DEPARTMENT OF BIOTECHNOLOGY

ANNA UNIVERSITY, CHENNAI

Vision:

The Department of Biotechnology is committed to evolve as a world class science and technology center by integrating quality and ethics in teaching and research.

Mission:

The mission of the department is

- To provide students a unique and multidisciplinary learning experience that will foster the young minds to develop as a researcher, entrepreneur etc.
- To enhance academic and industrial collaborative research initiatives for the development of biotechnological, food and therapeutic products.
- To emphasise and equip the students towards innovative industrial and research updates.
- To serve the society with utmost commitment, integrity, enthusiasm, and dedication

ANNA UNIVERSITY:: CHENNAI: 600 025

UNIVERSITY DEPARTMENTS

M.TECH. FOOD TECHNOLOGY

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM

1. PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

1. Able to design and develop technologies for industrial production of food products.
2. Analyse, evaluate and offer technical solutions for the food sector.
3. Participation in research and development projects leading to research degree.
4. Acquire innovative ideas and integrate with existing knowledge in the field.
5. Become an entrepreneur and be part of a supply chain management.

2. PROGRAMME OUTCOMES (POs):

After completion of two years of study, the Food technology Post Graduates will exhibit ability to:

PO	Graduate Attribute	Programme Outcome
1.	Engineering Knowledge	Graduates will demonstrate good knowledge of Statistics, Science and Technology to solve of engineering, technology and research problems
2.	Problem Analysis	They will be able to Identify, formulate and solve problems in areas of food storage, food processing & preservation, analytical and sensory techniques, food packaging and food engineering.
3.	Design/ development of solutions	Design new processes/ modifying the existing system to improve the performance and to satisfy the constraints.
4.	Conduct investigations of complex problems	They will be able to perform list of experiments, analyze and interpret the data.
5.	Modern tool usage	Apply various food analytical tools and techniques to improve the efficiency of the process and product.
6.	The Engineer and society	Conduct themselves to uphold the professional and social obligations.
7.	Environment and sustainability	Design the system with environment consciousness and sustainable development.
8.	Ethics	Interact with industry, business and society in a professional and ethical manner. They will full fill the needs of the nation and their

		role as citizens.
9.	Individual and team work	Function in a multidisciplinary team with individuality and also with team work spirit.
10.	Communication	They will communicate effectively in both written and spoken English.
11.	Project management and finance	Ability to design, do and interpret data's. Further can Implement cost-effective and improved system.
12.	Life-long learning	They will continue professional development and learning as a life-long activity.

3. MAPPING OF PROGRAMME EDUCATIONAL OBJECTIVE WITH PROGRAMME OUTCOMES

Programme educational objectives	PROGRAMME OBJECTIVES											
	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
1.	√	√			√							√
2.		√	√	√	√				√	√		
3.		√	√	√		√		√	√	√	√	
4.						√	√	√				
5.		√				√	√				√	

4. MAPPING OF COURSE OUTCOMES AND PROGRAMME OUTCOMES

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
		Transport Phenomena in Food Engineering	3	3	3	3	3	-	-	1	3	-	1	2
YEAR 1	Semester 1	Food storage Engineering	3	2	2	1	3	1	1	1	2	-	1	2
		Applied statistics and Numerical Methods in Food Technology	3	3	2	1	2	-	-	-	3	-	3	2
		Audit Course I												

		Research Methodology & IPR	-	3	-	2	-	3	-	3	2	-	2	2
		Professional Elective I												
		Professional Elective II												
		Professional Elective III												
		Food Engineering Laboratory	3	3	3	3	3	-	-	1	3	-	1	2

		Course Name	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PO12**
YEAR 1	**Semester 2**	Food packaging system	2	2	2	2	3	1	3	2	3	-	3	3
		Emerging Food Processing Techniques	2	2	2	2	2	--	-	1	3	-	1	2
		Non-Destructive Quality Evaluation of Foods	2	2	2	2	3	-	-	1	3	-	1	2
		Professional Elective IV												
		Professional Elective V												
		Audit Course II												
		Open Elective												
		Food Processing Techniques Laboratory	2	2	2	2	2	--	-	1	3	-	1	2
		Food packaging system Laboratory	2	2	2	2	3	1	3	2	3	-	3	3

		Course Name	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
YEAR 2	Semester 3	Food storage Engineering Laboratory	3	2	2	1	3	1	1	1	2	-	1	2
		Food analytical Techniques lab	2	3	3	3	3	2	-	2	3	-	-	3
		Internship/ Training	1	3	-	3	3	3	2	3	2	3	2	3
		Project Phase I	2	3	2	2	2	1	-	2	2	2	1	1
	Semester 4	Project Phase II	2	3	2	2	2	1	-	2	2	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

ANNA UNIVERSITY, CHENNAI

UNIVERSITY DEPARTMENTS

M.TECH FOOD TECHNOLOGY

REGULATIONS – 2019

CHOICE BASED CREDIT SYSTEM CURRICULUM AND

SYLLABI FOR I TO IV SEMESTERS

SEMESTER I

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD5101	Transport Phenomena in Food Engineering	PCC	2	1	0	3	3
2.	FD5102	Food storage Engineering	PCC	3	0	0	3	3
3.	FD5103	Applied Statistics and Numerical Methods in Food Technology	PCC	3	1	0	4	4
4.		Audit Course I*	AC	2	0	0	2	0
5.	RM5151	Research Methodology & IPR	RMC	2	0	0	2	2
6.		Professional Elective I	PEC	3	0	0	3	3
7.		Professional Elective II	PEC	3	0	0	3	3
8.		Professional Elective III	PEC	3	0	0	3	3
PRACTICALS								
9.	FD5111	Food Engineering Laboratory	PCC	0	0	4	4	2
			TOTAL	**21**	**2**	**4**	**27**	**23**

*Audit Course is Optional

SEMESTER II

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL PERIODS	CREDITS
				L	T	P		
THEORY								
1.	FD5201	Advances in Food packaging system	PCC	2	1	0	3	3
2.	FD5202	Emerging Food Processing Techniques	PCC	3	0	0	3	3
3.	FD5203	Non-Destructive Quality Evaluation of Foods	PCC	3	0	0	3	3
4.		Professional Elective IV	PEC	3	0	0	3	3
5.		Professional Elective V	PEC	3	0	0	3	3
6.		Audit Course II*	AC	2	0	0	2	0
7.		Open Elective	OEC	3	0	0	3	3
PRACTICALS								
8.	FD5211	Food Processing Techniques Laboratory	PCC	0	0	4	4	2
9.	FD5212	Food packaging system Laboratory	PCC	0	0	4	4	2
10.	FD5213	Internship / Training**	EEC	0	0	0	0	0
			TOTAL	**19**	**1**	**8**	**28**	**22**

*Audit Course is Optional

**Student should undergo a Internship/ Training for which assessment will be done during in the Third semester

SEMESTER III

S.NO.	COURSE CODE	COURSE TITLE	CATE GORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	FD5311	Food Storage Engineering Laboratory	PCC	0	0	4	4	2
2	FD5312	Food Analytical Techniques Laboratory	PCC	0	0	4	4	2
3	FD5313	Internship / Training**	EEC	0	0	0	0	2
4	FD5314	Project Phase I	EEC	0	0	12	6	6
			TOTAL	**0**	**0**	**20**	**14**	**12**

SEMESTER IV

S.NO.	COURSE CODE	COURSE TITLE	CATEGORY	PERIODS PER WEEK			TOTAL CONTACT PERIODS	CREDITS
				L	T	P		
PRACTICALS								
1	FD5411	Project Phase II	EEC	0	0	30	30	15
		TOTAL		**0**	**0**	**30**	**30**	**15**

TOTAL CREDITS: 72

PROFESSSIONAL CORE (PCC)

S.No.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	SEMESTER
1	FD5101	Transport Phenomena in Food Engineering	2	1	0	3	I
2	FD5102	Food storage Engineering	3	0	0	3	I
3	FD5103	Applied Statistics and Numerical Methods in Food Technology	3	1	0	4	I
4	FD5111	Food Engineering Laboratory	0	0	4	2	I
5	FD5201	Advances Food packaging system	2	1	0	3	II
6	FD5202	Emerging Food Processing Techniques	3	0	0	3	II
7	FD5203	Non-Destructive Quality Evaluation of Foods	3	0	0	3	II
8	FD5211	Food Processing Techniques Laboratory	0	0	4	2	II
9	FD5212	Food packaging system Laboratory	0	0	4	2	II
10	FD5311	Food Storage Engineering Laboratory	0	0	4	2	III
11	FD5312	Food Analytical Techniques Laboratory	0	0	4	2	III

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

LIST OF PROFESSIONAL ELECTIVES (PEC)

S. NO.	COURSE CODE	COURSE TITLE	CATE GORY	L	T	P	TOTAL CONTACT PERIODS	CREDITS
1	FD5001	Industrial Food Additives	PEC	3	0	0	3	3
2	FD5002	Engineering Properties of Foods	PEC	3	0	0	3	3
3	FD5003	Food Process Automation	PEC	3	0	0	3	3
4	FD5004	Food Process modelling and simulation	PEC	3	0	0	3	3
5	FD5005	Flavour Technology	PEC	3	0	0	3	3
6	FD5006	Functional Foods	PEC	3	0	0	3	3
7	FD5007	Sensory Attributes and Evaluation of Foods	PEC	3	0	0	3	3
8	FD5008	Dairy Process Engineering	PEC	3	0	0	3	3
9	FD5009	Fat and Oil Technology	PEC	3	0	0	3	3
10	FD5010	Cereal And Grain Process Technology	PEC	3	0	0	3	3
11	FD5011	Pulse and Oilseed Process Technology	PEC	3	0	0	3	3
12	FD5012	Meat And Poultry Process Technology	PEC	3	0	0	3	3
13	FD5013	Marine Food process Technology	PEC	3	0	0	3	3
14	FD5014	Spices, condiments and Plantation Products	PEC	3	0	0	3	3
15	FD5015	Beverage Technology	PEC	3	0	0	3	3
16	FD5016	Advanced Food Microbial Analysis	PEC	3	0	0	3	3
17	FD5017	Applications of Enzymes in Food Industry	PEC	3	0	0	3	3
18	FD5018	Advanced Food Fermentation Technology	PEC	3	0	0	3	3
19	FD5019	Nanotechnology in food applications	PEC	3	0	0	3	3
20	FD5020	Food Nutrigenomics	PEC	3	0	0	3	3
21	FD5021	Food Informatics	PEC	2	0	2	3	3

22	FD5022	By-product utilization in Food Industries	PEC	3	0	0	3	3
23	FD5023	Food legislation And standards	PEC	3	0	0	3	3
24	FD5024	Control of Food Infestations	PEC	3	0	0	3	3
25	FD5025	Food Product Design and Development	PEC	3	0	0	3	3
26	FD5026	Establishment and Management of Food Industry Systems	PEC	3	0	0	3	3

RESEARCH METHODOLOGY AND IPR COURSES (RMC)

S. No.	CODE NO.	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			L	T	P		
1	RM5151	Research Methodology and IPR	2	0	0	2	1

OPEN ELECTIVE COURSES [OEC]*

*(Out of 6 Courses one Course must be selected)

S.NO.	COURSE CODE	COURSE TITLE	PERIODS PER WEEK			CREDITS	SEMESTER
			Lecture	Tutorial	Practical		
1.	OE5091	Business Data Analytics	3	0	0	3	3
2.	OE5092	Industrial Safety	3	0	0	3	3
3.	OE5093	Operations Research	3	0	0	3	3
4.	OE5094	Cost Management of Engineering Projects	3	0	0	3	3
5.	OE5095	Composite Materials	3	0	0	3	3
6.	OE5096	Waste to Energy	3	0	0	3	3

AUDIT COURSES (AC)

Registration for any of these courses is optional to students

S. NO.	COURSE CODE	COURSETITLE	PERIODSPERWEEK			CREDITS	SEMESTER
			Lectur	Tutorial	Practical		
1.	AX5091	English for Research Paper Writing	2	0	0	0	1/2
2.	AX5092	Disaster Management	2	0	0	0	
3.	AX5093	Sanskrit for Technical Knowledge	2	0	0	0	
4.	AX5094	Value Education	2	0	0	0	
5.	AX5095	Constitution of India	2	0	0	0	
6.	AX5096	Pedagogy Studies	2	0	0	0	
7.	AX5097	Stress Management by Yoga	2	0	0	0	
8.	AX5098	Personality Development Through Life Enlightenment Skills	2	0	0	0	
9.	AX5099	Unnat Bharat Abhiyan	2	0	0	0	

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

EMPLOYABILITY ENHANCEMENT COURSES (EEC)

S.No.	COURSE CODE	COURSE TITLE	L	T	P	CREDITS	SEMESTER
1	FD5313	Internship / Training	0	0	0	2	III
2	FD5314	Project Phase I	0	0	12	6	III
3	FD5411	Project Phase II	0	0	30	15	IV

SUMMARY

S.No.	SUBJECT AREA	CREDITS PER SEMESTER				TOTAL CREDITS
		I	II	III	IV	
1	PCC	12	13	4		**29**
2	AC (Non Credit)	0	0			**0**
3	MC	2				**2**
4	PEC	9	6			**15**
5	OEC		3			**3**
6	EEC		0	8	15	**23**
	TOTAL	**23**	**22**	**12**	**15**	**72**

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SYLLABI

SEMESTER I

FD5101 TRANSPORT PHENOMENA IN FOOD ENGINEERING L T P C
2 1 0 3

OBJECTIVES

The course aims to

- acquaint and equip the students with the principles of heat and mass transfer and in food processing
- acquaint and equip the students with the latest technologies of dehydration of food products and the design features of different dryers.

UNIT I ENGINEERING PROPERTIES AND HEAT TRANSFER 9

Engineering properties of foods, their significance in processing and handling of food and food products. Introduction to Engineering principles – classification of transport processes – conservation of mass and energy balance – graphical, numerical and mathematical methods. Heat transfer- External and Internal Resistance, finite objects- Temperature time charts. Prediction of temperature in transient heat transfer. Boiling heat transfer- pool boiling- flow boiling. Radiation intensity and properties- Radiation shields and radiation effect on temperature measurements.

