|  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Course Title** | Chemical and Biological Materials | | | | **Course Type** | | | **Theory** | | |
| **Course Code** | **C1UB129T** | | | | **Class** | | | B.Tech.: First Year Programs | | |
| **Instruction delivery** | **Activity** | **Credits** | **Credit Hours** | | **Total Number of Classes per Semester** | | | | **Assessment in Weightage** | |
| **Lecture** | 3 | 3 | |
| **Tutorial** | - | - | | **Theory** | **Tutorial** | **Practical**  **Practical** | **Self-study** | **CIE** | **SEE** |
| **Practical** | - | - | |
| **Self-study** |  |  | |
| **Total** | 3 | 3 | | 45 | - | - | - | 50% | 50% |
| **Course Lead** | Dr. Umar Farooq | | | **Course Coordinator** | Dr. Sakshi Singh | | | | | |
| **Names Course Instructors** | **Theory** | | | **Practical** | | | | | | |
| Dr. Sakshi Singh, Dr. Umar Farooq, Dr. Lalit Prasad Joshi, Dr. Shafat Ahmad Khan, Dr. Pooja Agrawal, Dr. Anjali Gupta, Dr. Divya Tripathi, Dr. Sahil Kohli, Dr. Zubair Ahmad, Dr. Roopali Sharma, Dr. Jaya Tuteja, Dr. Ambikesh Dhar Dwivedi | | |  | | | | | | |

**COURSE OVERVIEW**

Learners in this course will be competent to understand the introduction of chemical and biological materials and their applications in the different fields. Different applications of biofuels, nanocomposites and liquid crystal in various fields are being discussed in which these materials can be integrated into systems, devices, and engineering solutions to enhance functionality and performance.

**PREREQUISITE COURSE**

|  |  |  |
| --- | --- | --- |
| **PREREQUISITE COURSE REQUIRED** | YES /No  **NO** | |
| **If, yes please fill in the Details** | **Prerequisite course code** | **Prerequisite course name** |
|  |  |

**COURSE OBJECTIVES**

1. To recognize the synthesis and applications of the chemical and biomaterials
2. To learn about chemical and biosensors and their recent applications
3. To analyze various applications of biofuels.

**COURSE OUTCOMES**

|  |  |
| --- | --- |
| **CO1** | Recognize the basic concepts, properties and applications of chemical and biomaterials. |
| **CO2** | Understand the fabrication of chemical and biomaterials. |
| **CO3** | Analyse the applications of biofuels in various fields. |
| **CO4** | Analyse the applications of chemical sensors and biosensors |

**BLOOM’S LEVEL OF THE COURSE OUTCOMES**

**THEORY**

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| CO No. | Remember  **KL1** | Understand **KL 2** | Apply  **KL 3** | Analyse **KL 4** | Evaluate **KL 5** | Create **KL 6** |
| CO1 |  | √ |  |  |  |  |
| CO2 |  | √ |  |  |  |  |
| CO3 |  |  |  | √ |  |  |
| CO4 |  |  |  | √ |  |  |

## COURSE ARTICULATION MATRIX

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **COs#/ POs** | **PO1** | **PO2** | **PO3** | **PO4** | **PO5** | **PO6** | **PO7** | **PO8** | **PO9** | **PO10** | **PO11** | **PO12** | **PSO1** | **PSO2** |
| 201.1 | 3 |  |  |  |  |  |  |  |  |  |  | 2 |  |  |
| 201.2 | 3 |  | 2 |  |  |  |  |  |  |  |  |  |  |  |
| 201.3 | 3 |  | 2 |  |  |  |  |  |  |  |  |  |  |  |
| 201.4 | 2 |  | 2 |  |  |  |  |  |  |  |  | 3 |  |  |

**Note:** 1-Low, 2-Medium, 3-High

**COURSE ASSESSMENT**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Type of Course** | **CIE Weightage** | | | **End Term Exam (ETE) Weightage** |
| **IA 1** | **IA 2** | **Mid Term Exam** |
| Theory (T) | 25 | 25 | 50 | 50 |
| Final Weightage | 25 | | 25 | 50 |
| **Total** | 100 | | | |

\*Assignment, Quiz, Class test, SWAYAM/NPTEL/MOOCs and etc.

