SHIVAJI UNIVERSITY, KOLHAPUR
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शिवाजी विद्यापीठ, कोल्हापूर ४१६ ००४, महाराष्ट्र
दूरध्वनी - इपीबीएक्स - २०६०९०००, अभ्यासमंडळे विभाग : ०२३१- २६०९०९४, २६०९४८७
वेबसाईट : www.unishivaji.ac.in ईमेल : bos@unishivaji.ac.in

Estd. 1962
"A++" Accredited by NAAC (2021)
With CGPA 3.52

SU/BOS/Sci & Tech/410 **Date: /07/2025**

To,

1) **The Head,**
Concerned Departments,
Shivaji University, Kolhapur

2) **The Principal/ Director,**
All affiliated Engineering Colleges/ Institute,
Shivaji University, Kolhapur.

Subject: Regarding revised syllabus of **Ph. D. Coursework** under the Faculty of Science and Technology as per National Education Policy 2020.

Sir/Madam,

With reference to the subject mentioned above, I am directed to inform you that the university authorities have accepted and granted approval to the revised syllabi, Nature of Question paper and equivalence of **Ph. D. Coursework** under the Faculty of Science & Technology as per National Education Policy 2020.

1.	Computer Science
2.	Food Science
3.	Environmental Science

This Syllabus, shall be implemented from the academic year **2025-26** onwards. A soft copy containing the syllabus is attached herewith and it is available on university website **www.unishivaji.ac.in NEP-2020@suk (Online Syllabus).**

You are therefore, requested to bring this to the notice of all students and teachers concerned.

Thanking you,

Yours faithfully,

Dr. S. M. Kubal
Dy. Registrar

Encl. : As above.
Copy to: For Information and necessary action.

1	The Dean, All Faculty	7	P.G.Admission Section
2	Director, Board of Examination and Evaluation	8	Affiliation T. 1 & T. 2 Section
3	The Chairman, Respective Board of Studies	9	Appointment A & B Section
4	All On Exam Section	10	P.G.Seminar Section
5	B.Sc. / M.Sc. Exam Section	11	I.T. Cell / Computer Centre
6	Eligibility Section	12	Internal Quality Assurance Cell (IQAC)

SHIVAJI UNIVERSITY, KOLHAPUR

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with CGPA 3.52

Structure and Syllabus of

Ph.D. Coursework

In Accordance With

National Education Policy – 2020

For

Ph.D. Food Science and Technology

Under Faculty of

Science and Technology

Syllabus to be implemented from

Academic Year: 2025-2026

SHIVAJI UNIVERSITY, KOLHAPUR

Doctor of Philosophy [Ph.D.] Course Work

COURSEWORK STRUCTURE

(To be implemented from Academic Year 2025-26 Onwards)

A) Pre Registration Coursework:

Sr. No.	Paper Title	No. of credit	Examination Scheme			
			Theory		Minimum Passing 40%	Total Marks
			Continuous Assessment	Written Examination		
1	Research and Publication Ethics (RPE)	2	20	30	20	50
Written Exam : MCQ TYPE / To be Conducted faculty wise through Examination Section						

Before the confirmation of registration, the scholar has to complete Pre -Registration Coursework. Continuous Assessment of the candidate will be done through tutorials, assignments, quizzes and group discussions. Weightage will be given for active participation in each of the assignment and activity. Final written examination will be conducted at the end of the course.

B) After Registration Pre Ph.D. Coursework:

The candidate should complete Pre PhD Course work which will be conducted by the Research Centre. Candidates will be notified the schedule of course works. Attendance is compulsory for the course work. Candidates successfully completing the course work will need to fill examination form**.**

1) Total No .of Compulsory Papers as per UGC Guideline:

Sr. No.	Subject/Papers	No. of Credits	Marks
1	Research Methodology, Quantitative Techniques and Computer Application	4	100
2	Recent Trends in the subject concerned	4	100
3	Optional Paper (Based on Specialization)	4	100
	Total	12	300

2) Scheme of Teaching:

Sr. No.	Paper Title	Teaching Scheme			
		Lectures in Hours	Seminars in Hours	Library Work in Hours	Total Hours
1	Research Methodology, Quantitative Techniques and Computer Application	40	10	10	60
2	Recent Trends in the subject concerned	40	10	10	60
3	Optional Paper (Based on Specialization)	40	10	10	60