UNIT II MASS TRANSFER 9

Mass transfer – diffusion process- steady state diffusion of gases through solids, convective mass transfer- Unsteady state mass transfer: Transient state diffusion of gases.

Multicomponent transport: Binary systems, mass transport in food processing operations- osmotic dehydration and dimensional analysis.

UNIT III STERILIZATION PROCESS 9

Methods of sterilization and equipment involved- latest trends in thermal processing Sterilization value-definitions-lethal rates-reference temperatures-integrated F values - Arrhenius approach-cooking value-origin and rationale of cooking value-quality retention pasteurization value-process achievement standards. Thermal death rate kinetics - Determination of F values: process safety-general method, graphical method, numerical method-analytical methods-formula methods Balls methods, Gillespis method, Hayakawa method-factor affecting F value-microbiological methods-inoculated pack method-encapsulated spore method, heat penetration curves, cold point, calculation of processing time and temperature, Process evaluation techniques, optimization and validation of thermal processes

UNIT IV MEMBRANE SEPARATION PROCESS 9

Membrane filtration spectrum - membrane materials and structures - membrane modules-principles of membrane filtration - microfiltration, ultrafiltration, reverse osmosis and nanofiltration processes - transport model, estimation of model parameters, Performance Characteristics, design of membrane systems – batch, feed and bleed systems, single pass system, diafiltration systems, co-current permeate flow system, pilot plant trials, sample design calculations - batch, feed and bleed systems, continuous system, operation of membrane systems, membrane applications in the food industry.

UNIT V DRYING AND DEHYDRATION 9

Psychrometry in relation to drying, residence time equation and calculation, Drying of food - Innovation and trends in drying technologies, Impinging steam drying: basic features, hydrodynamics and heat transfer Pulsed fluid bed drying: principles and examples Low pressure superheated steam drying: Basic principle of LPSSD, LPSSD of food and biomaterials, mathematical modelling of LPSSD Airless drying, drying in mobilized beds, vacuum jet drying, Acoustic drying, RF vacuum drying, Contact sorption drying: mechanism, characteristics of sorbents/carriers, Heat pump assisted drying: Classification, fundamentals of heat pump dryers, heat and mass transfer mechanisms, optimum use of heat pump in drying systems, innovative heat pump design systems. Sonic drying: basic characteristics of sound, sound generation, mechanism of sonic drying, drying kinetics, sound assisted dryers. Pulse combustion drying: principle, combustors design and construction, types of combustors, Hybrid drying technologies:

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 analyse heat, mass and momentum transfer analysis.
CO2 understand validation of a thermal process
CO3 analyze industrial problems along with appropriate approximations and boundary conditions

TEXTBOOKS/REFERENCES

1. Bird R. Byron, Warren E. Stewart and Edwin N. Lightfoot. Transport Phenomena. John Wiley & Sons, Inc. New York. 2009.
2. Earle, R.L. Unit Operations in Food Processing. Pergamon Press, Oxford, U.K. 2013.
3. Wilhelm, L.R., D.A. Suter and G.H. Brusewitz. Food and Process Engineering Technology textbook. ASAE. © American Society of Agricultural Engineers. ISBN: 1-892769-43-3. 2005.
4. Yunus A Cengel. Heat and Mass Transfer. Mc graw Hill Campanies Inc., New York. 2011.
5. Holman. J. P. H. Heat Transfer. Mc Graw Hill Campanies Inc., New York. 2009.
6. Geankoplis J. Christie. Transport Process and Unit Operations. Third Edition, Prentice Hall of India, New Delhi. Heinemann, New Delhi. India Pvt. Ltd., New Delhi. 1999.
7. Paul Singh, R. and Dennis R. Heldman.. Introduction to Food Engineering. Elsevier India Pvt. Ltd., New Delhi. 2008
8. Arun S. Mujumdar. Hand Book of Industrial Drying Volume I. Marcel Dekker Inc. NewYork. 2006.
9. Karel,M., O.R. Fennema and D.B. Lund. Principles of Food Science, Part II – Physical principles of food preservation. Marcel Dekker Inc, New York. 2003.

Course Articulation Matrix

Course Outcome Statement		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Analyse heat, mass and momentum transfer analysis.	3	3	3	3	3	-	-	1	3	-	1	2
CO2	Understand validation of a thermal process	3	3	3	3	3	-	-	1	3	-	1	2
CO3	analyze industrial problems along with appropriate approximations and boundary conditions	3	3	3	3	3	-	-	1	3	-	1	2
	Over all CO	3	3	3	3	3	-	-	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5102 **FOOD STORAGE ENGINEERING** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to

- Provide In-depth knowledge on safe storage of food materials.
- Enable design of storage Structures for various categories of food products

UNIT I FOOD GRAIN STORAGE 6

Grain storage principles- factors- changes during storage. indoor storage system- Bag storage, bulk storage, bunkers, cap storage bags outdoor storage system – cold storage, hermetic storage, vacuum and gas storage - moisture movement during bulk storage of grains – pressure distribution in storage bins - grain storage structures - location and material selection for storage building - types - traditional, modern, temporary and permanent storage structures, factors affecting qualities of grains during packaging and storage, functional requirements of storage structures - traditional storage structures in India and their improvements

UNIT II DESIGN OF GRAIN STORAGE SYSTEM 11

Grain storage ecosystem- biotic and abiotic factors- Moisture and temperature migration- Cold spots and hot spots. Aeration – Cooling- dehydration in grain storage, Grain storage in silos, bins and godowns – RCC and steel structures - aeration system for various storage structures, grain pressure theories - design of bulk storage structures, bag storage, godowns, Theory and nature of grain flow, pressure distribution, flow patterns-hoppers and ducts – design - Loading and unloading mechanism.

Grain handling equipment - Bulk handling of food grains-Bulk conveying equipments - design calculations, Design and estimation of energy requirement and damage to biomaterials during mechanical handling - operational features - management and maintenance of grain storage, code of practices for safe storage of food grains.

UNIT III STORAGE OF FRUITS AND VEGETABLES 6

Harvest and pre-harvest factors, pre-storage treatments, Controlled and modified atmosphere storage - effect of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, gas exchange modelling, Effect of storage temperature on shelf life in CAS and MAS. Storage of Intermediate moisture Foods -storage of dehydrated fruits and vegetables. Novel MAP applications for fresh-prepared produce - MAP gases - testing novel MAP applications - Pack houses, CA and MA storage – principles, methods - optimization of storage gas composition, rate of supply, control systems for O2 and CO2., CA and MA transport technologies and applications,

UNIT IV COLD STORAGE SYSTEM 10

Food Cooling and Precooling, Cooling Process Parameters – Analysis – estimation of cooling time – for liquid, solid. Food Freezing Process - Freezing Time Estimation, design of food freezers, equipment for refrigeration of liquid, bulky foods and thin/particulate foods, vacuum cooing, cryogenic freezers, Thawing. Ice manufacture: principles and systems of ice production, basic types of ice, ice makers, Treatment of water for making ice, brines, freezing tanks, ice cans, air agitation, quality of ice. Low temperature Refrigeration: cryogenic fluid and fluid properties; liquefaction; application in food

Defining overall Shelf-life, remaining shelf life in the context of Chilled & Frozen foods; - Deterioration modes of food items; Models of quality deterioration- Kinetic model; shelf-life model; Q10/q10 model; TTT model for the remaining shelf – life; General procedure for shelf– life testing – the 11 steps procedure. Accelerated shelf life testing – steps procedure.

UNIT V COLD STORAGE DESIGN AND LOAD ESTIMATION 12

Cold storage – importance – types of cold store - Design of cold storage and air conditioning systems - types of loads in cold storage and their calculations, Products going in cold chain, their temperature and humidity requirements, construction of cold storage, equipment selection, insulating materials, vapor barriers, care and maintenance of cold storage, packaging needs and their compatibility in cold chain, Design of cold storage for food

products– Meat product, Fishery Product, Dairy Products. Storage of food commodities - biochemical changes during storage - storage factors affecting losses, storage requirements, thermal design of structures

Cooling/Refrigeration load calculations: Load sources, product cooling, conducted heat, convection heat, internal heat sources, heat of respiration, peak load, miscellaneous load

Cold chain: Introduction, scope and importance of cold chain in food processing industry and retail chain, components of cold chain and integration, components of cold chain, Cold chain maintenance, Repair and Replacement, refrigerated transport, cold chain and logistics management, Temperature recording devices used during transport, documentation and traceability.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand trends and development storage technologies aiming at assuring the safety and quality of food.

CO2 familiarise design, construction, operation, control and maintenance of commercial refrigeration systems and cold storages

CO3 understand food storage design.

TEXTBOOKS AND REFERENCES

1. Chakravarty,Post-Harvest Technology of Cereals, Pulse and Oilseeds. IBH Publ. Mahajan and Goswami. Food and Process Engineering. 2005.
2. Ojha TP and Michael AM. Principles of Agricultural Engineering. Jain Brothers.2010.
3. Osling, T. G. Applied Air conditioning and refrigeration. Applied Science Publishers Ltd. London. 1980.
4. Holowell, E.R., Cold Storage and Freezer Storage Manual, AVI Pub. Co. 1980.
5. A. Ciobanu,. and G. Lasku, V. Bersescu, Cooling Technology in the Food Industry, Abacus Press, 1976.
6. Multon, J.L. (ed). Preservation and storage of grains, seeds and their by - products. CBS Publishers and Distributors, 1989.
7. Koelet, P.C. and Gray T. B. Industrial refrigeration, Principles, Design and Applications.CRC, 2017.
8. Mascheroni. R.H. Operations in Food Refrigeration, CRC, 2012.
9. W.F. Stoecker, —Industrial Refrigeration Handbook, McGraw Hill Professional, 1998.
10. Arora, C. P. Refrigeration and Air conditioning. Tata-McGraw-Hill Publishing Co., New Delhi.1981.
11. William, H.S., R.F. Julian, Air conditioning and Refrigeration. John Wiley and Sons, Inc. London. 1986.
12. Elhadi M. Yahia, Modified and Controlled Atmospheres for the Storage, Transportation, and Packaging of Horticultural Commodities, 2009 by Taylor & Francis Group.

Course Articulation Matrix

Course Outcome Statement		Programme Outcome (PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	To provide knowledge about selected trends and development storage technologies aiming at assuring the safety and quality of food.	3	3	1	1	3	1	-	2	2	-	-	2
CO2	To impart knowledge of design, construction, operation, control and maintenance of commercial refrigeration systems and cold storages	3	2	3	1	3	1	1	2	2	-	2	2
CO3	The students will acquire cutting edge knowledge on the food storage design.	3	3	3	1	3	1	1	1	2	-	2	2
Overall CO		3	2	2	1	3	1	1	1	2	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5103 APPLIED STATISTICS AND NUMERICAL METHODS IN FOOD TECHNOLOGY **L T P C 3 1 0 4**

OBJECTIVES

The course aims to

- train the students to address the mathematical problems involved in biological sciences
- understand various sampling, quantitative and statistical problems pertaining to biotechnology.

UNIT I ROOT FINDING METHOD, SYSTEM OF LINEAR EQUATIONS AND INTERPOLATION **12**

Root finding – Newton Raphson method – Simultaneous linear equations – Direct method – Gauss elimination method – Pivoting – Gauss Jordan method – Iterative methods – Jacobi and Gauss Seidal methods – Difference table – Newton's forward and backward interpolation – Newton's divided differences – Lagrangian interpolation.

UNIT II NUMERICALINTEGRATION AND INITIAL VALUE PROBLEM FOR ORDINARY DIFFERENTIALEQUATIONS **12**

Trapezoidal and Simpson's 1/3 rules – Taylor series and Euler methods – Fourth order Runge-Kutta method for first order differential equations – Predictor-corrector method – Adam-Bashforth method

UNIT III EMPIRICAL STATISTICS **12**

Types of sampling – Description of discrete and continuous data – Measures of Central tendency and dispersion for grouped and ungrouped data – Measures of position – Box and Whisker plot.

UNIT IV ESTIMATION THEORY **12**

Unbiased Estimators – Method of Moments – Maximum Likelihood Estimation – Curve fitting by Principle of least squares – Regression Lines.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT V TESTING OF HYPOTHESIS **12**

Sampling distributions – Type I and Type II errors – Tests based on Normal, t, ^{2} and F distributions for testing of mean, variance and proportions – Tests for Independence of attributes and Goodness of fit.

TOTAL:60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand basic problem solving techniques.
CO2 learn about advance integral and differential problems.
CO3 understand different statistical analysis methods.

TEXT BOOKS/REFERENCES

1. Grewal, B.S., "Numerical methods in Engineering and Science", 10th Edition, Khanna Publishers, New Delhi, 2014.
2. Gupta S.C. and Kapoor V.K.," Fundamentals of Mathematical Statistics", Sultan Chand & Sons, 11th Edition (Reprint), 2019.
3. Iyengar, S. R. K., Jain, R. K. and Mahinder Kumar Jain, "Numerical Methods for Scientific and Engineering Computation", 6th Edition, New Age International Publishers, New Delhi, 2012.
4. Miller, I. and Miller, M., "John E. Freund's Mathematical Statistics", Pearson, 8th Edition, 2013.
5. Mann, P.S., "Introductory Statistics", John Wiley and Sons. Inc 5th Edition, 2004.
6. Miller, I. and Freund, J. E., "Probability and Statistics for Engineers", Pearson, 9th Edition, 2017.
7. Montgomery, D.C. and Runger, G.C., "Applied Statistics and Probability for Engineers", Wiley Student Edition, 2007.
8. Walpole, R.E., Myers R.H., Myres S.L., and Ye, K., "Probability ad Statistics for Engineers and Scientists", Pearson Education, Asia, 8thEdition, 2007.

Course Articulation Matrix

Course Outcome Statements		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Understand the basic problem solving techniques	3	3	2	1	2	-	-	-	3	-	3	2
CO2	Learn about advance integral and differential problems	3	3	2	1	2	-	-	-	3	-	3	2
CO3	Understand different statistical analysis methods	3	3	2	1	2	-	-	-	3	-	3	2
Overall CO		3	3	2	1	2	-	-	-	3	-	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

RM5151 **RESEARCH METHODOLOGY AND IPR** **LT P C**
2 0 0 2

COURSE OBJECTIVES:

To impart knowledge and skills required for research and IPR:

- Problem formulation, analysis and solutions.
- Technical paper writing / presentation without violating professional ethics
- Patent drafting and filing patents.

