## SEMESTER S5

### NANOTECHNOLOGY IN FOOD

| Course Code | PEFTT522 | CIE Marks | 40 |
|---|---|---|---|
| Teaching Hours/Week (L: T:P: R) | 3-0-0-0 | ESE Marks | 60 |
| Credits | 3 | Exam Hours | 2 Hrs. 30 min. |
| Prerequisites (if any) | Nil | Course Type | PE |

**Course Objectives:**

1.Develop students' knowledge in nanoparticles, covering their synthesis, characterization, and unique properties.

2.Explore the potential applications of nanotechnology in the food industry by leveraging the distinctive features of nanomaterials.

## SYLLABUS

| Module No. | Syllabus Description | Contact Hours |
|---|---|---|
| 1 | **Introduction to nanotechnology**<br>Introduction to nanotechnology- Definition, History. Nanoparticles - Physical, Chemical andBiological properties. Quantum dots, nanocomposites, nanofibers, nanowires, nanotubes, nanoforms of carbon.<br>**Environmental toxicology of engineered nanoparticles**. Monitoring nanoparticles - Risk governance, General regulations on safety aspects, Regulation aspects of nano scale food ingredients. | 9 |
| 2 | **Synthesis and characterization of nanomaterials:**<br>Bottom up Synthesis and Top down Approach – Physical, chemical and Biological methods ofnanoparticles synthesis. Characterization of nanomaterials – UV Visible Spectroscopy, X-ray diffraction technique, Scanning Electron Microscopy, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques -AFM, SPM, STM, SNOM, ESCA, SIMS. | 9 |

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| | | |
|---|---|---|
| **3** | **Nano-engineered food ingredients and additives:**<br>Nano materials for food applications - functionalized nanomaterials, nano additives. Foodprocessing and food safety and bio-security - Nanotechnology for improving food quality, detection of contaminants, Electrochemical sensors for food analysis | **9** |
| **4** | **Nanotechnology in food packaging and food preservation:**<br>Nanomaterials for bacterial, fungal and viral inhibition – properties, mode of action. Nanopackaging for enhanced shelf life -nano composites, nano coatings, nanomembranes.Role in active packaging - Smart/ Intelligent packaging.<br>**Potential hazards and regulations:**<br>Potential hazards - health risks, toxicity of nanoparticles, effects of inhaled particles -respiratory systems, skin exposure to nanoparticles, hazards and risks of exposure tonanoparticles. | **9** |

**Course Assessment Method**
**(CIE: 40 marks, ESE: 60 marks)**

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**Continuous Internal Evaluation Marks (CIE):**

| Attendance | Assignment/ Microproject | Internal Examination-1 (Written) | Internal Examination- 2 (Written ) | Total |
|---|---|---|---|---|
| **5** | **15** | **10** | **10** | **40** |

**End Semester Examination Marks (ESE)**

*In Part A, all questions need to be answered and in Part B, each student can choose any one full question out of two questions*

| Part A | Part B | Total |
|---|---|---|
| • 2 Questions from each module.<br>• Total of 8 Questions, each carrying 3 marks<br>**(8x3 =24marks)** | • Each question carries 9 marks.<br>• Two questions will be given from each module, out of which 1 question should be answered.<br>• Each question can have a maximum of 3 sub divisions.<br>**(4x9 = 36 marks)** | **60** |

**Course Outcomes (COs)**

At the end of the course students should be able to:

| Course Outcome | | Bloom's Knowledge Level (KL) |
|---|---|---|
| **CO1** | Understand the history of nanotechnology, nanoparticles and its properties. | **K1,K2** |
| **CO2** | Develop a basic knowledge in synthesis and characterization of nanoparticles. | **K2** |
| **CO3** | Recognize nano-engineered food ingredients and additives. | **K3** |
| **CO4** | Understand the application of various nanoparticles in food packaging and nano-sensing | **K3** |
| **CO5** | Understand the toxic effects and risk associated with engineered nanoparticles | **K4** |

Note*: K1- Remember, K2- Understand, K3- Apply, K4- Analyse, K5- Evaluate, K6- Create*

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**CO-PO Mapping Table:**

| | PO1 | PO2 | PO3 | PO4 | PO5 | PO6 | PO7 | PO8 | PO9 | PO10 | PO11 | PO12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **CO1** | 3 | 2 | | | | | | | | | | 1 |
| **CO2** | 3 | 2 | 2 | | | | | | | | | 1 |
| **CO3** | 2 | 2 | 3 | | | | | | | | | 1 |
| **CO4** | 2 | 2 | | | | | | | | | | 1 |
| **CO5** | 3 | 3 | | | | | | | | | | 1 |

| Text Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Introduction to nanotechnology | Charles P. Poole and Frank J. Owens. | Wiley Publishing | 2008 |
| **2** | Nanotechnology: An Introduction to Synthesis, Properties and Applications of Nanomaterials | Thomas Varghese & K.M. Balakrishna. | Atlantic Publishing | 2012 |
| **3** | Nanotechnology in Agriculture and Food Science | Monique A. V. Axelos and Marcel Van de Voorde. | Wiley VCH | 2017 |
| **4** | Nanotechnologies in Food | Qasim Chaudhary, Laurence Castle, Richard Watkins. | RSC Publishing | 2017 |
| **5** | Nanotoxicity: From In Vivo and In Vitro Models to Health Risks. | Saura C. Sahu | Wiley-Blackwell | 2009 |

| Reference Books | | | | |
|---|---|---|---|---|
| **Sl. No** | **Title of the Book** | **Name of the Author/s** | **Name of the Publisher** | **Edition and Year** |
| **1** | Nanotechnology in the Agri-Food Sector: Implications for the Future | Prof. Dr. Lynn J. Frewer, Prof. Dr. Willem Norde, Arnout Fischer and Dr. Frans Kampers. | Wiley-VCH Verlag GmbH & Co. KGaA | 2011 |
| **2** | Nanotechnology in the Food,Beverage and Nutraceutical Industries | Qingrong Huang. | Woodhead Publishing, | 2012 |
| **3** | Advances in Nanosensors for Biological and Environmental Analysis | Akash Deep and Sandeep Kumar | Elsevier | 2019 |

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| Video Links (NPTEL, SWAYAM…) | |
|---|---|
| **Module No.** | **Link ID** |
| **1** | https://youtu.be/ebO38bbq0_4 |
| **2** | https://archive.nptel.ac.in/courses/118/107/118107015/#, https://youtu.be/w6DD-Yw4t60, https://youtu.be/rR7GwTqxFOE |
| **3** | https://archive.nptel.ac.in/courses/118/107/118107015/, https://archive.nptel.ac.in/courses/118/107/118107015/ |
| **4** | https://archive.nptel.ac.in/courses/118/107/118107015/, https://archive.nptel.ac.in/courses/118/107/118107015/ |

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