3) Scheme of Examination:

Sr. No.	Paper Title	Examination Scheme				
		No. of credits	Theory Marks	Internal Marks	Minimum Passing 40%	Total Marks
1	Research Methodology, Quantitative Techniques and Computer Application	4	80	20	40	100
2	Recent Trends in the subject concerned	4	80	20	40	100
3	Optional Paper (Based on Specialization)	4	80	20	40	100
Total		**12**				**300**

- Theory Examination: is to be conducted by the university with duration of 3 hours per paper.
- Internal Examination is to be conducted by the concerned departments or research centers in the following form:

1. For Paper-I and Paper-II the internal evaluation will include 2 Seminars of 10Marks each
2. For Paper-III the internal evaluation will include 2 seminars of 10 Marks each
   a) Seminars (Submission and Presentation) - 10 marks
   b) Literature Review: Submission and Presentation - 10 marks

STANDARD OF PASSING:

i) The scholar should secure minimum 40% marks to complete the course work in individual paper. Ph.D. scholar has to obtain a minimum of 55% of marks or its equivalent grade in the UGC 7-point scale in the course work in order to be eligible to continue in the programme and submit the dissertation/thesis (as per R.D.11.9). The candidate will be allowed to reappear the examination for one, two or three papers if he/she could not achieve 55% aggregate in coursework examination.

ii) The examination shall be conducted at the end of each academic year.

iii) The evaluation of the performance of the scholars shall be as per scheme of examination.

iv) Question Paper shall be set in the view of the / in accordance with the entire syllabus and preferably covering each unit of syllabus.

NATURE OF QUESTION PAPER AND SCHEME OF MARKING:

The nature of question paper for the subject/paper shall be as indicated below:

a. Short answered questions (20 Marks)
   (Any Four Out of Six Questions)
b. Long answered questions (20 Marks)
   (Any Two Out of Four Questions)
c. Short notes (20 Marks)
   (Any Four Out of Six Questions)
d. Problems / Cases/Exercise Oriented Questions. (20 Marks)
   (Any One Out of Two Questions)

Note: ***Question paper should focus on all units in the syllabus***

C) Training in Teaching/Education/Pedagogy during their doctoral period as follow.
[Total Credits: 4]

Sr. No	Paper Title	No. of Credit	Theory/ Practical Marks	Internal Marks	Minimum Passing 40%	Total Marks	Remark
1	Training in Teaching (Theory)	2	40	10	20	50	E- Content Pre-pared by BOS Education
2	Training in Teaching (Practical)	2	50	-	20	50	Practical Based BOS of concerned subject (e.g. Seminar, etc.)
	Total	4	90	10	40	100	

- Training is to be conducted at university department and the consequent evaluation and assessment is to be done as per the curricular framework. Papers will have separate passing head for theory examination and internal evaluation as 36+4=40

New/Revised Syllabus for Ph.D. Coursework
(Ph.D. in Food Science and Technology)

Paper – I		
Research Methodology, Quantitative Techniques and Computer Application		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Understand and analyze research methodologies relevant to food science and technology.

CO2: Apply quantitative techniques and research designs for experimental studies in food science.

CO3: Develop high-quality scientific documents and effectively communicate research findings.

CO4: Integrate computer applications and emerging digital tools in food research and innovation.

CO5: Demonstrate independent research competence and readiness for high-quality scholarly work.

Unit 1: Research Methodology [10 Lectures]

- Introduction to Research Methodology
- Definition, Objectives, and Types of Research
- Research Process and Scientific Methods
- Experimental, Observational, and Survey Research
- Qualitative vs Quantitative Research Approaches

Unit 2: Quantitative Techniques, Research Design and Data Collection [10 Lectures]

- Statistical Analysis: Descriptive and Inferential Statistics
- Hypothesis Testing: General guidelines, Tools and Techniques
- Application of Statistical Software (e.g., SPSS, R, SAS, STATA, Minitab, Excel)
- Design of Experiments (DOE) in Food Science and Technology
- Data Collection Techniques and Sampling Methods

Unit 3: Scientific Writing, Communication and Publishing Research [10 Lectures]

- Structure and Components of Research & Review Papers, Book Chapters and Theses
- Literature Review and Citation Styles
- Preparing Research Presentations (Posters, Oral Presentations)
- Research Documentation and Reference Management
- Plagiarism, Falsification, and Fabrication of Data
- Copyrights, Patents, and Trademarks