UNIT I RESEARCH PROBLEM FORMULATION 6

Meaning of research problem- Sources of research problem, criteria characteristics of a good research problem, errors in selecting a research problem, scope and objectives of research problem. Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, necessary instrumentations

UNIT II LITERATURE REVIEW 6

Effective literature studies approaches, analysis, plagiarism, and research ethics.

UNIT III TECHNICALWRITING /PRESENTATION 6

Effective technical writing, how to write report, paper, developing a research proposal, format of research proposal, a presentation and assessment by a review committee.

UNIT IV INTRODUCTION TO INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Nature of Intellectual Property: Patents, Designs, Trade and Copyright. Process of Patenting and Development: technological research, innovation, patenting, development. International Scenario: International cooperation on Intellectual Property. Procedure for grants of patents, Patenting under PCT.

UNIT V INTELLECTUAL PROPERTY RIGHTS (IPR) 6

Patent Rights: Scope of Patent Rights. Licensing and transfer of technology. Patent information and databases. Geographical Indications. New Developments in IPR: Administration of Patent System, IPR of Biological Systems, Computer Software etc.
Traditional knowledge Case Studies, IPR and IITs.

TOTAL: 30 PERIODS

COURCE OUTCOMES:

1. Ability to formulate research problem
2. Ability to carry out research analysis
3. Ability to follow research ethics
4. Ability to understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity
5. Ability to understand about IPR and filing patents in R & D.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓										
CO2	✓											
CO3	✓							✓				
CO4	✓				✓							
CO5	✓					✓						✓

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Asimov, “Introduction to Design”, Prentice Hall, 1962.
2. Halbert, “Resisting Intellectual Property”, Taylor & Francis Ltd ,2007.
3. Mayall, “Industrial Design”, McGraw Hill, 1992.
4. Niebel, “Product Design”, McGraw Hill, 1974.
5. Ranjit Kumar, 2nd Edition, “Research Methodology: A Step by Step Guide for beginners” 2010

FD5111 FOOD ENGINEERING LABORATORY L T P C
0 0 4 2

OBJECTIVES

The course aims to

- analyse applications of heat and mass transfer principles.
- enable students to develop models for optimization of process conditions for different food applications

LIST OF EXPERIMENTS

1. Determination of engineering properties of foods - density, particle size, porosity, colour, texture, viscosity, specific heat, freezing point depression.
2. Separation of immiscible phase using appropriate centrifuge, fractional distillation of multi component mixtures
3. Determination of particle size index of powdered food materials
4. Study of pneumatic conveyers using fluidized solids
5. Determination of freezing curves for selected fresh fruits and vegetables
6. Convective heat transfer through IR radiation and its effect on baking of food products.
7. Construction of weibull diffusion model for diffusion of water out of food samples during osmosis.
8. Thermo bacteriology – calculation of D, Z and F value in retort and process time calculation
9. Study of ultra-filtration/membrane and reverse osmosis separation process
10. Construction of transport model for ultrafiltration of milk solids from milk.
11. Performance evaluation of rapid extraction (filtration) for different particle size of fruits.
12. Construction of mathematical models for low pressure superheated steam drying of food products.
13. Canning and bottling of food products for commercial sterility.
14. Optimization of process conditions for drying of food products in fluidized bed dryers, spray dryer.
15. Texture and Colour Measurement of foods

TOTAL: 60 PERIODS

TEXTBOOKS/ REFERENCES

1. GustavoV. Barbosa-Canovas, Food Engineering Laboratory Manual, 2017, Technomic Publishing company Inc.
2. Shri K. Sharma, Steven J. Mulvaney, Syed S. H. Rizvi, Food Process Engineering: Theory and Laboratory LIST OF EXPERIMENTS, 1999, Wiley
3. Syed S.H. Rizvi, Gauri S. Mittal, Experimental Methods in Food Engineering, 1992, Springer

OUTCOMES

At the end of the course the students will be able to

CO1 understand heat, mass and momentum transfer analysis.
CO2 validation of a thermal process
CO3 analyze industrial problems along with appropriate approximations and boundary conditions

Accessed

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course Outcome Statement		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Heat, mass and momentum transfer analysis.	3	3	3	3	3	-	-	1	3	-	1	2
CO2	validation of a thermal process	3	3	3	3	3	-	-	1	3	-	1	2
CO3	analyze industrial problems along with appropriate approximations and boundary conditions	3	3	3	3	3	-	-	1	3	-	1	2
Overall CO		3	3	3	3	3	-	-	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER II

FD5201	**ADVANCES IN FOOD PACKAGING SYSTEM**	**L T P C** **2 1 0 3**

OBJECTIVES

The course aims to

- educate and equip students with latest food packaging technologies for adoption in food industry
- facilitate students to have in-depth knowledge in design and development of packaging systems for various categories of food products.

UNIT I PACKAGING SYSTEMS AND METHODS 11

Bag – in - box; Microwave packaging; Retort pouch technology, Active packaging; Intelligent packaging, Antimicrobial packaging; Bio-degradable packages, Non-migratory bioactive polymers (NMBP)in food packaging - types and applications; Suitability and new material selection, material characterization, Recent trends, Application of nanotechnology in laminates, composite and coatings; coating for enhancing packaging properties, Edible packages; bacterial production of polymer, Packaging-flavour interactions, Factors affecting flavour absorption, Role of the food matrix and different packaging materials, Effect of irradiation of polymeric packaging material on the formation of volatile compounds, Protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture,. Case studies: Packaging and lipid oxidation, Modelling lipid oxidation and absorption Shelf life evaluation of packaged food, package characterization and testing; Time - temperature indicators (TTIs), Defining and classifying TTIs, Requirements for TTIs, The development of TTIs, Current TTI systems, Maximizing the effectiveness of TTIs, Using TTIs to monitor shelf - life during distribution, Using TTIs to optimize distribution and stock rotation. retail packs, transport packages and ancillary packaging materials, gas concentration indicators,

UNIT II PACKAGING EQUIPMENT 8

Container cleaning – Air blast, Ionized air blast, Water rinse, Wash and Rinse. Aggressive wash and rinse, Sterilization, Bottle orienting systems. Filling Equipment and method - solid, liquid, semi - solid food - types of fillers - filler for glass bottle, paper bottle, pouches, plastic cup thermoforming equipment; form – fill - seal equipment, sealing equipment, labelling, capping, canning and cartoning equipment. Industrial packaging: unitizing – Shrink and Stretch Wrapping, palletizing, containerizing, Rigid and semi - rigid containers; Thermoformed packages – skin packaging and Blister Packaging; Flexible containers; form – fill - seal systems.

UNIT III INTRODUCTION TO FOOD PACKAGING DESIGN 8

Information required before designing a package for food product: Product, Targeted consumers, marketing a product, branding requirements, style of packaging, budget – Steps in designing of food packaging: Nature of products, Understanding the protection that is needed for food, Packaging material requirement and different layers of packaging, Choosing the right type of packaging material and package type, Package line development, packaging line engineering, Creating information architecture for printing, Evaluation of packaging design, Reuse of containers ; Child resistant package - design of security features, Barcodes, RFID Vision/inspection, Metal detectors and x-ray inspectors, Smart tracking systems, Case study

UNIT IV STRUCTURAL AND GRAPHIC DESIGN IN FOOD PACKAGING 8

Package Design Evaluation – ocular tests, questionnaires, Role of Structure, Structural Design – folding cartons, cans, glass containers, plastic containers, bags and pouches, Importance of the packaging structure in containment and protection of food products, Optimization of food packaging structure and performance, Graphic design: Typography, Color, Illustration, Marketing Studies, Package Aesthetics, Decoration Aspects, Layout and Feature Selection – Customer attraction, Interaction, Interface and Feedback, Life cycle Assessment, Legal issues, Recent trends. Closure design: Function, Types, Selection considerations, Closure dimensioning, Metal closures, Closure seals, Plastic closures, Injection moulds and Closure design, Tamper evident closures, Child resistant closures. Special closures and functions

Attested

UNIT V PACKAGING OF FRESH AND PROCESSED FOOD 10

Food packaging laws and regulation, food labelling, Packaging requirements for different foods and processing methods - General classification and packaging types, varieties and trends; packaging of convenience foods; Packaging of Food products – Fresh Fruits and vegetables, Packaging of Fruit juices, Packaging of Jams and Jellies, Packaging of Pickles and Chutneys, Packaging of Fats and Edible oils, Packaging of Break - fast cereals, Packaging of Tea, Coffee & other Beverage products; Packaging of Soft Drinks; Packaging of Bakery products - Bread, Biscuits & Cakes; Packaging of Snack foods; Packaging of Ready - cook products; Packaging of Spices, Condiments, Oleoresins; Packaging of Meat and Poultry Products; Packaging of Fish and other Sea - foods; Packaging of Dairy Products ; Packaging requirements for Thermal -processed, Dehydrated, Frozen, Irradiated and other specially processed foods - Packaging for Defence food, space food, high energy food for high altitude, functional foods, Recent trends and advancements in food packaging.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 develop the knowledge of students in the area of food packaging designs and the technologies used in packaging design.

CO2 equip with latest food packaging technologies for adoption in food industry.

CO3 gain knowledge on Hazards and toxicity associated with packaging materials and laws, regulations and the monitoring agencies involved food safety, labelling of foods

TEXT BOOKS/REFERENCES

1. Robertson, G.L. “Food Packaging: Principles and Practice” (2nd Edition), Taylor & Francis, 2006.
2. Ahvenainen, R (Ed.) “Novel Food Packaging Techniques”, CRC Press, 2003.
3. Mathlouthi, M. “Food Packaging and Preservation”, Aspen Publisher 2013.
4. Han, J.H. (Ed.) “Innovations in Food Packaging”, Elsevier /Academic Press, 2013.
5. Douglas Riccardi, “Food Packaging Design”, Design Media Publishing Limited, 2015.
6. Marianne R. Klimchuk and Sandra A. Krasovec, “Packaging Design: Successful Product Branding from Concept to Shelf”, Wiley, 2006.
7. Walter Soroka, “Fundamentals of packaging technology”, 3rd Edition, Institute of packaging professionals, Naperville, Illinois, USA, 2002.

Course Articulation Matrix

Course Outcome Statement		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Develop the knowledge of students in the area of food packaging designs and the technologies used in packaging design.	3	2	3	2	3	1	3	2	3	-	3	3
CO2	equip with latest food packaging technologies for adoption in food industry.	2	2	3	1	3	1	3	2	3	-	3	3
CO3	gain knowledge on Hazards and toxicity associated with packaging materials and laws, regulations and the monitoring agencies involved food safety, labelling of foods	1	3	2	2	3	1	3	2	3	-	3	2
Overall CO		2	2	2	2	3	1	3	2	3	-	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5202 EMERGING FOOD PROCESSING TECHNIQUES L T P C
3 0 0 3

OBJECTIVES

The course aims to

- familiarize students with advanced food processing techniques and its applications
- understand the effect of Novel non thermal methods on quality and safety of food products

UNIT I PRESSURE AND HEAT TREATMENT 9

Non thermal technologies in preservation of foods – necessity and advantages – Status and trends of Non thermal technologies in preservation of foods - High pressure treatment of food – Governing Principles – Process equipment, processing and effect on microorganisms - Combined Pressure-Heat treatment on Quality Attributes of Foods

UNIT II ULTRASOUND, LIGHT AND MICROWAVE 9

Ultrasound – Principle of operation – mechanism of inactivation of microorganisms and enzymes– UV light and pulsed light preservation – Principles of operation – microbial inactivation mechanism, Microwave Technology- principle – application – sterilization, tempering, drying, puffing, coagulation and other processing applications.

UNIT III PEF AND OHMIC HEATING 9

Pulsed Electric Field – Principles of operation – Equipment – processing - control parameters – Microbial Inactivation Mechanism – Effects on Fluid food nutritional and Quality parameters, Ohmic Heating – Principle – Equipment – Effect on Food quality and microbes inactivation.

UNIT IV MAGNETIC FIELD AND RADIATION PROCESSING 9

Introduction to irradiation technologies – general mode of action – Equipment and operational parameters – Food safety and shelf life of irradiated liquid foods - Oscillating Magnetic Fields-Magnetic files- Generation – Mechanisms- Inactivation of Microorganisms – Magnetic fields in food preservation, Infra-red – Mechanism of IR absorption by food – IR emitters and spectral bands – applications.

UNIT V OZONE, COLD PLASMA AND RF PROCESSING 9

Generation of ozone – batch and continuous process of Ozone for inactivation – Factors affecting efficacy of ozone processing – Effect on food quality –Methods of generation of cold plasma – Control parameters – batch and continuous method of cold plasma treatment for decontamination. Radiowave Frequency – principle – factors influencing RF heating process – applications

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand different non thermal processing of food and its application in food processing

CO2 familiarize students with Novel non thermal methods for sterilization of food

CO3 understand the effect of Novel non thermal methods on quality and safety of food products

TEXTBOOKS/REFERENCES

1. Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW1 7BY, UK. 2012.
2. Gustavo V. Barbosa-Cánovas, María S. Tapia and M. Pilar Cano, Novel Food Processing Technologies, CRC Press. ISBN: 0-8247-5333-X. 2005.
3. Sun, D. Emerging Technologies for Food Processing, Academic Press, 2005.
4. Ohlsson, T. and Bengtsson, N. Minimal Processing technologies in the food industry, Woodhead Publishing Limited, 2002.

5. Ioannis S. Boziaris, Novel Food Preservation and Microbial Assessment Techniques, CRC Press. 2014.
6. Gaurav Tewari and Vijay K. Juneja, Advances in Thermal and Non-Thermal Food Preservation, Blackwell Publishing. 2007.
7. Gustava C Barbosa-Canovas, Q Howard Zhang, Pulsed Electric Fields in Food Processing Lancaster Pa: Technomic Publishing Co. ISBN 1566767830. 1999.
8. Gustavo V. Barbosa- Canovas, Usha R. Pothakamury, Enrique Palou and Barry G. Swanson. Nonthermal Preservation of Foods. Marcel Dekker Inc. New York. 1998.

