

25UECT413	FLEXIBLE ELECTRONICS	Category	L	T	P	R	Credit	Year of Introduction
		PEC	3	0	0	0	3	2025

Preamble: This course introduces materials, device structures, fabrication techniques, and applications of flexible and printed electronics used in healthcare, IoT, displays, and smart textiles. The subject bridges conventional semiconductor technology with next-generation organic, polymer, and nanomaterial-based electronics, preparing students for innovations in wearable technology and sustainable electronic design.

Prerequisite: Nil

Course Outcomes: After the completion of the course, the student will be able to:

CO	Course Outcomes	Knowledge Level
CO1	Describe the fundamentals, advantages, and mechanical considerations of flexible electronics.	K2 Understand
CO2	Identify materials and substrates used in the fabrication of flexible electronic devices.	K2 Understand
CO3	Describe the printing and fabrication techniques used for realizing flexible circuits and systems.	K2 Understand
CO4	Illustrate flexible electronic devices and their applications in wearables, healthcare, and IoT.	K3 Apply

Mapping of course outcomes with program outcomes and program specific outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2
CO1	3	2	2	-	1	-	-	-	-	-	-	2	-
CO2	3	-	2	-	1	-	-	-	-	-	1	2	1
CO3	3	-	2	-	2	-	-	-	-	-	2	3	2
CO4	3	-	2	-	-	2	-	-	-	-	2	3	2
Avg	3	2	2	-	1.33	2	-	-	-	-	1.25	2.5	1.25

Mapping of course outcomes with Knowledge and Attitude Profile (WK)

	WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
CO1	*	*	*	*	*	*		*	
CO2	*	*	*	*	*	*		*	
CO3	*	*	*	*	*	*		*	
CO4	*	*	*	*	*	*	*	*	

Wks Mapped with the course

WK1	WK2	WK3	WK4	WK5	WK6	WK7	WK8	WK9
*	*	*	*	*	*	*	*	

Mark Distribution:

Total Marks	CIE Marks	ESE Marks	ESE Duration
100	40	60	2.5 hrs

Continuous Internal Evaluation Pattern:

Attendance	: 5 marks
Continuous Assessment Test	: 20 marks
Continuous Assessment Assignment	: 15 marks

SYLLABUS

Module 1 (12 hrs)

Evolution from rigid silicon electronics to flexible and stretchable systems, Advantages, Comparison of flexible with conventional electronics. Basics of thin-film devices on flexible substrates. Mechanical aspects: bending radius, strain, neutral mechanical plan.

Module II (10 hrs)

Flexible substrate materials: PET, PEN, Polyimide (PI), PDMS, Conductive materials: Silver nanoparticles, CNTs, graphene, Organic semiconductors and printable dielectric materials, Transparent conductive electrodes and alternatives to ITO, Electrical, thermal, and mechanical material requirements.

Module III (10 hrs)

Additive manufacturing in electronics, Printing techniques, Roll-to-roll (R2R) manufacturing for large-area electronics, Low-temperature processing methods, Packaging and encapsulation challenges.

Module IV (10 hrs)

Flexible Thin-Film Transistors (TFTs), Flexible sensors: strain, pressure, temperature, biosensors, Flexible OLED displays and lighting systems, Flexible antennas and RF components, Flexible energy storage: batteries and supercapacitors, Applications: Wearable healthcare monitoring, Smart textiles and E-skin, Flexible IoT devices and smart packaging Future trends and sustainability in flexible electronics

Text Books:

1. Nathan, A., Ahnood, A., Cole, M. T., *et al.* (2012). *Flexible electronics: Materials and applications*. Springer.
2. Someya, T. (2013). *Stretchable electronics*. Wiley-VCH.

Reference Books:

1. Rogers, J. A., Someya, T., & Huang, Y. (2010). Materials and mechanics for stretchable electronics. *Science*, 327(5973), 1603–1607. <https://doi.org/10.1126/science.1182383>
2. Hsu, Y.-Y., & Su, W.-F. (2019). *Organic electronics: Materials, manufacturing, and applications*. CRC Press.
3. Khan, S., Lorenzelli, L., & Dahiya, R. (2015). Technologies for printing sensors and electronics over large flexible substrates: A review. *IEEE Sensors Journal*, 15(6), 3164–3185. <https://doi.org/10.1109/JSEN.2014.2375203>

END SEMESTER EXAMINATION – MODEL QUESTION PAPER

Course Code	25UECT413
Course Name	Flexile Electronics
Max. Marks: 60	Duration: 2.5 Hours

Part A (Answer all questions. Each question carries 3 marks)				
Qn No.	Question	Marks	CO	BL
1	Explain the advantages of flexible electronics in wearable healthcare applications.	3	CO1	L2
2	Describe the structure of a thin-film device fabricated on a flexible substrate.	3	CO1	L2
3	Explain the role of PDMS in flexible electronic applications.	3	CO2	L2

4	Explain the need for transparent conductive electrodes.	3	CO2	L2
5	Elucidate the roll-to-roll (R2R) manufacturing?	3	CO3	L2
6	Explain the role of encapsulation in flexible electronics.	3	CO3	L2
7	A foldable smartphone requires a display that can withstand repeated bending. Demonstrate the appropriate display technology and explain its suitability.	3	CO4	L3
8	A wearable fitness band requires continuous monitoring of body movement. Select a suitable flexible sensor and justify your choice.	3	CO4	L2
Part B <i>(Answer any one full question from each Module. Each carries 9 marks)</i>				
Qn No.	Question	Marks	CO	BL
Module I				
9.	Describe the structure and operation of thin-film devices fabricated on flexible substrates.	9	CO1	L2
OR				
10.	Explain the mechanical aspects of flexible electronics, including bending radius, strain, and neutral mechanical plane.	9	CO1	L2
Module II				
11.	Explain the electrical, thermal, and mechanical requirements of materials used in flexible electronics.	9	CO2	L2
OR				
12.	A smart textile incorporates sensors, conductive tracks, and flexible electronic components. Explain how substrate materials, conductive materials, and dielectric materials contribute to the performance of the smart textile system.	9	CO2	L2
Module III				
13.	Explain different printing techniques used for the fabrication of flexible electronic devices.	9	CO3	L2
OR				
14.	Describe low-temperature processing methods and the challenges associated with packaging and encapsulation in flexible electronics.	9	CO3	L2

Module IV				
15.	Design a flexible IoT-based smart packaging system by selecting appropriate sensors, antennas, and energy storage elements. Explain your design decisions.	9	CO4	L3
OR				
16.	A next-generation electronic skin (E-skin) system requires sensing, communication, and energy storage capabilities. Develop a suitable flexible electronic solution and justify the selection of components.	9	CO4	L3