Unit 4: Computer Applications in Food Research [10 Lectures]

- Modeling and Simulation in Food Processes
- Image Analysis and Machine Vision
- Computer-Aided Sensory and Consumer Research
- Nutritional and Formulation Software
- Bioinformatics and Foodomics
- Artificial Intelligence (AI) and Machine Learning (ML)
- Lab Automation and IoT in Food Labs

Reference Books:

1. Bordens, K. S., & Abbott, B. B. (2011). *Research Design and Methods: A Process Approach. 8th Edition.* McGraw-Hill Education. New York
2. Creswell, J. W. (2009). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches.3rd Edition.* SAGE Publications. California
3. Gastel B. & Day R. A. (2016). How to Write and Publish a Scientific Paper. 8th Edition. Cambridge University Press. GreenwoodABC- CLIO, LLCCalifornia
4. Heldman, D. R., & Singh, R. P. (2019). *Introduction to food engineering* (5th ed.). Academic Press.
5. Kothari, C. R. (2004). *Research Methodology: Methods and Techniques. 2nd Revised Edition.* New Age International Publishers. New Delhi
6. Kumar, R., & Pandey, S. K. (2020). *Internet of Things (IoT) in agriculture and food: Technologies, principles and applications*. CRC Press.
7. Lawless, H. T., & Heymann, H. (2010). *Sensory evaluation of food: Principles and practices* (2nd ed.). Springer.
8. Sun, D.-W. (Ed.). (2016). *Computer vision technology in the food and beverage industries* (2nd ed.). Woodhead Publishing.

New/Revised Syllabus for Ph.D. Coursework
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Paper – II		
Recent Trends in Food Science and Technology		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Understand emerging domains and research priorities in food science

CO2: Critically evaluate recent advances in thermal food processing technologies

CO3: Demonstrate a comprehensive understanding of non-thermal food processing technologies

CO4: Investigate and apply innovative packaging and green extraction technologies

CO5: Formulate and propose innovative research solutions in processing and packaging

CO6: Develop scientific communication skills for advanced food science research

Unit 1: Research Areas and Trends in Food Science & Technology [10 Lectures]

- Functional Foods and Nutraceutical
- Plant-Based and Alternative Proteins
- Fermentation Science Pro-biotics, Pre-biotics and Post-biotics
- Waste valorization in food industries
- Up-cycling food by-products

Unit 2: Advances in Thermal Food Processing [10 Lectures]

- Freeze-drying and spray-drying innovations
- Microwave Heating and its applications
- Infrared (IR) Heating and its applications
- Radio Frequency (RF) Heating and its applications
- Ohmic heating and its applications

Unit 3: Advances in Non-Thermal Food Processing [10 Lectures]

- High-pressure processing (HPP)
- Pulsed electric field (PEF) processing
- Ultrasound-assisted processing
- Cold plasma technology
- Clean Label and Natural antimicrobials and bio-preservatives

Unit 4: Recent Trends in Packaging and Green Extraction Technology [10 Lectures]

- Active and Intelligent Packaging
- Nanotechnology in food packaging
- Biodegradable and edible packaging
- Green Extraction Technologies: SFE, SWE and PLE
- Encapsulation of Food Additives

Reference Books:

1. Ahmed, J., & Varshney, S. K. (Eds.). (2021). *Biodegradable polymers in the food industry*. Springer.
2. Barbosa-Cánovas, G. V., & Juliano, P. (2005). *Engineering aspects of thermal food processing*. CRC Press.
3. Brennan, J. G. (Ed.). (2006). *Food processing handbook*. WILEY-VCH, Germany
4. Chemat, F., & Vian, M. A. (2014). *Alternative solvents for natural products extraction*. Springer.
5. Da-Wen Sun (2005). Emerging Technologies for Food Processing. Elsevier Academic Press. UK
6. Fellows, P. (2000). *Food processing technology: Principles and practice*. Woodhead Publishing Limited., England
7. Galanakis, C. M. (Ed.). (2020). *Upcycling of food waste to value-added products*. Academic Press.
8. Han, J. H. (Ed.). (2013). *Innovations in food packaging* (2nd ed.). Academic Press.
9. Jafari, S. M. (Ed.). (2017). *Nanoencapsulation of food ingredients by specialized equipment*. Academic Press.
10. McClements, D. J., & Grossmann, L. (2021). *The plant-based diet revolution: Understanding and optimizing plant-based meat and dairy alternatives*. Academic Press.
11. Misra, N. N., & Koubaa, M. (Eds.). (2021). *Cold plasma technology for novel food processing and preservation*. Academic Press.
12. Ramaswamy, H. S., & Marcotte, M. (2006). *Food processing: Principles and applications*. CRC Press.
13. Wildman, R. E. C. (Ed.). (2016). *Handbook of nutraceuticals and functional foods* (2nd ed.). CRC Press.
14. Zhang, H. Q., Barbosa-Cánovas, G. V., Balasubramaniam, V. M., Dunne, C. P., Farkas, D. F., & Yuan, J. T. C. (Eds.). (2011). *Nonthermal processing technologies for food*. Wiley-Blackwell.