Course Articulation Matrix

Course Outcome Statement		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand different non thermal processing of food and its application in food processing	3	2	2	2	3	-	1	1	3	-	1	2
CO2	familiarize students with Novel non thermal methods for sterilization of food	3	1	1	2	2	-	-	1	3	-	1	2
CO3	understand the effect of Novel non thermal methods on quality and safety of food products	1	2	1	2	3	-	-	1	3	-	1	2
Overall CO		**2**	**2**	**2**	**2**	**2**	**-**	**-**	**1**	**3**	**-**	**1**	**2**

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5203 NON-DESTRUCTIVE QUALITY EVALUATION OF FOODS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- familiarize and train the students in non-destructive quality evaluation methods and its applications in food processing.
- enable students to relate the physical characteristics of food constituents at molecular and functional level to that of the product characteristics

UNIT I COLOUR AND MORPHOLOGY 9

Non-destructive quality evaluation methods – Machine vision system- Food image formation - acquisition –analysis-interpretation – enhancement – Determination of size, shape and color of food products - gray and color image processing of food –Morphological Image processing – Applications, Colour analysis: optical aspects, CIE colour system, Tristimulus color system, Abridged methods.

UNIT II X-RAY IMAGING TECHNIQUES 9

Soft X-ray systems –principles and methods of soft X-ray generation - image formation – detection and recording of X-ray image of food products– processing area - analysis techniques –Determination of internal defects in fruits and vegetables.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT III ACOUSTIC SYSTEM 9

Fundamentals of acoustic resonance system – Acoustics properties – measurement of acoustic resonance – impact device – Sound capturing device – amplifiers - attenuation coefficient - Digital signal analyzer – Determination of maturity level of fruits and vegetables - Application in fruit quality evaluation.

UNIT IV THERMAL IMAGING 9

Thermal imaging – NIR hyper spectral imaging – FTIR - operation and components - generation of image – acquisition - interpretation - Determination of internal defects and quality evaluation in food grains.

UNIT V THERMAL AND FOOD MICROSTRUCTURE ANALYSIS 9

Thermal analysis: food structure basics (amorphous, crystalline), principle and methods of analysis – TGA, DSC, modulated DSC – applications. **Food Microstructure Techniques**: Scanning and Transmission electron microscopes, Atomic force microscope, Nuclear magnetic resonance and its types – X – ray diffraction, X – ray diffraction Fluorescence analysis and its types – Structural analysis of macromolecules such as carbohydrates, proteins, and lipids – Structural analysis of micro molecular bio chemicals.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 develop the knowledge of students in the area of quality evaluation through machine vision system and sound capturing device

CO2 familiarize students with molecular mechanisms that underlie the macroscopic behaviour of foods

CO3 familiarize students with molecular mechanisms that underlie the macroscopic behaviour of foods

TEXTBOOKS/REFERENCES

1. Chris Solomon and Toby Breckon, Fundamentals of Digital Image Processing - A Practical Approach with Examples in Matlab, Wiley-Blackwell, ISBN-13: 978-0470844731.
2. David Attwood, Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications, Cambridge University Press, 1999, ISBN-13: 978-0-521-65214-6.
3. Hans Grahn, Paul Geladi, Techniques and Applications of Hyperspectral Image Analysis, Wiley-Vch, ISBN 978-0-470-01086-0.2007.
4. Michael Vollmer, Klaus-Peter Mollmann, Infrared Thermal Imaging: Fundamentals, Research and Applications, Wiley-Vch, ISBN:978-3-527-40717-0.2010.
5. Siegfried Stapf, Song-I Han, NMR Imaging in Chemical Engineering, Wiley-Vch, ISBN-13: 978-3-527-31234-4.2006.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course Outcome Statements		Programme Outcome (PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	develop the knowledge of students in the area of quality evaluation through machine vision system and sound capturing device	2	2	3	2	3	-	1	2	3	-	1	2
CO2	enable students to relate the physical characteristics of food constituents at molecular and functional level to that of the product characteristics	2	2	2	3	3	-	-	1	3	-	1	2
CO3	familiarize students with molecular mechanisms that underlie the macroscopic behaviour of foods	2	2	2	3	3	-	-	1	3	-	1	2
Over all CO		2	2	2	2	3	-	-	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5211 FOOD PROCESSING TECHNIQUES LABORATORY L T P C
0 0 4 2

OBJECTIVES

The course aims to

- improve knowledge of students in novel food processing techniques.
- analyse the advanced food processing techniques involved in food preservation.

LIST OF EXPERIMENTS

1. Determining effect of combined heat and pressure treatment in food using High Pressure processor
2. a) Sonication treatment of grains b) Thermo sonication of fluid foods
3. Ultra violet treatment of leafy vegetables
4. Microwave sterilization of food
5. Pulsed light processing of food
6. Batch and continuous Ozone processing for microbial inactivation
7. Cold plasma treatment of fruits and leafy vegetables
8. High Intensity Pulsed Electric Field Techniques
9. Application of light pulses in the sterilization of foods and packaging materials
10. Ohmic heating of fluid food.
11. Effect of irradiation on food products
12. Effect of oscillating magnetic field on microbial inactivation.
13. RF treatment of food products
14. Puffing and flaking of food.

TOTAL:60 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 understand different non thermal processing of food and its application in food processing

CO2 familiarize students with various methods for sterilization of food

CO3 understand the effect of Novel methods on quality and safety of food products

TEXTBOOKS/REFERENCES

1. Chris Solomon and Toby Breckon, Fundamentals of Digital Image Processing - A Practical Approach with Examples in Matlab, Wiley-Blackwell, ISBN-13: 978-0470844731.
2. David Attwood, Soft X-Rays and Extreme Ultraviolet Radiation: Principles and Applications, Cambridge University Press, 1999, ISBN-13: 978-0-521-65214-6.
3. Cullen, P.J., Tiwari, B.K. and Valdramidis V.P. Novel thermal and non-thermal technologies for fluid foods. Academic press, 32 Jamestown Road, London NW1 7BY, UK. 2012

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand different non thermal processing of food and its application in food processing	3	2	2	2	3	-	1	1	3	-	1	2
CO2	familiarize students with various methods for sterilization of food	3	1	1	2	2	-	-	1	3	-	1	2
CO3	understand the effect of Novel methods on quality and safety of food products	1	2	1	2	3	-	-	1	3	-	1	2
Over all CO		2	2	2	2	2	--	-	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5212 **FOOD PACKAGING SYSTEMS LABORATORY** **L T P C**
0 0 4 2

OBJECTIVES

The course aims to

- facilitate students to have in-depth knowledge in design and development of packaging systems for various categories of food products.
- educate and equip students with latest food packaging technologies for adoption in food industry

LIST OF EXPERIMENTS

1. Design of cans for packaging of food product and analyzing its effect on product.
2. Multilayer packaging system development for food products.
3. a) Design of package for modified atmospheric storage of any fruits or vegetables. b) To study textural characteristics of selected fruit/ vegetable under MAP storage
4. Testing of chemical resistance of various packaging materials
5. Development of oxygen scavenger systems for food products
6. Application of anti-microbial packaging for moisture sensitive foods
7. Evaluation of chemical residue migration from package to food
8. Study of time temperature indicators
9. Determination of oxidative changes in packaged foods
10. Comparative evaluation of flexible and rigid packages for fragile foods
11. Case studies on Shelf life evaluation of packaged food product.
12. Study of aseptic packaging system
13. Determination of oil and grease resistant test for packaging films
14. Determination of respiration rate in fresh fruits and vegetables

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 develop food packaging designs and the technologies used in packaging design. **CO2** gain knowledge on latest food packaging technologies for adoption in food industry. **CO3** understand hazards and toxicity associated with packaging materials and laws, regulations and the monitoring agencies involved food safety, labelling of foods

TEXT BOOKS/REFERENCES

1. Robertson, G.L. “Food Packaging: Principles and Practice” (2nd Edition), Taylor & Francis, 2006.
2. Ahvenainen, R (Ed.) “Novel Food Packaging Techniques”, CRC Press, 2003.
3. Mathlouthi, M. “Food Packaging and Preservation”, Aspen Publisher 2013.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	To develop the knowledge of students in the area of food packaging designs and the technologies used in packaging design.	3	2	3	2	3	1	3	2	3	-	3	3
CO2	Educate and equip students with latest food packaging technologies for adoption in food industry.	2	2	3	1	3	1	3	2	3	-	3	3
CO3	Students gain knowledge on Hazards and toxicity associated with packaging materials and laws, regulations and the monitoring agencies involved food safety, labelling of foods	1	3	2	2	3	1	3	2	3	-	3	2
Over all CO		2	2	2	2	3	1	3	2	3	-	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER III

FD5311	**FOOD STORAGE ENGINEERING LABORATORY**	**L T P C** **0 0 4 2**

OBJECTIVES

The course aims to

- acquaint and equip the students with in-depth knowledge on safe storage of food materials.
- analyse the effect of various storage Structures for various categories of food products.

LIST OF EXPERIMENTS

1. Physical and thermal properties of grain
2. Grain drying and pressure drop studies
3. Effect of humidity and temperature of storage on the quality of rice.
4. Design of packaging for storage of grains and effect of different packaging material on quality of grains.
5. Estimation of energy requirement and optimization for sieving of different grains to remove extraneous matters without affecting the grain structure.
6. Study on the effect of oxygen, nitrogen and carbon dioxide on the storage of fruits and vegetables.
7. Effect of moisture content, water activity, and environmental conditions on the storage shelf life of fruits and vegetables.
8. Study the effect of rapid and gradual cooling on food products in walk-in cold storage system.
9. Storage of food products in different refrigerated temperatures to study its effect on microbial load.
10. Calculate the amount of energy required to freeze 1 kg of mango to 0, -5, -10, -15 and -20 ºC.
11. Effect of freezing and thawing cycle on the physical, chemical and microbial nature of food products in blast freezer.
12. Evaluate the effect of refrigeration and freezing on the cooked and uncooked food products. Calculate the energy requirement for both samples and also analyze the efficiency of the given process. Microscopic structural analysis of food products.
13. Study on effect of moisture content of the food product on the cooling and freezing load through the batch freezing system.
14. Effect of retail packaging materials on the efficiency of refrigeration and freezing of food products. Correlate the insulating nature of packaging materials with the energy requirement for freezing and refrigeration.
15. Calculate the heat dissipated during respiration of fruits and vegetables, to optimize the necessary energy requirement for refrigeration in batch system for 24hr in batch storage conditions.
16. Study on the effect of air and water as a cooling medium for food products.
17. Effect of liquid nitrogen freezing on fruits and vegetables.
18. Evaluate the effect of storage structures and stacking on the refrigeration and freezing of food products in walk-in storage container.

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 provide knowledge about trends and development of storage technologies aiming at assuring the safety and quality of food.

CO2 understand design, construction, operation, control and maintenance of commercial refrigeration systems and cold storages

CO3 acquire cutting edge knowledge on the food storage design.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

TEXTBOOKS/REFERENCES

1. Chakravarty, Post-Harvest Technology of Cereals, Pulse and Oilseeds. IBH Publ. Mahajan and Goswami. Food and Process Engineering. 2005.
2. Ojha TP and Michael AM. Principles of Agricultural Engineering. Jain Brothers. 2010.
3. Osling, T. G. Applied Air conditioning and refrigeration. Applied Science Publishers Ltd. London. 1980.
4. Holowell, E.R., Cold Storage and Freezer Storage Manual, AVI Pub. Co. 1980.
5. A.Ciobanu,. and G.Lasku, V. Bersescu, Cooling Technology in the Food Industry, Abacus Press, 1976.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	provide knowledge about selected trends and development storage technologies aiming at assuring the safety and quality of food.	3	3	1	1	3	1	-	2	2	-	-	2
CO2	impart knowledge of design, construction, operation, control and maintenance of commercial refrigeration systems and cold storages	3	2	3	1	3	1	1	2	2	-	2	2
CO3	acquire cutting edge knowledge on the food storage design.	3	3	3	1	3	1	1	1	2	-	2	2
Over all CO		3	2	2	1	3	1	1	1	2	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5312 FOOD ANALYTICAL TECHNIQUES LABORATORY L T P C
0 0 4 2

OBJECTIVES

The course aims to

- analyse food products and its ingredients.
- utilize advanced instrumentation techniques for in depth understanding of macro and micro molecules in food.

LIST OF EXPERIMENTS

1. Determining the Degree of Methylation and Acetylation of Pectin.
2. Determination of Neutral Sugars by Gas Chromatography of Their Alditol Acetates.
3. HPLC of Mon- and Disaccharides Using Refractive Index Detection.
4. Infrared Spectroscopic Determination of Total Trans Fatty Acids.
5. Polarographic and Spectrophotometric Assay of Diphenol Oxidases (Polyphenol Oxidase).
6. Analysis, separation, identification and quantification of carbohydrates & amino acids of proteins through LC-MS.
7. Analysis, separation, identification and quantification of flavours through GC-MS.
8. Structural elucidation of proteins through MALDI-TOF and XRD.
9. Flavour and Taste analysis of food products through Electronic nose and Electronic tongue.
10. Identification and estimation of minerals present in food products through ICP-OES and AAS.