|  |
| --- |
| **Course Content** |
| **Biomaterials:** Types of Biomaterials, Biocompatibility, Surface Properties of Biomaterials, Applications of Metallic Biomaterials, Biocompatible materials. Ceramic biomaterials, bioactive ceramics, Polymeric Biomaterials. Diamond like carbon films. **Liquid Crystals**: Introduction, types, Applications in LCDs, optical switches, Spatial Light Modulators, Optical tuning and data processing, Holographic displays. **Nanocomposites**: Introduction, fabrication, Carbon-metal nanocomposites, Bio-inspired nanocomposites. Application of Nanocomposites in Aerospace, Coating, Mechanical, Electrical & Electronics, Fuel cell, thermoelectric device, thermal interface materials (thermal management of computer devices). **Chemical sensors**: Introduction, types, Application in environmental monitoring (Air quality sensors), fire detection and prevention, gas sensors for storage, industrial emission control, mobile devices and wearables. **Biosensors**: Introduction, types of biosensors, components of Biosensors, Applications in environmental monitoring, bioprocess monitoring, security and defence, wearable health devices, fitness tracker, biometric sensors, gaming and entertainment. **Biofuels:** Synthesis, properties, applications in transportation, agriculture and industries. |

**LESSON PLAN FOR Theory Courses**

**FOR THEORY 15 weeks \* 3 Hours = 45 Classes (1credit = 1 Lecture Hour)**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Lecture No.** | **Topics** | **Lecture/Tutorial Plan** | **Skill** | **Competency** |
|  | Types of Biomaterials | L | Explain the concept of biomaterials and their types | Understand the applications of various types of biomaterials |
|  | Biocompatibility | L |
|  | Surface Properties of Biomaterials | L |
|  | Applications of Metallic Biomaterials | L |
|  | Biocompatible materials | L |
|  | Ceramic biomaterials | L |
|  | Bioactive ceramics | L |
|  | Polymeric Biomaterials | L |
|  | Diamond like carbon films | L |
|  | Introduction to liquid crystals | L | Explain the basics of liquid crystals and their applications in LCDs and other applications | Study the various types and applications of liquid crystals |
|  | Types of liquid crystals | L |
|  | Applications in LCDs | L |
|  | optical switches | L |
|  | Spatial Light Modulators | L |
|  | Optical tuning and data processing | L |
|  | Optical tuning and data processing | L |
|  | Holographic displays | L |
|  | Introduction to Nanocomposites | L | Learn about nanocomposites and understand their types and applications in various fields. | Understand nanocomposites and their applications |
|  | Fabrication of Nanocomposites | L |
|  | Carbon-metal nanocomposites | L |
|  | Bio-inspired nanocomposites | L |
|  | Application of Nanocomposites in Aerospace, Coating | L |
|  | Application of Nanocomposites in Electronics, Fuel cell | L |
|  | Application of Nanocomposites in thermoelectric device, thermal interface materials | L |
|  | Application of Nanocomposites in thermal management of computer devices | L |
|  | Chemical sensors: Introduction | L |
| Study and understand chemical sensors and their applications | Understand the concept of chemical sensors and their application |
|  | Types of Chemical Sensors | L |
|  | Application in environmental monitoring (Air quality sensors) | L |
|  | Application in fire detection and prevention | L |
|  | Application in gas sensors for storage | L |
|  | Application in industrial emission control | L |
|  | Application in mobile devices and wearables | L |
|  | Biosensors: Introduction and types | L | Analyse the importance of biosensors and study their applications in various fields | Understand and explain the concept and types of biosensors |
|  | Components of Biosensors | L |
|  | Applications in environmental monitoring, bioprocess monitoring | L |
|  | Applications in security and defence, wearable health devices, fitness tracker | L |
|  | Applications in biometric sensors, gaming and entertainment. | L |
|  | Biofuels: Synthesis, properties | L | Understand the need and importance of biofuels and their applications | Analyse the biofuels and their various properties |
|  | Applications in transportation | L |
|  | Applications in agriculture and industries. | L |

**Text Book (s)**

1. Materials Science, Computer and Information Technology, Trans Tech Publications Ltd., 2014
2. Nanocomposites: Materials, Manufacturing and Engineering. Published by De Gruyter 2013.
3. Smart Biosensors in Medical Care. Academic Press; 1st edition. 2020.
4. Chemical Sensors and Biosensors: Fundamentals and Applications. Wiley; 1st edition. 2012.

**Reference Books**

1. Molecular Electronics: Bio-sensors and Bio-computers. Springer Science & Business Media, 2012.
2. Piezoelectric Sensors (Springer Series on Chemical Sensors and Biosensors. 2007.