New/Revised Syllabus for Ph.D. Coursework
(Ph.D. in Food Science and Technology)

Elective I : Paper – III [A]		
Advances in Food Science and Nutrition		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Understand the recent advancements in nutrient chemistry.

CO2: Study the functionality of major nutrients in human nutrition.

CO3: Study the functionality of minor nutrients in human nutrition.

CO4: Assess the chemistry and efficacy of food additives.

CO5: Design and develop functional foods and nutraceutical products.

Unit 1: Advances in Carbohydrate and Protein Chemistry [10 Lectures]

- Structural and functional diversity of carbohydrates
- Advances in Carbohydrate chemistry and Modifications
- Recent advances in protein structure-function relationships
- Protein-protein and protein-polysaccharide interactions
- Enzymatic modification and protein engineering in foods

Unit 2: Advances in Chemistry of Lipids, Vitamins, and Minerals [10 Lectures]

- Structural and functional diversity of Lipids
- Lipidomics in food science
- Advances in Water- and fat-soluble vitamins
- Advances in Bioaccessibility and absorption of minerals.

Unit 3: New Developments in Food Additives and Ingredients [10 Lectures]

- Natural and Synthetic colors and flavors
- Antioxidants: Mechanism of action and regulatory aspects
- Emulsifiers, stabilizers, thickeners: Types and food applications
- Low- and high-intensity sweeteners
- Innovative approach in use of novel food ingredients

Unit 4: Functional Foods and Nutraceutical [10 Lectures]

- Concepts and classifications: Prebiotics, probiotics, symbiotics
- Low-calorie and diabetic-friendly food products
- Nutritional therapy and specialty diets
- Functional food formulations: Supplementation and Fortification
- Regulatory and safety aspects

Reference Books:

1. Akoh, C. C. (Ed.). (2017). *Food Lipids: Chemistry, Nutrition, and Biotechnology* (4th ed.). CRC Press.
2. Belitz, H. D., Grosch, W., & Schieberle, P. (2009). *Food Chemistry* (4th ed.). Springer. https://doi.org/10.1007/978-3-540-69934-7
3. Bodwell, C. E. (Ed.). (1987). *Evaluation of proteins for humans*. AVI Publishing.
4. Damodaran S. andParkin KL. (2017). *Fennema's Food Chemistry*. 5th ed. CRC Press.
5. Damodaran, S., Parkin, K. L., & Fennema, O. R. (2017). *Fennema's Food Chemistry* (5th ed.). CRC Press.
6. Francis, F. J. (2000). *Food Additives*. CRC Press.
7. Gibson, G. R., & Williams, C. M. (Eds.). (2000). *Functional Foods: Concept to Product*. Woodhead Publishing.
8. Imeson, A. (2010). *Food Stabilisers, Thickeners and Gelling Agents*. Wiley-Blackwell.
9. Joshi, S. A. (2010). *Nutrition and dietetics* (4th ed.). Tata McGraw-Hill Education.
10. Milner, M., Scrimshaw, N. S., & Wang, D. I. C. (Eds.). (1978). *Protein resources and technology*. AVI Publishing.
11. Salunkhe, D. K., & Kadam, S. S. (Eds.). (1989). *Handbook of world legumes: Nutritional chemistry, processing technology and utilization* (Vols. 1–3). CRC Press.
12. Shils, M. E., Shike, M., Ross, A. C., Caballero, B., & Cousins, R. J. (2005). *Modern Nutrition in Health and Disease* (10th ed.). Lippincott Williams & Wilkins.
13. Swaminathan, M. (1986). *Handbook of food and nutrition* (Vols. 1–2). The Bangalore Printing and Publishing Co.
14. Wildman, R. E. C. (Ed.). (2016). *Handbook of Nutraceuticals and Functional Foods* (2nd ed.). CRC Press.