11. Identification and quantification of pesticide residues in food ingredients and products through LC-QTOF.
12. Determination of absorbed oil content in fried foods and Monitoring the primary and secondary oxidative rancidity in oils.
13. Identification of heavy metals from food.
14. List of experiments on external and internal quality parameters of eggs.
15. Determination of Caffeine/sugars/benzoic acid in Beverages by HPLC.
16. Viscosity Measurement Using a Brookfield Viscometer.
17. Identification and Analysis of flavouring compound of ginger by gas chromatography system
18. Determination of Solid Fat Content by Nuclear Magnetic Resonance

TOTAL: 60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 describe and use advanced analytical methods used for quantifying the composition and reactions of food components

CO2 Interpret and report data derived from analysis in a meaningful way

CO3 Choose appropriate analytical techniques for foods

CO4 Know when and how to use a technique in a food processing environment such as QA &QC

TEXT BOOKS/REFERENCES

1. Wrolstad, R. “Handbook of Food Analytical Chemistry”. John Wiley Sons, 2005.
2. Adriana S. Franca, Leo M.L. Nollet. “Spectroscopic Methods in Food Analysis”. 1st Edition, CRC Press, Taylor and Francis group, 2017.
3. Semih Otles. “Handbook of Food Analysis Instruments”. 1st Edition, CRC Press, Taylor andFrancis group, 2008.
4. Semih Otles. “Methods of Analysis of Food Components and Additives”. 2nd Edition, CRC Press, Taylor and Francis group, 2011.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Describe and use advanced analytical methods used for quantifying the composition and reactions of food components	2	3	3	3	3	2	-	2	3	-	-	3
CO2	Interpret and report data derived from analysis in a meaningful way	2	3	3	3	3	2	-	3	3	-	-	3
CO3	Choose appropriate analytical techniques for foods	2	3	3	3	3	2	-	2	3	-	-	3
CO4	Know when and how to use a technique in a food processing environment such as QA &QC	-	3	3	3	3	2	-	3	3	-	-	3
Over all CO		2	3	3	3	3	2	-	2	3	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5313 **INTERNSHIP / TRAINING**

(4 WEEKS DURING II SEMESTER - SUMMER) **L T P C**
0 0 0 2

OBJECTIVES

The course aims to

- encourage the students to get connected with any industry/organization
- acquire knowledge on solving practical problems, gaining work experience and skills.

The students individually undergo training in reputed Food companies for the specified duration. At the end of the training, a report on the work will be prepared and presented by the student. Students will be evaluated through a viva-voce examination by a team of internal staff.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	The students will be trained in their employability skills	1	3	3	-	3	3	3	2	3	2	-	3
CO2	The Students will gain the problem solving ability	1	3	3	-	3	3	3	2	3	2	-	3
CO3	Their presentations skills will also be improved and they secure hands on experience	1	3	3	-	3	3	3	2	3	2	-	3
Over all CO		2	1	3	3	-	3	3	3	2	3	2	-

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5314 **PROJECT PHASE I** **L T P C**
0 0 12 6

OBJECTIVE

The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution.

COURSE CONTENT

Students should identify one project that can be carried out in two phases either in-house or in industry or research institutes. When working outside, an internal guide from the department will monitor and review progress of work.

OUTCOMES:

At the end of the course the students will be able to

CO1 develop employability skills
CO2 improve problem solving ability
CO3 improve presentations skills and secure hands on experience

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	The students will be trained in their employability skills	2	3	2	3	2	1	-	2	2	2	1	1
CO2	The students will gain the problem solving ability	2	3	3	3	2	1	-	2	2	2	1	1
CO3	Their presentations skills will also be improved and they secure hands on experience	2	3	2	2	2	1	-	2	2	2	1	1
Over all CO		2	3	2	2	2	1	-	2	2	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

SEMESTER IV

FD5411 **PROJECT PHASE II** **L T P C**
0 0 30 15

OBJECTIVE

The project work aims to train the students on systematic analysis of a problem and to enable them to bring out a solution.

COURSE CONTENT

Students should extend their projects based on the preliminary research work during phase I. When working outside, an internal guide from the department will monitor and review progress of work.

OUTCOMES:

At the end of the course the students will be able to

CO1 develop employability skills
CO2 improve problem solving ability
CO3 improve presentations skills and secure hands on experience

Course Articulation Matrix

Course outcome Statement		**Programme outcome(PO)**											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	The students will be trained in their employability skills	2	3	2	3	2	1	-	2	2	2	1	1
CO2	The Students will gain the problem solving ability	2	3	3	3	2	1	-	2	2	2	1	1
CO3	Their presentations skills will also be improved and they secure hands on experience	2	3	2	2	2	1	-	2	2	2	1	1
Over all CO		2	3	2	2	2	1	-	2	2	2	1	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

PROFESSIONAL ELECTIVES (PEC)

FD5001 INDUSTRIAL FOOD ADDITIVES L T P C
3 0 0 3

OBJECTIVES

The course aims to

- expose the students to different additives and their effect in food
- expose the students in regulation involved in the use of natural and synthetic additives.

UNIT I INTRODUCTION 9

Definitions of Food Additives, Classification and Functions, Legitimate uses of Additives in foods, Intentional & Non-Intentional additives, Indirect food additives; Difference between Additives & Adulterants, Food uses and functions in formulations; Toxicological evaluation of food additives.

UNIT II ACIDULANTS AND SWEETENERS 9

Uses & functions of: Acid, Base, Buffer systems, Salts and Chelating/Sequestering agents, Masticatory substances. Low calorie and non-nutritive sweeteners, Polyols.

UNIT III ANTIOXIDANTS & STABILIZING AGENTS 9

Antioxidants, Emulsifying and stabilizing agents, Anti-caking agents, Thickeners, Firming agents. Flour bleaching agents and Bread improvers.

UNIT IV ANTIMICROBIALS, CLARIFYING AGENTS AND PROPOELLANTS 9

Anti- microbial agents / Class I and Class II preservatives, Clarifying agents. Gases and Propellants. Tracers and other additives.

UNITV COLORANTS AND FLAVOURS 9

Flavours (synthetic and natural) Types of flavours, Flavours generated during processing – reaction flavours, Stability of flavours during food processing, flavour emulsions; essential oils and oleoresins.

Food colorants- FSSAI permitted Natural and synthetic food colors, Shades imparted, Stability during processing and applications.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand principles of chemical preservation of foods

CO2 understand role of different food additives in the processing of different foods and their specific functions in improving the shelf life, quality, texture and other physical and sensory characteristics of foods

CO3 familiarise regulations and the monitoring agencies involved in controlling the safer use of additives in foods

TEXTBOOKS/REFERENCES

1. Branen AL, Davidson PM & Salminen S. “Food Additives”., 2nd Ed., Marcel Dekker., 2001
2. Gerorge AB. “Encyclopedia of Food and Color Additives”., Vol. III.CRC Press., 1996
3. Gerorge AB. “Fenaroli’s Handbook of Flavour Ingredients”., 5th Ed., CRC Press., 2004.
4. Morton ID & Macleod AJ. “Food Flavours”., Part A, B, C., Elsevier., 1990
5. Stephen AM. “Food Polysaccharides and Their Applications”., Marcel Dekker., 2006.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand the principles of chemical preservation of foods	1	2	2	1	1	1	1	1	3	-	-	1
CO2	understand the role of different food additives in the processing of different foods and their specific functions in improving the shelf life, quality, texture and other physical and sensory characteristics of foods	1	2	2	1	1	1	1	1	3	-	-	1
CO3	know the regulations and the monitoring agencies involved in controlling the safer use of additives in foods	1	2	2	1	1	1	1	1	3	-	-	1
Over all CO		1	2	2	1	1	1	1	1	3	-	-	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5002 ENGINEERING PROPERTIES OF FOODS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- acquaint and equip the students with different techniques of measurement of engineering properties.
- make the students understand the nature of food constituents in the design of processing equipment

UNIT I SURFACE AND GAS EXCHANGE PROPERTIES 9

Importance and applications in the crop processing design - factors affecting the properties - physical characteristics - determination – apparatus. Aero dynamics of agricultural products - drag coefficients - terminal velocity - pressure drop in packed beds.

Surface Properties - Gibbs Adsorption Equation, Contact Angle, Critical Surface Tension, Polar and Dispersive Contributions to Surface Energy, Effects of Adsorbed Layer Composition and Structure on Interfacial Energy, Measurement Techniques - Contact Angle, Liquid Surface Tension, γ_L^d and γ_S^d

Gas Exchange Properties - Respiration and Fermentation Models, Gas Transport Properties, Measurement Techniques - O2 and CO2 Concentration, heat of respiration, Skin Resistance and Gas Diffusion Properties, Gas Exchange Data for Selected Fruits and Vegetables.

UNIT II ELECTRICAL AND COLORIMETRIC PROPERTIES 9

Electrical properties – Relations between Electrical Conductivity and Other Transport Properties, Effect of Microstructure, Temperature, Electric Field Strength, Ingredients for Solid Foods, Solid–Liquid Mixtures - Models for Effective Electrical Conductivity, Effects of Solids in Tube Flow, Methods of Measurement, effect of moisture content on electrical properties optical properties-transmittance-reflectance-image processing.

Dielectric Properties - Measurement Principles, Frequency and Temperature Dependence - Dielectric Properties below Freezing and above Boiling Temperatures, Temperature Dependence of Loss Factor and Runaway Heating, Composition Dependence – effect on food, Assessment of Food Quality.

Colorimetric Properties: Measurement of Color, Specialized Colorimeters, Research and Quality Control Approaches, Color Tolerances, Development of Instruments.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT III THERMAL PROPERTIES 9

Unfrozen Foods - Importance on Quality and Safety of Foods, Modeling and Optimization of Processes, Sources of Data on Thermal Properties, Computerized and On-Line Databases, Software for Predicting Thermal Properties of Foods, Density, Specific Heat - Predictive Equations, Influence of Structure of Food, Measurement Methods, Other Properties Relevant to Thermal Processing of Foods - Compressibility and Thermal Expansion, Glass Transitions, Sorption and Hydration Properties, thermal diffusivity – determination – effect of moisture content and temperature on thermal properties – differential scanning calorimetry (DSC)

Frozen Foods - Experimental Approaches, Initial Freezing Point and Unfrozen Water, Density, Thermal Conductivity, Enthalpy, Specific Heat, Thermal Diffusivity - Modeling of the Thermal Properties of Frozen Foods, Prediction of Unfrozen Water During Freezing of Foods, Limitations of Predictive Models

UNIT IV RHEOLOGY OF FOOD PRODUCTS 9

Rheology: Introduction, Stress and Deformation, Elastic Solids and Newtonian Fluids, Viscometric Functions, Rheological Classification of Fluid Foods, Viscoelasticity, Effect of Temperature, Effect of Concentration on Viscosity - Combined Effect Temperature – Concentration, Mechanical Models - Hooke's Model, Newton's Model, Kelvin's Model Maxwell's Model, Saint-Venant's Model, Mechanical Model of Bingham's Body

Semiliquid Foods: Fundamental Methods - Rotational Viscometers Oscillating Flow, Capillary Flow, Back Extrusion Viscometry, Squeezing Flow Viscometry, Empirical methods - Adams Consistometer, Bostwick Consistometer, Tube Flow Viscometer, Imitative Methods, Obtaining the Rheological Parameters - Capillary Viscometer, Concentric Cylinder Viscometer, applied Problems.

Texture of food materials - methods – subjective and objective methods - initiative and empirical tests - dynamic test for food texture evaluation, mechanical damage and maximum allowable load for agricultural products.

UNIT V PROPERTIES OF FOOD POWDERS 9

Physical Properties - Density and Porosity, Particle Shape, Strength Properties - Hardness and Abrasiveness, Friability and Attrition, Compression Properties of Food Powders, Compression Methods, Compression Mechanisms during Uniaxial Compression Tests, Surface Area, **Chemical and Physicochemical Properties** - Instant Properties and Evaluation, Stickiness in Food Powders – Bridging, Thermodynamic Adsorption, Cohesion and Cohesion Properties, Test Methods, Water Activity and Glass Transition Temperature - Application of Compression in Foods, Research Update in Food Powder Properties.

Food structuring: traditional food structuring and texture improvement, approaches to food structuring, extrusion and spinning, structuring fat products, structure and stability, gels, gelation mechanisms, mixed gels, the microstructure of gels, structure-property relations in gels.

Examining food microstructures: history of food microstructure studies, light microscopy, transmission electron microscopy, scanning electron microscopy, other instrumentation and techniques, image analysis: image acquisition, image processing, measurement analysis.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand the importance of food polymers

CO2 understand the effect of various methods of processing on the structure and texture of food materials

CO3 understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

TEXTBOOKS/REFERENCES

1. Jowitt Ronal, Felix Escher, Bengt Hallsrram, Hans F. T. Meffert, Walter E.C. Spices, Gilbert Vox, 1983. Physical properties of foods. Applied Science Publishers, London.
2. Mohesenin. N.N. 1980. Thermal properties of Foods and Agricultural Materials. Gordon and Breach Science Publishers, New York.
3. Mohesenin. N.N.1986. Physical properties of Plant and Animal Materials. Gordon and Breach Science Publishers, New York.
4. Peleg, M. and E.B.Bagelay. Physical properties of foods. AVI publishing Co. USA. 1983.
5. Rao, M.A., S.S.H.Rizvi and A.K.Datta. Engineering properties of foods. CRC press, Taylor and Francis, London. 2005.
6. Singhal,O.P. and D.V.K. Samuel. Engineering Properties of Biological Materials. Saroj Prakasan. 2003.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	enable students to understand the importance of food polymers	2	3	3	2	3	-	-	-	3	-	1	2
CO2	enable the students to understand the effect of various methods of processing on the structure and texture of food materials	3	3	3	2	3	-	-	2	3	-	1	2
CO3	understand the interaction of food constituents with respect to thermal, electrical properties to develop new technologies for processing and preservation	3	3	3	2	3	-	-	2	3	-	1	2
Over all CO		2	3	3	2	3	-	-	2	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5003 FOOD PROCESS AUTOMATION L T P C
3 0 0 3

OBJECTIVES

The course aims to

- develop knowledge of students in the automation of processes involved in the food industry.
- familiarize in the areas of data analysis, modelling, predictive control of different processing steps in food industry.

UNIT I INTRODUCTION 9

Food quality, automated evaluation of food quality, food quality quantization and process control, typical problems in food quality evaluation eg., beef quality evaluation; food odor measurement, continuous snack food frying quality.

Data acquisition: Sampling elaboration with examples, concepts and systems for data acquisition such as: ultrasonic signal acquisition for beef grading, electronic nose data acquisition for food odor measurement, snack food frying data acquisition for quality process control, Image acquisition: elaboration with examples.

UNIT II DATA ANALYSIS 9

Data pre-processing, Static data analysis, Dynamic data analysis, Image processing: Image segmentation, Image feature extraction etc.

