect, cross section of absorption, emission spectrum, characterization of organic laser materials. Organic micro-/nanoscale lasers, current research status.	8	20
7	**Organic Electrochemical Transistor:** device structure of OECT, working principle of OECT devices, functionalization of OECT devices, sensor applications: Ion and pH sensors, humidity sensors, and biosensors.	6	10
	Total	42	100

Reference Book:

- Guangye Zhang, Chen Xie, Peng You, Shunpu Li, Introduction to Organic Electronics Devices, Springer, 2022.
- Stephen R. Forrest, Organic Electronics – Foundations to Applications, Oxford University Press, 2020.
- Luis Alcacer, The Physics of Organic Electronics, IOP Science, 2022.

Suggested Course Practical List:

- The practical work will be carried out based on the content covered during the academic session.

List of Laboratory/Learning Resources Required:

- List of Hardware: FPGA/CPLD programming tool, Multimeter, Power supply, function generator, oscilloscope
- List of Software: EDA Tools – Cadence, Synopsis, Siemens, Multisim
- List of Useful websites MOOCs:---
    - Course-related online MOOCs on NPTEL/SWAYAM platform
    - Recent publications in reputed journal/conferences

****