New/Revised Syllabus for Ph.D. Coursework
(Ph.D. in Food Science and Technology)

Elective II : Paper – III [B]		
Advances in Food Bio-technology		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Understand the advanced principles of bioprocess technology and industrial applications.

CO2: Demonstrate knowledge in upstream and downstream food bioprocess technologies.

CO3: Evaluate tissue culture techniques and genetic engineering approaches in food biotechnology.

CO4: Develop process approach in production and stability of enzymes used in food processing.

CO5: Study the fermentation techniques to develop novel and functional food products.

Unit 1: Bioprocess Technology **[10 Lectures]**

- Introduction to Bioprocesses
- Overview of upstream and downstream processing in food biotech.
- Bioreactors and Fermentation Kinetics.
- Sterilization, aeration, agitation, pH and temperature control.
- Scaling up criteria and process optimization from lab to industrial scale.

Unit 2: Plant & Animal Tissue Culture, GM Foods **[10 Lectures]**

- Fundamentals of Tissue Culture and Cell Culture Techniques.
- Plant Tissue Culture Techniques and advancements.
- Animal Cell Culture in food research and synthetic meat.
- Genetically modified (GM) foods: Biosafety and Regulatory concerns.
- Genetic modification techniques

Unit 3: Enzyme Technology **[10 Lectures]**

- Microbial, plant, and animal sources of enzymes.
- Isolation, purification and characterization of enzymes.
- Kinetics and stability of enzymes.
- Enzyme Immobilization Techniques.

Unit 4: Fermented Foods and Application of Bio-technology [10 Lecture]

- Alcoholic Fermentations: Products and Process Advances
- Organic Acid Fermentations: Products and Process Advances
- Traditional Fermented Foods: Products and Process Advances
- Advances in Functional foods and probiotics

Reference Books:

1. Bains W. 1993, Biotechnology from A to Z, Oxford Univ. Press, Oxford.
2. Bhojwani, S. S., & Razdan, M. K. (2005). *Plant tissue culture: Theory and practice* (Rev. ed.). Elsevier.
3. Bisswanger, H. (2017). *Enzyme kinetics: Principles and methods* (3rd ed.). Wiley-VCH.
4. Crueger, W. and Crueger A. 1984. Biotechnology: A Textbook of Industrial Microbiology, Science Tech. Madison, USA.
5. Doran, P. M. (2012). *Bioprocess engineering principles* (2nd ed.). Academic Press.
6. Freshney, R. I. (2016). *Culture of animal cells: A manual of basic technique and specialized applications* (7th ed.). Wiley-Blackwell.
7. Joshi, V. K. and Pandey, A Ed. 1999. Biotechnology. Food Fermentation, (2Vol. set). Education Publ. New Delhi.
8. Knorr, D. 1982. Food Biotechnology. Marcel Dekker, New York.
9. Pandey, A., Webb, C., Soccol, C. R., & Larroche, C. (2005). *Enzyme technology*. Springer.
10. Ray, R. C., & Joshi, V. K. (Eds.). (2014). *Microorganisms and fermentation of traditional foods*. CRC Press.
11. Sammour, R. (2017). *Genetically modified foods and social concerns*. Springer.
12. Shuler, M. L., & Kargi, F. (2017). *Bioprocess engineering: Basic concepts* (3rd ed.). Prentice Hall.
13. Stanbury, P. F., Whitaker, A., & Hall, S. J. (2017). *Principles of fermentation technology* (3rd ed.). Elsevier.
14. Steinkraus, K. H. (2004). *Handbook of indigenous fermented foods* (2nd ed.). CRC Press.
15. Tamang, J. P. (2010). *Himalayan fermented foods: Microbiology, nutrition, and ethnic values*. CRC Press.
16. Wrolstad, R. E. (Ed.). (2010). *Food Carbohydrate Chemistry*. Wiley-Blackwell.

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Elective III : Paper – III [C]		
New Food Product Development and Sensory Science		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Understand types of food products and explain key terminologies in food product development.

CO2: Plan and design food product development projects, incorporating critical stages.