UNIT III MODELLING **9**

Modelling strategies: Theoretical and empirical modelling, Static and dynamic modelling, Linear statistical modelling, ANN modelling etc.

UNIT IV PREDICTION **9**

Prediction and classification, Sample classification for beef grading, examples such as, based on linear statistical and ANN models, Electronic nose data classification for food odour pattern recognition, Snack food classification for eating quality evaluation based on linear statistical and ANN models, One-step-ahead prediction

UNIT V CONTROL **9**

Process control, internal model control, Predictive control, Neuro-fuzzy PDC for snack food frying process, Systems integration: Food quality quantization systems integration, Food quality process control systems integration, Food quality quantization and process control systems development

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand fundamental of system integration for foods processing.
CO2 develop and manage automation of processes in their future industrial ventures.
CO3 acquaint with different techniques of automation in Food Processing.

TEXTBOOKS/REFERENCES

1. Doeblin, E. O. and Manik, D. N. Measurement Systems: Applications and Design, Tata McGraw Hill, 2003.
2. Kuo, B. C. Automatic Control Systems, Prentice Hall, 2002.
3. Huang, Y., Whittaker, D., and Lacey, R. E. Automation for food engineering: food quality quantization and process control, CRC Press, 2001.
4. Bhuyan, M. Measurement and control in food processing, CRC Press, 2006.
5. Zude, M. Optical Monitoring of Fresh and Processed Agricultural Crops, CRC Press, 2009.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand fundamental of system integration for foods processing.	3	3	3	2	3	-	-	1	3	-	-	1
CO2	develop and manage automation of processes in their future industrial ventures.	2	3	2	1	3	-	-	1	3	-	-	1
CO3	acquaint with different techniques of automation in Food Processing.	3	3	3	1	3	-	-	1	3	-	-	1
Over all CO		2	3	2	1	3	-	-	1	3	-	-	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5004 FOOD PROCESS MODELING AND SIMULATION L T P C
3 0 0 3

OBJECTIVES

The course aims to

- elucidate students with advanced knowledge in engineering modeling of the food processes
- inculcate students with recent trends in development and simulation of process models for prediction and scale up.

UNIT I PROCESS MODELING 9

Introduction to Process Modeling: Balance equations and rate equations, mathematical models, empirical models and linear regression, systematic modelling approach, general property balance models in food processing, analytical solutions to ordinary differential equations, Laplace transformations and numerical methods in mathematical modeling.

UNIT II TRANSPORT PHENOMENA MODELS 9

Transport Phenomena Models: Equation of continuity, equation of energy, equation of motion, ODE models in food processing, transport phenomena models involving PDE, chart solutions to unsteady state transport problem, interfacial mass transfer, and rheological modeling.

UNIT III KINETIC MODELING 9

Kinetic Modeling: Kinetics and food processing, the rate expression, temperature effects on the reaction rates, enzyme catalyzed reaction kinetics, metabolic process engineering, microbial kinetics, kinetics of microbial death, model of ideal reactors, modeling batch and continuous thermal processing operations of foods.

UNIT IV MATHEMATICAL MODELING 9

Mathematical Modeling in Food Engineering Operations Moving boundary and other transport phenomena models for processes involving phase change, unit operation models: drying, baking, frying, evaporation, distillation, extraction, crystallization.

UNIT V MODEL SOLUTION AND SIMULATION TOOLS 9

Model Solution and Simulation tools MATLAB/ SCILAB/ SIMULINK as tools for solving mathematical models and for simulation. Solution strategies for lumped parameter models and distributed parameter models. Simulation of food manufacturing processes.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 gain knowledge on development of simulation models for various food processes

CO2 understand the importance of Computer applications for perfection and automation.

CO3 familiarize students to solve the mathematical model equations using numerical technique

TEXTBOOKS/REFERENCES

1. Hangos, K. M. andCameron, I. T. ProcessModeling and Model Analysis, Academic Press, 2001.
2. Ozilgen, M. Food process modeling and control: chemical engineering applications, Gordon and Breach Science Publishers, 1998.
3. Bakalis, S., Knoerzer, K., Fryer, P.J., (eds). Modeling food processing operations. Elsevier, 2015.
4. Ozilgen, M. Handbook of food process modeling and statistical quality control: with extensive MATLAB applications. (CRC Press, 2011)
5. Das, H. Food processing operations analysis. Asian books private limited; 2005.
6. Tijskens, L.M., Hertog, M.L., Nicolaï, B.M., (eds). Food process modelling. (Woodhead Publishing; 2001)

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	understand and development of simulation models for various food processes	3	3	3	2	3	-	-	1	3	-	-	1
CO2	understand the importance of Computer applications for perfection and automation.	2	3	2	1	3	-	-	1	3	-	-	1
CO3	familiarize students to solve the mathematical model equations using numerical technique	3	3	3	1	3	-	-	1	3	-	-	1
Over all CO		2	3	2	1	3	-	-	1	3	-	-	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5005 FLAVOUR TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to

- describe manufacturing procedures used to produce the common food flavouring materials
- understand the flavour compounds involved in development of flavour
- understand the analytical techniques involved in flavour analysis
- understand mechanisms of flavour perception

UNIT I SOURCES AND TYPES OF FOOD FLAVOURS 9

Principal types of flavourings used in foods, Nature-identical flavouring substances, Artificial flavouring substances, Flavour constituents from onion, garlic, cheese, milk, meat, vegetables, fruits; Flavour constituents of wine, coffee, tea, chocolate, spices and condiments, Fragrance oil (Vanilla, Mandarin orange, Cinnamon, Lemongrass, Peppermint etc.) essential oil flavour. Basics of flavour, flavour and taste perception, smell and taste sensation, olfaction, flavour compounds, volatile flavour compounds, chemesthesis and chemesthetic responses, tactile response, Aroma compounds, flavour profile, bio-flavour and reconstituted flavour.

UNIT II FLAVOUR COMPOUNDS 9

Methods of flavour extraction, isolation, separation; Distillation, solvent extraction, enzymatic extraction, static headspace, dynamic headspace etc

Flavouring materials: natural flavouring – derivatives of spices, essential oils, oleoresins, fruits and fruit juices and concentrates. Aromatic vegetable flavours, flavours derived from processing and roasting, enzymatically derived and modified flavouring, flavours made by fermentation, pyrolysis, biotechnology role to produce flavour, production of natural flavour by microbial and enzymatic action.

Flavour intensifier/ potentiators – chemistry and technology, classifications – traditional, yeast extract, table salt as Flavour potentiators, HVP, MSG and 5'-Nucleotides – toxicity, other potentiators – umami tasting glutamate conjugates, alapyridaine, sweetness potentiators, maltol and ethyl maltol, cyclic enolones

Unit III PROCESS FLAVOURS 9

Process flavours: Effect of processing on organoleptic quality of food, flavour precursors, flavour development on cooking, microwave heating, roasting, baking, smoking, boiling, cooling, freezing, caramelization, fermentation, pathway for flavour formation via maillard

reaction, kinetics of maillard reaction and flavour formation, flavours from lipids, deep fat fried flavours, Principles and techniques of flavour encapsulation, types of encapsulation; Factors affecting stabilization of encapsulated flavour and their applications in food industry – Effect of storage, processing, transportation and environmental conditions on flavour components.

UNIT IV FLAVOUR ANALYSIS 9

Sample preparation and Aroma Isolation, methods of aroma isolation, instrumental analysis of aroma isolates – GC, GC/O, GC-MS/O, E-nose, Taste compounds – volatile and non volatile compounds, off – flavour and taints in food, sensory aspects of off-flavour testing – due to chemical change, microbes.

UNIT V FLAVOUR LEGISLATION 9

Flavour legislation, Modelling flavour release, Useful principles to predict the performance of polymeric flavour delivery systems, Delivery of flavours from food matrices, Packaging and flavour compounds interaction On-line monitoring of flavour processes, Sensory methods of flavour analysis.

TOTAL:45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 understand the various mechanisms of flavour formation and flavour release
CO2 explain metabolic routes leading to flavour formation in plants
CO3 Recognize off-flavour defects in foods and strategies of identification.

TEXTBOOKS/REFERENCES

1. Gray Reineccius, Flavour chemistry and Technology, CRC Press/Taylor & Francis, Boca Raton, 2006
2. Sources Book of Flavours, 2nd Ed. 1994, G. Reineccius, Chapman and Hall. New York, 928 pp.
3. Flavour measurents, 1993, C.T.Ho & C. Manley Ed., Marcel Dekker Inc. IFT Basic Symposium series, 379 pp.
4. Heath, H. B. Flavour chemistry and technology, Springer Netherlands, 1986.
5. Piggott, J. R., Paterson, A. Understanding Natural Flavours, Springer US, 1994.
6. Morton, I. D., Macleod A. J. Food Flavour - Introduction, Elsevier Scientific Pub. Co., 1982.
7. Yamanishi, T. Tea, coffee, cocoa, and other beverages, Recent advances in flavour researches, Marcel Dekker NY, 1981.
8. Gabelman, A. Bioprocess Production of Flavour, Fragrance, and Color Ingredients, J. Chem. Educ., ACS Publication, 1995.
9. Ashurst P. R. Food Flavourings, Springer US, 1991.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Understand mechanisms of flavour formation and flavour release	2	3	3	2	3	1	-	2	2	-	1	2
CO2	Explain metabolic routes leading to flavour formation in plants	2	3	1	1	3	-	-	2	2	-	-	2
CO3	Recognize off-flavour defects in foods and strategies of identification	2	3	3	3	3	1	-	3	2	-	1	2
Over all CO		2	3	2	2	3	1	-	2	2	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5006 **FUNCTIONAL FOODS** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to

- impart the knowledge on the importance of functional ingredients and nutraceuticals
- understand the utilization of functional ingredients in development of new food products including health foods, functional foods and specialty foods.

UNIT I IMPORTANCE OF MICRONUTRIENTS AND BIOACTIVE COMPONENTS **9**

Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks etc. Infant nutrition and dietary Formulations for meeting normal and special needs of infants, current status of infant foods, additives for infant foods. Foods for aged persons, design consideration, ingredients for geriatric foods.

UNIT II FOOD FORTIFICATION **9**

Food fortification - techniques for fortifying foods with minerals and vitamins, High protein foods prospective nutraceuticals for fortification of foods. Nutritional significance of dietary fibers, classes of dietary fibers, fortification techniques for fibers in foods.

UNIT III FOOD FOR HEALTH SIGNIFICANCE **9**

Technological aspects of reduced calorie foods, alternatives for calorie reduction, low calorie sweeteners, bulking agents and their application, fat replacers and their utilization in low calorie dairy foods. Nutritional and health significance of sodium in foods, Alternatives for sodium in foods, techniques for reducing sodium in processed dairy foods. Bio-flavours and flavour enhancers. Herbs, various classes of herbs, their therapeutic potential and application in foods, determination of bioavailability of nutrients

UNIT IV FOOD FOR DISEASE CONTROL **9**

Definition and various classes of phytochemicals, Special foods/nutrients their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc.
Special foods/nutrients for persons suffering with milk allergy and lactose intolerance with special emphasis on nutrients and foods. Sports foods – ingredients, components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition.

UNIT V CLASSIFICATION AND SAFETY **9**

Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classed of nutraceuticals and functional foods. Safety; marketing strategy and consumer response; economic analysis and costing of novel foods, recent advances in different categories and type of foods, Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and synbiotics.

TEXTBOOK: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 gain knowledge on nutraceuticals and functional foods.
CO2 learn about food fortification and its application.
CO3 understand the role of phytochemicals for disease control.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

TEXTBOOKS/REFERENCES

1. Chadwick, R. Functional Foods. Springer Publ., Berlin. 2003.
2. Desai, B. B., Handbook of Nutrition and Diet. Marcel Dekker, New York. 2000.
3. Gibson, G., and William, Cristine. Functional Foods. CRC Press, Boca Roston, Boston. 2000.
4. Goldberg I (Ed.), Functional Foods. Chapman & Hall, New York. 1994.
5. Haberstroh, Chuck E., Fat and Cholesterol Reduced Foods. Gulf Publishing Company, Huston. 1991.
6. Mazza G., 1998. Functional Foods. Biochemical and Processing aspects. Technomic Publishing Company, Basel.
7. Mitchell, J.R. and Ledward D.A. Functional properties of Food Macromolecules. Elsevier Applied Science Publishing Company, London. 1986.
8. Mitchell, H. Sweeteners and Sugar Alternatives in Food Technology. Oxford's Blackwell Publishers, Oxford. 2006.
9. Mudambi, S.R. and Rajagopla M.V. Fundamentals of Foods and Nutrition. Wiley Eastern, Delhi. 1981.
10. Nabors, Lyn O'Brien, Alternative Sweeteners. Marcel Dekker, New York. 2001.
11. Pomeranz, Y. Functional Properties of Food Components. Academic Press Publications, San Diego, USA. 1991.
12. Sadler M.J. and Saltmarch, Michael. Functional foods: The consumer, The products and the evidence. Royal Society of London. 1998.
13. Saltmarch M. (Ed.) and Butriss, Judd. Functional foods II: Claims and Evidence. Royal Society of Chemistry, London. 2000.
14. Schmidl, Mary K. and Labuza, T.P. Essentials of Functional Foods Aspen Publishers, Maryland. 2000.
15. Shi, J., Mazza, G. and Maguer M. Le. Functional foods: Biochemical and Processing aspects. CRC press. Boca roston, Boston. 2002.
16. Smith, J. Technology of reduced additives. Blackie Academic and professional, London. 1993.
17. Watson, R. R. Functional foods and Neutraceuticals in cancer prevention. Iowa State Press, Iowa. 2003.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	have knowledge of the classes of Nutraceuticals and functional food.	2	-	-	-	-	-	-	1	-	-	-	3
CO2	knowledge about food fortification and its application.	2	1	1	1	2	-	1	-	-	-	-	2
CO3	role of phytochemicals for disease control.	2	1	2	3	1	-	2	2	-	-	-	3
Over all CO		2	1	1	1	1		1	1	-	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5007 SENSORY ATTRIBUTES AND EVALUATION OF FOODS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- inculcate students with knowledge on principles and significance of the sensory perception mechanism
- understand various techniques in quality and sensory analysis of food products.