**Journals/Magazines/Govt. Reports/Gazatte/Industry Trends**

1. Chemosensors, https://www.mdpi.com/journal/chemosensors
2. Biosensors, https://www.mdpi.com/journal/biosensors

**PROBLEM-BASED LEARNING**

|  |  |  |  |
| --- | --- | --- | --- |
| **S. No.** | **Questions** | **Marks** | **Topic** |
| 1 | Define biocompatibility. | 2 | Chemical and Biological Materials |
| 2 | What do you understand by a liquid crystal? | 2 | Chemical and Biological Materials |
| 3 | List at least four types of chemical sensors. | 2 | Chemical and Biological Materials |
| 4 | Differentiate between carbon-metal and bio-inspired nanocomposites | 5 | Chemical and Biological Materials |
| 5 | Write a detailed note on application of chemical sensors in air quality monitoring. | 5 | Chemical and Biological Materials |
| 6 | Draw a schematic diagram of LCD. | 5 | Chemical and Biological Materials |
| 7 | Describe the application of chemical sensors in mobile devices. | 5 | Chemical and Biological Materials |
| 8 | Comment on the recent trends in the development of nanocomposite materials. | 5 | Chemical and Biological Materials |
| 9 | Mention in detail various components of biosensors. | 5 | Chemical and Biological Materials |
| 10 | Describe in detail the use of biogas and bioethanol used as biofuels. | 7 | Chemical and Biological Materials |
| 11 | Elaborate the various challenges in biofuel production. | 7 | Chemical and Biological Materials |
| 12 | Describe in detail the application of nanocomposites in thermoelectric devices. | 7 | Chemical and Biological Materials |
| 13 | What are various types of liquid crystals? Enumerate in detail. | 7 | Chemical and Biological Materials |
| 14 | Explain how the introduction of nanocomposites has changed the face or aerospace industry. | 7 | Chemical and Biological Materials |
| 15 | Summarize the various types of biomaterials. | 7 | Chemical and Biological Materials |
| 16 | Analyse the future prospects for bioceramics in various fields. | 7 | Chemical and Biological Materials |
| 17 | Elaborate the application of liquid crystals in optical switches. | 7 | Chemical and Biological Materials |
| 18 | Enumerate the various generations of biofuels with examples. | 7 | Chemical and Biological Materials |
| 19 | Discuss the application of chemical sensors in gas sensing technology. | 7 | Chemical and Biological Materials |
| 20 | What are the different types of nanocomposites? Explain in detail. | 7 | Chemical and Biological Materials |
| 21 | Define biofuels. | 2 | Chemical and Biological Materials |
| 22 | Write a short note on biosensors. | 5 | Chemical and Biological Materials |
| 23 | Discuss how can biofuels work as potential alternatives for the exhaustible fossil fuels. | 7 | Chemical and Biological Materials |
| 24 | Describe the application of chemical sensors in fire detection. | 2 | Chemical and Biological Materials |
| 25 | Analyse the working of a transducer. | 7 | Chemical and Biological Materials |
| 26 | Draw a diagram representing the components of a biosensor. | 5 | Chemical and Biological Materials |
| 27 | State how biosensors have impacted our life? | 5 | Chemical and Biological Materials |
| 28 | Write a detailed note on bio-active ceramics. | 5 | Chemical and Biological Materials |
| 29 | Differentiate between various types of liquid crystals. | 7 | Chemical and Biological Materials |
| 30 | Discuss the impact of biomaterials on our day to day life. | 5 | Chemical and Biological Materials |
| 31 | Analyse the various challenges of using biofuels as sources of energy. | 5 | Chemical and Biological Materials |
| 32 | Write a short note on smart gas sensors. | 5 | Chemical and Biological Materials |
| 33 | Discuss how CNTs are best suited for their role in nanocomposite applications. | 5 | Chemical and Biological Materials |
| 34 | How biosensors have enhanced our safety via its implication in defense and security. | 5 | Chemical and Biological Materials |
| 35 | Define the role of biosensors in wearable health devices | 5 | Chemical and Biological Materials |
| 36 | Discuss in detail various applications of polymer nanocomposites. | 5 | Chemical and Biological Materials |
| 37 | Elaborate the use of biofuels in transportation. | 5 | Chemical and Biological Materials |
| 38 | Illustrate the application of liquid crystals in holographic displays. | 5 | Chemical and Biological Materials |
| 39 | Review the various applications of ceramic biomaterials. | 5 | Chemical and Biological Materials |
| 40 | Analyse the application of chemical sensors in wearable devices. | 5 | Chemical and Biological Materials |
| 41 | Describe the surface properties of biomaterials. | 5 | Chemical and Biological Materials |
| 42 | How does nanocomposite coating help in enhancing the properties of materials? | 5 | Chemical and Biological Materials |
| 43 | Mention the limitations of usage of metallic biomaterials. | 5 | Chemical and Biological Materials |
| 44 | Comment on the various categories of polymeric biomaterials. | 5 | Chemical and Biological Materials |
| 45 | Describe the application of chemical sensors in fire detection. | 5 | Chemical and Biological Materials |