CO3: Evaluate and apply appropriate shelf-life testing protocols for product quality assessment.

CO4: Explain the principles of sensory science and its modalities.

CO5: Apply sensory evaluation methods to assess food product quality and consumer acceptance.

Unit 1: Introduction to Food Product Development (FPD) [10 Lectures]

- Classification of new food products
- Creating Products from Concepts and Vice Versa
- Bottom-up Innovation: Creating Product Concepts from First Principles
- Failure analysis: Why some food products fail in the market.
- Academic-industry collaboration and technology transfer.
- Project planning and funding for FPD research

Unit 2: Food Product Development (FPD) Process [10 Lectures]

- Identifying Critical Steps in the New Product Development Process
- Stages of FPD Process and Design Thinking in FPD
- Techniques for Process Optimization and Formulations
- Experimental Design in Food Formulation
- Functional and nutritional role of ingredients in FPD
- Shelf-Life Testing Methods: Real-Time & Accelerated Shelf Life Testing

Unit 3: Sensory Science Fundamentals [10 Lectures]

- Introduction to sensory evaluation and its role in FPD.
- Sensory modalities – taste, aroma, texture, appearance.
- Anatomy and physiology of sensory perception.
- Sensory thresholds, adaptation, cross-modal interactions.
- Selection and training of sensory panelists.

Unit 4: Sensory Evaluation Techniques **[10 Lectures]**

- Discrimination tests (triangle, duo-trio, paired comparison).
- Descriptive analysis (QDA, Spectrum, Free Choice Profiling).
- Affective/hedonic testing – consumer panels and acceptance testing.
- Time-intensity and Temporal Dominance of Sensations (TDS).
- Sensory-instrumental correlation and multivariate data analysis.

Reference Books:

1. Beckley, J. H., Paredes, D., & Lopetcharat, K. (2017). Accelerating new food product design and development (2nd ed.). Wiley-Blackwell.
2. Cardello, A. V. (1996). The role of the human senses in food acceptance. In G. A. Moskowitz (Ed.), Food texture and viscosity: Concept and measurement (pp. 1–40). Academic Press.
3. Earle, M., Earle, R., & Anderson, A. (2001). Food product development. Woodhead Publishing.
4. Fuller, G. W. (2016). New food product development: From concept to marketplace (3rd ed.). CRC Press. https://doi.org/10.1201/b10933
5. Graf, E., & Saguy, I. S. (1991). Food product development: From concept to the marketplace. Van Nostrand Reinhold. https://doi.org/10.1002/9781119149324
6. Lawless, H. T., & Heymann, H. (2010). Sensory evaluation of food: Principles and practices (2nd ed.). Springer. https://doi.org/10.1007/978-1-4419-6488-5
7. Meilgaard, M. C., Civille, G. V., & Carr, B. T. (2006). Sensory evaluation techniques (4th ed.). CRC Press.
8. Stone, H., Bleibaum, R. N., & Thomas, H. A. (2012). Sensory evaluation practices (4th ed.). Elsevier. https://doi.org/10.1016/C2009-0-63037-5
9. Valentin, D., Chollet, S., & Abdi, H. (2018). Multivariate analysis of sensory data. Wiley.
10. Winger, R. J., & Wall, G. (2006). Food product innovation: A background paper. FAO.

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Elective IV : Paper – III [D]		
Advanced Food Analysis and Instrumentation		
Credits: 04 Credits	**Lectures: 40 Lectures**	**Marks: 100 Marks**

Course Outcomes (COs)

CO1: Explain the principles and scope of advanced food analysis

CO2: Apply spectroscopic and chromatographic techniques to analyze food components

CO3: Differentiate between analytical techniques based on their principles and uses

CO4: Evaluate and validate methods for food quality and safety

CO5: Develop protocols using modern tools for specific food analysis challenges

Unit 1: Advances in Sampling and Food Analysis [10 Lectures]

- Scope and Significance. Analytical process and quality assurance
- Principles of Sampling.
- Preparation and Storage of analytical samples
- Introduction to advances in instrumental food analysis

Unit 2: Spectroscopic Techniques [10 Lectures]

- UV-Visible Spectroscopy
- Infrared (FTIR), Near-IR (NIR)
- Atomic Absorption (AAS), ICP-OES
- Fluorescence and Mass Spectrometry (MS)
- Raman spectroscopy applications