UNIT I PRINCIPLES AND SIGNIFICANCE 9

Definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects; Factors affecting food acceptance; Terminology related to sensory evaluation, test protocol considerations

Basic principles: Senses and sensory perception, physiology of sensory organs, classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses.

UNIT II FLAVOURS AND ODOUR 9

Flavour: Definition and its role in food quality; Taste: Classification, taste qualities, relative intensity, reaction time, effect of disease, temperature, and taste medium on taste, basic tastes, interaction of tastes;

Odour: Definition, classification, neutral-mechanisms, olfactory abnormalities, odor testing, techniques, thresholds, odour intensities, olfaction; Visual, auditory, tactile and other senses, vision, audition, oral perception other than taste;

UNIT III SENSORY MEASUREMENTS 9

Factors influencing sensory measurements: Attitudinal factors, motivation psychological errors in judgment, relation between stimulus and perception adaptation;

Correlation of sensory and instrumental analysis; Requirements of sensory evaluation, sampling procedures; Interrelationship between sensory properties of food products and various instrumental and physico-chemical tests

UNIT IV SENSORY QUALITY EVALUATIONS 9

Application of sensory testing: sensory evaluation in food product development, sensory evaluation in quality control. Laboratory quality measurement: Types of tests, panel selection and testing environment, serving procedures, instruction to judges, difference tests, directional difference tests, classification of difference tests, two-sample tests, three-sample tests, multisampling tests, comparison of procedures, ranking, scoring, hedonic scaling, , statistical interpretation of results, dilution procedures, descriptive sensory analysis, contour method, other procedures;

UNIT V MARKET ANALYSIS 9

Consumer measurement: Factors influencing acceptance and preference, objectives of consumer preference studies, information obtained from consumer study, factors influencing results from consumer surveys, methods of approach, development of the questionnaire, types of questionnaires, serving procedures; Comparison of laboratory panels with consumer panels; Limitations of consumer survey.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 have detailed knowledge on physiology and mechanism of human sensory perceptions.

CO2 understand sensory analysis and quality evaluations

CO3 do market analysis and evaluate customer acceptance and preferences.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

TEXTBOOKS/REFERENCES

1. Amerine, M.A., Pangborn, R.M. and Rossles, E.B. 1965. Principles of Sensory Evaluation of Food. Academic Press, London.
2. Early, R. 1995. Guide to Quality Management Systems for Food Industries. Blackie Academic.
3. Jellinek, G. 1985. Sensory Evaluation of Food - Theory and Practice. Ellis Horwood.
4. Lawless, H.T. and Klein, B.P. 1991. Sensory Science Theory and Applications in Foods. Marcel Dekker.
5. Macrae, R., Rolonson Roles and Sadlu, M.J. 1994. Encyclopedia of Food Science & Technology & Nutrition. Vol. XI. Academic Press.
6. Maslowitz, H. 2000. Applied Sensory Analysis of Foods. Vols. I, II. CRC Press, Boca Raton, FL, USA.
7. Piggot, J.R. 1984. Sensory Evaluation of Foods. Elbview Applied Science Publ.
8. Potter, N.N. and Hotchleiss, J.H. 1997. Food Science, 5th Ed. CBS Publishers, Delhi.
9. Rai, S.C. and Bhatia, V.K. 1988. Sensory Evaluation of Agricultural Products. Indian Agricultural Statistics Research Institute (ICAR), New Delhi.
10. Stone, H. and Sidel, J.L. 1985. Sensory Evaluation Practices. Academic Press, London.
11. Harry, T. Lawless, Hildegarde Heymann. 2010. Sensory Evaluation of Food: Principles and Practices, 2nd Ed., Springer, New York or Dordrecht Heidelberg, London.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	Have detailed knowledge on the physiology and mechanism of human sensory perceptions.	2	1	1	1	-	1	-	1	-	-	-	2
CO2	Improve their knowledge about sensory analysis and quality evaluations	2	1	1	1	2	-	-	1	-	-	-	2
CO3	Do market analysis and evaluate customer acceptance and preferences.	2	1	1	1	2	-	-	1	-	-	-	2
Over all CO		2	1	1	1	1	1	-	1	-	-	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5008	DAIRY PROCESS ENGINEERING	L T P C
		3 0 0 3

OBJECTIVES

The course aims to

- impart the knowledge about processes that are carried out in development of different dairy products in industry.
- familiarize Students with different techniques used in preservation of milk and milk products

UNIT I PROCESSING AND STORAGE OF MILK 9

Introduction –Composition and Physico-chemical properties of milk and milk constituents – LP system, microbiology of milk and Quality assurance. Milk reception – Cooling methods-Transportation and Storage of milks. Quality determination and grading of milk. Cleaning and disinfection of transport, storage facilities and handling equipments. Milk processing - terminologies – Process flow diagram. Pasteurization – principles and objectives – methods – sterilization – UHT processed milk products, their properties and prospects, types of UHT plants – equipments and working principles, hybrid technology for pasteurization of milk, microwave processing of milk.

UNIT II UNIT OPERATIONS AND MILK PRODUCTS 9

Cream separation – principles – gravity and centrifugal separation – equipments and working principles. Homogenization – theory - effect on milk - working principle of homogenizers - Principles and equipment for bactofugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Cleaning and sanitization - CIP cleaning - bottle fillers and cappers- form fill seal machines— aseptic filling

Recombined milk - fluid milk - standardized - toned - reconstituted milks. Special Milks - Soft curd milk – Flavoured milk - Vitaminized milk – sterilized milk - irradiated milk. Condensed milk - PFA/BIS requirements of sweetened condensed milk - standardization. Evaporated milk- manufacturing technology - defects and remedies. Fermented Milk Products – Yoghurt - Acidophilus milk - technology and microbiology. Cheese – varieties - manufacturing methods

UNIT III ENZYME AND MICROBIAL INFLUENCE IN MILK PRODUCTS 9

Microbial rennet and recombinant chymosin, characteristics and application in cheese making; exogenous free and microencapsulated enzymes, immobilized enzymes-their application in accelerated ripening of cheese; enzymatically modified cheeses (EMC) their utilization in various food formulations.

Technological requirements of modified micro-organisms for production of cheese and fermented milk products; technological innovations in the development of functional dairy foods with improved nutritional therapeutic and pro-biotic attributes; physiologically active bio-peptides/ nutraceuticals.

UNIT IV BY PRODUCTS AND ITS PROPERTIES 9

Protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, probiotic cheese and fermented Milks; bifidus factors in infant food formulations their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.

Microbial polysaccharides their properties and applications in foods, production of alcoholic beverages and industrial products from starch; whey and other by-products; bio-sweeteners types properties and their applications in dairy and food industry.

UNIT V SHELF LIFE PARAMETERS AND PRESERVATION 9

Bio-preservatives- characteristics and their application in enhancing the shelf life of dairy and food products. Practical Effect of exogenous enzymes on hydrolysis of protein and fat in culture containing milk systems; to study the various factors affecting the coagulation of milk by microbial rennets. Manufacture and evaluation of pro-biotic cheese and fermented milks; determination of glycolysis, proteolysis and lipolysis in cheese and fermented milk;

enzymatic process for manufacture of low lactose milk whey products; preparation of casein hydrolysis; visit to a bio-processing unit.
Current trends in cleaning and sanitization of dairy equipment: biological; detergents; Automation; Ultrasonic techniques in cleaning; bio-detergents, development of sanitizers-heat; chemical; radiation, mechanism of fouling and soil removal; Bio-films, assessing the effectiveness of cleaning and sanitization of dairy products.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 understand dairy products processing methods,

CO2 gain knowledge on special manufacturing processes of cream separation, Protein hydrolysates, functional dairy foods and others

CO3 have practical knowledge on analysis of milk and milk products.

TEXTBOOK/REFERENCES

1. Chirikjian Jack G. 1995. Biotechnology-Theory and Techniques, Jones and Bartlett Publishers, London.
2. Murlidhar Meghwal, Megh R. Goyal, Rupesh S. Chavan, Dairy Engineering: Advanced Technologies and Their Applications, 2017, CRC Press
3. Engineering Aspects of Milk and Dairy Products, edited by Jane Selia dos Reis Coimbra, Jose A. Teixeira, 2010, CRC Press
4. Goldberg Israel. 1994. Functional Foods. Chapman & Hall, New York.
5. Walstra P, Geurts TJ, Noomen A, Jellema A & Van Boekel MAJS. 1999. Dairy Technology – Principles of Milk Properties and Processes. Marcel Dekker
6. P. Walstra, Pieter Walstra, Jan T. M. Wouters, Dairy Science and Technology, Second Edition, 2005, Taylor & Francis.
7. Megh R. Goyal, Anit Kumar, Anil K. Gupta, Novel Dairy Processing Technologies: Techniques, Management, and Energy conservation, 2018, CRC Press
8. Ashok Kumar Agrawal, Megh R. Goyal, Processing Technologies for Milk and Milk Products: Methods, Applications and energy usage, 2017, CRC Press

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	dairy and dairy products processing methods,	2	1	2	-	-	-	1	-	1	-	-	2
CO2	the special manufacturing processes of cream separation, Protein hydrolysates, functional dairy foods and others	1	1	2	-	-	-	1	-	1	-	-	2
CO3	practical knowledge on analysis of milk and milk products.	1	1	2	1	1	-	1	-	2	1	-	2
Over all CO		1	1	2	2	1	-	1	-	1	1	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5009	FAT AND OIL TECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES

The course aims to

- inculcate the students with details of different methods of extraction of fat in food industries.
- understand processes involved in purification and modification of fat and oil for production of different products

UNIT I INTRODUCTION 9

Major Sources of fats and oils, chemical composition; physical and chemical characteristics; functional and nutritional importance of dietary oils and fats. Post-harvest handling storage and processing of oilseeds for directs use and consumption.

UNITII EXTRACTION, REFINING AND OIL BLENDS 9

Extraction of oil by mechanical expelling and solvent extraction and obtaining de-oiled cakes suitable for edible purposes. Processing of other plant sources of edible oils and fats like coconut, cottonseed, rice bran, maize germ, etc. Refining: Clarification, degumming, neutralization (alkali refining), bleaching, deodorization techniques / processes. Blending of oils.

UNIT III MODIFIED FAT 9

Hydrogenation, fractionation, winterization, dewaxing, inter-esterification – chemical and enzymatic catalyst, animal fat modification through nutritional changes - for obtaining tailor-made fats and oils, Speciality fats and designer lipids for nutrition and dietetics, especially by biotechnology.

UNIT IV PROPERTIES AND ANALYSIS OF FAT AND OIL 9

Physical, chemical and nutritional properties of fats and oils Analytical parameters – melting behaviour, low temperature properties, unsaturation, saponification, GC, NIR, FTIR, ^{1}HNMR, ^{13}CNMR, ^{31}P NMR, mass spectrometry,

UNIT V FAT PRODUCTS 9

Production of Spreads – butter, butter oil, lard, tallow, ghee, margarine, Vanaspati, flavoured spreads, baking fats and shortenings, low fat spreads, major uses of edible fat and oils - frying oils and fats, salad oils, mayonnaise, salad cream, chocolate and confectionery fat, ice creams, vegetable fat in dairy products, edible coating, emulsifying agent, appetite suppressant, non-edible uses of fats and oils.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand specific processing technologies used for fats and oils

CO2 apply scientific principles in the processing technologies specific to the materials.

CO3 design the procedure for obtaining oil from oil plants

TEXTBOOKS/REFERENCES

1. Bailey's Industrial Oil & Fat Products, Daniel Swern, 2000, 4th ed.John Wiley & Sons.
2. The Industrial Chemistry of Facts & Waxes 3rd edition. by Balliere,Tindall & Cox.
3. Henry Basil Wilberforce Patterson, Handling & Storage of Oiseeds,Oils,Fats & Meal,1989, Elsevier Applied Science Publishers.
4. Frank Gunstone, Oils and Fats in the Food Industry, 2008, 1st edition, Wiley
5. Frank Gunstone, The Chemistry of Oils and Fats: Sources, Composition, Properties and Uses, 2004, 1st edition, Blackwell Publishing
6. Modern Technology Of Oils, Fats & Its Derivatives (2nd Revised Edition) By NIIR Board of consultants and Engineers, 2013, Asia Pacific Business Press.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	understand and identify the specific processing technologies used for Fats and oils	3	3	3	3	3	-	1	1	3	-	1	2
CO2	understand the application of scientific principles in the processing technologies specific to the materials.	3	3	3	3	2	-	1	1	3	-	1	2
CO3	use knowledge of object technology to design the procedure for obtaining oil from oil plants	2	3	3	3	3	-	1	1	3	-	1	2
Over all CO		2	3	3	3	2	-	1	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5010 CEREALS AND GRAIN PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to

- Educate and equip students with latest cereal processing technologies for adoption in food industries.
- understand the various methods involved in safe storage of grains

UNIT I RICE PROCESSING 9

Paddy – area and production- Paddy quality and classification- drying, cleaning, grading, sorting, packaging and storage -Process involved in rice milling - Machines for paddy processing – parboiling plant – types of dryers –cleaners - dehusking equipments – paddy separators- rice polishing equipments different types- Water mist rice polisher – rice moisture conditioning – types of graders - colour sorter and rice quality control - shelf life and spoilage.

UNIT II WHEAT PROCESSING 9

Wheat-area and production-Nutritional quality-wheat varieties- drying, cleaning, grading, sorting, packaging and storage - modern wheat milling process- flour milling-Soft and Durum wheat processing – equipment for conditioning – break rolls – sifters – purifiers - shelf life and spoilage.

UNIT III MAIZE PROCESSING 9

Maize – area and production – maize as food and feed- drying, cleaning, grading, sorting, packaging and storage - Milling process for maize- different unit operations- Beall degerminator – degermination with roller mills- Wet milling of maize – process - shelf life and spoilage.