Unit 3: Chromatographic Techniques [10 Lectures]

- Gas Chromatography (GC) and GC-MS
- High-Performance Liquid Chromatography (HPLC)
- Ultra Performance Liquid Chromatography (UPLC)
- Supercritical Fluid Chromatography (SFC)

Unit 4: Thermal, Structural and Rheological Analysis [10 Lectures]

- Differential Scanning Calorimetry (DSC)
- Thermogravimetric Analysis (TGA)
- Nuclear Magnetic Resonance (NMR)
- Scanning Electron Microscopy (SEM)
- Texture Analysis and Rheometry

Reference Books:

1. Barrow, G. M. (2007). *Introduction to molecular spectroscopy*.McGraw-Hill Education.
2. Boca Raton, FL Yeshajahu Pomeranz and Clifton E. Meloan (1994). Food Analysis Theory And Practice. 3rd Edition. Chapman & Hall One Penn Plaza New York, NY.
3. Clark, J. P., & Jung, S. (2021). *Food Processing and Technology: Principles and Practice*. Wiley-Blackwell.
4. Dong, M. W. (2006). *Modern HPLC for practicing scientists*. Wiley-Interscience.
5. Nielsen, S. S. (Ed.). (2017). *Food analysis* (5th ed.). Springer. https://doi.org/10.1007/978-3-319-45776-5
6. Nollet, L. M. L., & Toldrá, F. (Eds.). (2012). *Handbook of analysis of active compounds in functional foods*. CRC Press.
7. Paré J.R.J. and Bélanger J.M.R. (1997). Instrumental Methods in Food Analysis. Elsevier Science
8. Pomeranz, Y., & Meloan, C. E. (2000). *Food analysis: Theory and practice* (3rd ed.). Springer.
9. Reichenbach, S. E., & Ni, M. (2021). *Advances in chromatography: Techniques and applications in food analysis*. Elsevier.
10. Semih Ötles (2009). Handbook of Food Analysis Instruments. CRC Press Taylor & Francis Group,
11. Skoog, D. A., Holler, F. J., & Crouch, S. R. (2017). *Principles of instrumental analysis* (7th ed.). Cengage Learning.
12. Sun, D.-W. (Ed.). (2008). *Modern techniques for food authentication*. Academic Press.

C) Training in Teaching/Education/Pedagogy during their doctoral period [Total Credits: 04 Credits)

1) Training in Teaching (Theory)		
As per E-content provided by BOS Education of Shivaji University Kolhapur		
Credits: 02 Credits	**Lectures: 30 Hours**	**Marks: 50 Marks**

2) Training in Teaching (Practical)		
Practical Based on Processing Equipments and Analytical Instrumentation in Food Science and Technology		
Credits: 02 Credits	**Practical: 30 Hours**	**Marks: 50 Marks**

List of Practical and Activity to be performed by the research student

- Demonstration of tray dryer and its parameters
- Demonstration of fluidized bed dryer and its parameters
- Demonstration of freeze dryer and its parameters
- Demonstration of spray dryer and its parameters
- Demonstration of extrusion equipment (single-screw & twin-screw) and its parameters
- Proximate analysis of Food using Soxhlet (Fat), Kjeldahl (Protein), and Muffle Furnace (Ash)
- Analysis of Moisture using Moisture Balance
- Analysis of Water Activity using Water Activity Meter
- Texture analysis using a texture analyzer
- Color analysis using Hunter Lab/Chromameter
- Use of digital refractometer and pH meter
- Conducting a lab demonstration for UG/PG students
- Preparing lab manuals, SOPs, and safety protocols
- Trouble-shooting and maintenance of lab instruments

Suggestive Readings

- AOAC International. (2022). *Official Methods of Analysis of AOAC International*
- Manual(s) of Method(s) of Analysis for various food products. https://fssai.gov.in/cms/manuals-of-methods-of-analysis-for-various-food-products.php
- Pomeranz, Y., & Meloan, C. E. (2000). *Food analysis: Theory and practice* (3rd ed.). Springer.
- Ranganna, S. (2000). *Handbook of analysis and quality control for fruit and vegetable products* (2nd ed.). Tata McGraw-Hill.Barbosa-Cánovas, G. V., Fontana, A. J.,
- Yadav DN & Sharma M (2016). *Practical manual in food process engineering*. New India Pub.