UNIT IV MILLET PROCESSING 9

Area and production of barley, oat and millets – nutritive value of barley, oat and millets – drying, cleaning, grading, sorting, packaging and storage - processing of barley- equipment - finished products and end-uses of barley- Process involved in modern oat milling process- different unit operations involved in oat processing – different methods of millet processing – malting of millets - shelf life and spoilage.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT V BY-PRODUCTS 9

Utilization of by-products - composition and nutritional value, consumption. Value addition - suitability of flour required for different products; Traditional process technique - parching, puffing, popping, roasting or toasting, frying, flaking, fermentation, extraction, malting - techniques - basic process - effectiveness in increase energy density, canning, papad process

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 prepare themselves for possible industrial endeavours.
CO2 understand utilization of by-products from cereals
CO3 gain knowledge on milling, parboiling and other products

TEXTBOOKS/REFERENCES

1. Amalendu Chakraverty, Arun M.mujumdar, G.S.V.Raghavan and Hosahalli S. Ramaswamy. 2010. Hand Book of Postharvest Technology – Cereals, Fruits, Vegetables, Tea and Spices.Marcel and Dekker Inc., New York
2. Asiedu JJ.1990. Processing Tropical Crops. ELBS/MacMillan.
3. Chakraverty A.2000. Post-harvest technology of cereals, pulses and Oilseeds. Oxford and IBH Publishing Co., New Delhi.
4. Gavin Owens, 2000. Cereals processing technology, CRC Press.
5. Karel Kulp, 2000. Handbook of Cereal Science and Technology, Second Edition, CRC Press
6. Sewa Rram and B.Mishra. 2010. Cereals – Processing and Nutritional quality. New India Publishing Agency, New Delhi.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	cereal and cereal products processing and to prepare themselves for possible industrial endeavors.	2	1	2	1	-	-	1	-	1	-	-	2
CO2	utilization of by-products from cereals	1	1	2	-	-	-	1	-	1	-	-	2
CO3	application of practical knowledge of milling, parboiling,	1	1	2	1	-	-	1	-	2	-	-	2
Over all CO		1	1	2	1	-	-	1	-	1	-	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5011 PULSES AND OILSEED PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to

- enable the students to gain an insight into basic aspect of pulse and oilseed processing technology
- understand the importance of primary secondary and tertiary processing of pulse and oilseed with special emphasis on their process and equipments.

UNIT I INTRODUCTION 9

Concept of primary secondary and tertiary processing, concept of milling, Expression and extraction process. Application of different pretreatment on pulse and oilseed processing like parboiling, thermal treatment, enzymatic treatment and their effect on recovery and milling efficiency.

UNIT II PULSE PROCESSING 9

Production and consumption of different pulses in Indian and world, Milling of Pulses, Machinery and equipment for pulse, Dry and wet milling of pulses, antinutrional factor and removal methods, effect of processing on nutritional value, Technology of legume based and blended extrudates, shelf life and spoilage of pulses

UNIT III OIL EXTRACTION 9

Mechanical expression of oil – ghani, power ghani, rotary, hydraulic press, screw press, expellers, filter press - principle of operation and maintenance-solvent extraction process – steps involved, batch and continuous-continuous solvent extraction process, Oil quality and standard quality regulations, shelf life and oxidative stability of oil, Other source of edible oil like corn germ, rice bran, almond oil, coconut oil.

UNIT IV OILREFINING AND PROCESSING 9

Refining of oil – objectives – characterization - degumming, deacidification, bleaching of oil, decolourising agents, deodorization process, and winterization processes. Hydrogenation of oil – selectivity – catalyst – batch type hydrogenation – regeneration of catalyst-vanaspati, ghee and margarine. Characterization and types of fat replacers and their specific uses

UNIT V PULSE AND OILSEED PRODUCTS 9

Legume based value added product, Instant dhal, Pulse flour products, soy based value added product, groundnut based value added product, fermented products, By product utilization of pulse milling, pulse broken, meal and cake utilization, lecithin, Technology of oilseed protein isolates

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 process pulse and oil seed
CO2 process Value added products from pulse and oil seed
CO3 application of practical knowledge of pulse milling and oil extraction techniques.

TEXTBOOKS/REFERENCES

1. Acharia, K.T. 1990. Oil seeds and oil milling in India. Oxford and IBH publication, New Delhi.
2. Chakraverty, A. Post Harvest Technology of Cereals, Pulses and Oilseeds. Oxford and IBH Publishing Co, Calcutta (1995)
3. H. Lawson, Food Oils and Fats- Technology, Utilization, and Nutrition, Chapman and Hall, 1994.
4. Harry Lawson. 1997. Food oils and Fats, Technology, Utilization and Nutrition. CBS Publishers and Distributors, New Delhi

5. J.Bachmann, Oilseed Processing for Small Scale Producers, ATTRA Publication, 2004. K.K.Rajah, Fats in Food Technology, Sheffield Academic Press, 2002
6. Sahay, K. M. and K.K. Singh. 1994. Unit operation of Agricultural Processing, Vikas Publishing House Pvt.Ltd., New Delhi.
7. Salunkhe, D.K., Kadam, S.S. Ed. 1989. Handbook of World Food Legumes: Chemistry, Processing and Utilization, (3 vol. set). CRC Press, Florida.
8. W.Hamm and R.J.Hamilton, Edible oil Processing, CRC Press, 2000
9. Weiss, T.J. 1970. Food Oils and their uses. The AVI Publishing Company, Inc. Westport, Connecticut.
10. Willians, P. and N and J. Devine., —The Chemistry and Technology of Edible Oils and Fatsll, Pergamon Press, London, 1984

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	pulse and oil seed processing	2	1	2	1	-	-	1	-	1	-	-	2
CO2	processing of Value added products from pulse and oil seed	1	1	2	1	-	-	1	-	1	-	-	2
CO3	application of practical knowledge of pulse milling and oil extraction techniques	1	1	2	1	-	-	1	-	2	-	-	2
Over all CO		1	1	2	1	-	-	1	-	1	-	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5012 MEAT AND POULTRY PROCESS TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to

- impart knowledge about the advancement in the processing of meat poultry from a food engineer view point.
- educate on abattoir design, sanitation practices, preservations methods, product development, quality control, packaging practices, effluent treatment and proper disposal of wastes in meat, poultry and processing.

UNIT I SLAUGHTERING HOUSE AND EQUIPMENTS 9

Abattoir Layout, designing - equipment, operation and maintenance of slaughter houses and processing plants - hygiene and sanitary conditions in meat processing plant-pre-slaughter judging, inspection, grading of animals - Humane slaughter- principles and methods of stunning - machineries for slaughter and dressing. Automation in meat and poultry industry.

UNIT II ADVANCES IN MEAT AND POULTRY INDUSTRIES 9

Advances in meat industry, Advances in poultry dressing, meat yield. Automation in broiler farming, control of shrinkage and methods of slaughter - specifications, standards and marketing of egg and egg products- preservation and maintenance of quality of eggs - spoilage of egg and its prevention - freezing- pasteurization.

UNIT III NOVEL MEAT PROCESSING TECHNIQUES 9

Novel processing methods in meat and poultry processing. Effect of high-pressure processing, pulsed electric field, Power ultrasound, Irradiation of meat and poultry product, changes in protein, lipid and carbohydrate profile if any in meat due to processing.

UNIT IV MEAT SAFETY AND QUALITY ANALYSIS 9

Quality and safety analysis: Microbial analysis, Chemical analysis and Physical analysis. Instrumental analysis to ensure safety and quality: Adulteration in meat and meat products, IR analysis system for identification on type of meat, Mass spec. and Chromatographic analysis. Pathogenic microbe identification, Aspects of meat preservation for control of meat spoilage.

UNIT V MEAT PACKAGING, BYPRODUCTS AND REGULATIONS 9

Packaging of meat and meat products - modified atmosphere packaging - vacuum packaging - retort pouch processing – packaging of egg and egg products - utilization of by-products and wastes from meat and poultry processing industries - waste treatment and pollution control- Environmental Audits-Regulations on pollution control.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand and identify the specific processing technologies used for meat and such foods and the various products derived from these materials.

CO2 grasp the changes in the composition of foods with respect to the type of processing technology used.

CO3 understand and apply advanced preservation and packaging techniques for meat and poultry products.

TEXTBOOKS/REFERENCES

1. Fidel Toldra.(2010). Handbook of Meat Processing
2. Kerry J, Kerry J and Ledward D. 2005. Meat Processing-Improving Quality. Woodhead publishing Ltd., UK.
3. Leo M.L. Nollet, Fidel Toldra.2006. Advanced Technologies For Meat Processing. Taylor and Francis.
4. Panda, P.C. 1998. Text Book on Egg and Poultry Technology, Vikas Publishing House Pvt. Ltd., New Delhi.
5. Pearson AM and Dutson TR. 1999. Advances in Meat Research. Vol. IX. Quality Attributes and their Measurement in Meat, Poultry and Fish
6. Stadelman W and Cotterill OJ. 2002. Eggs Science and Technology. 4th Ed.CBS

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand and identify the specific processing technologies used for meat and such foods and the various products derived from these materials.	3	3	3	3	3	-	1	1	3	-	1	2
CO2	grasp the changes in the composition of foods with respect to the type of processing technology used.	3	3	3	3	2	-	1	1	3	-	1	2
CO3	understand and apply advanced preservation and packaging techniques for meat and poultry products.	2	3	3	3	3	-	1	1	3	-	1	2
Over all CO		2	3	3	3	2	-	1	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5013	MARINE FOOD PROCESS TECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES

The course aims to

- understand advanced concepts involved in the production, processing of marine products
- study about quality assurance of marine products

UNIT I INTRODUCTION 9

Importance of marine products, fishing resources – inland, marine, blackish water fisheries - harvesting methods – crafts – gears

UNIT II COMPOSITION AND QUALITY OF MARINE FOOD 9

Composition and nutritive value of marine – protein, omega 3 fatty acid, toxic component-biochemical and microbiological changes in marine - evaluation of fish qualities - transportation of fish, washing and grading.

UNIT III PROCESSING OF MARINE FOOD 9

Processing of fish and shellfish – different types of ice and their advantage - freezing – individual quick freezing – canning – salting – drying and dehydration - smoking of fish- Irradiation- fish mince and surumi - packing, storage and transportation of chilled and frozen fish– packaging of frozen fish – marketing - cold chain and export trade – transportation and marketing of frozen products - packaging and packaging materials

UNIT IV MARINE FOOD PRODUCTS 9

Fish meal, bone meal, fish oil, surgical sutures from intestine, chitin and chitosan - fermented fish products – fish paste products (fish sausage and ham, etc.) – fish protein concentrates-utilization of fish processing

UNIT V SPOILAGE AND QUALITY CONTROL 9

Spoilage of marine products –quality control of fresh fish - quality control during freezing and chilling - HACCP of marine products – quality assurance of marine products

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 have in depth knowledge on handling and transportation of marine products.
CO2 process marine and their by-products
CO3 understand quality of marine products and quality issues in post-production and factors affecting the quality

TEXTBOOKS/REFERENCES

1. Andrew L. Winton, Kate Barber Winton, 1993. Fish and Fish products Agro Botanical Publishers, India.
2. Balachandran K. K. 2001. Post harvest technology of fish and fish products. Daya Publishing House, New Delhi.
3. Gopakumar, K. 1993. Fish Packaging Technology (Materials and Methods) concept publishing company, New Delhi.
4. Govindan, T. K. 1985. Fish Processing Technology. Oxford and IBH Pub. Co. Pvt. Ltd.
5. Mallett, C.P. 1993, Frozen Food Technology, Chapman and Hall, London
6. Zeathen, P. 1984. Thermal processing and quality of foods. Elsevier applied science publishers, London

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	have in-depth Knowledge regarding handling and transportation of marine products.	3	3	3	3	3	-	1	1	3	-	1	2
CO2	gain knowledge on the processing of marine and their by-products	3	3	3	3	2	-	1	1	3	-	1	2
CO3	understand the quality of marine products and quality issues in post-production and factors affecting the quality	2	3	3	3	3	-	1	1	3	-	1	2
Over all CO		2	3	3	3	2	-	1	1	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5014 SPICES, CONDIMENTS AND PLANTATION PRODUCTS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- study about processing of spices and plantation crops
- understand the technology used for their processing, preservation and value addition.

UNIT I SIGNIFICANCE OF SPICES AND CONDIMENTS 9

Spices and Condiments - Description of various types of spices and condiments, their composition, functional properties, flavouring agents. Nutritive value of spices and their health benefits. Intermediate Moisture Products viz., ginger paste, ginger – garlic paste, tamarind paste, tamarind concentrate, processing of spices like chilli, turmeric pepper, ginger etc.

UNIT II POWDERS 9

Spice Powders and Curry Powders: importance in culinary preparations, preparation methods, grinding and packaging methods for spice powders like chilli powder, turmeric powder, ginger powder, garlic powder; and Masala Powders for chicken masala, meat masala, biryani masala, chat masala etc. Importance of Cryogenic grinding of spices.

UNIT III ESSENTIAL OIL AND OLEORESINS 9

Spice Oils – Concept and importance of spice oils from spices like and condiments like clove, cardamom, cinnamom etc. Extraction methods of spice oils by various techniques, viz., solvent extraction, steam distillation etc. Extraction of Oleoresins- Concept and importance of oleoresins in food processing, solvent extraction of oleoresins. De-solventization methods, regulatory and statutory requirements for oleoresin processing.

UNIT IV TEA AND COFFEE 9

Plantation crops-description of various types of plantation crops viz. coconut, areca nut coffee, tea, cocoa etc.

Production and processing of Tea leaves: Black tea, Green tea and Oolong tea. chemistry of tea manufacturing and tea quality; tea aroma precursors; tea flavour; tea grades; storing of tea Instant tea, tea concentrates, decaffeinated tea, flavoured tea; herbal tea.

Production and processing of coffee cherries by wet and dry methods to obtain coffee beans, grinding, storage and preparation of brew, Soluble /Instant coffee, Use of chicory in coffee, decaffeinated coffee, coffee concentrate.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT V COCOA AND COCONUT 9

Production, processing and chemical composition of cocoa beans. Cocoa Processes: Cleaning, roasting, alkalization, cracking and fanning, Nib grinding for cocoa liquor, cocoa butter and cocoa powder. Manufacturing process for chocolate: Ingredients, Mixing, Refining, Conching, Tempering, Moulding etc. to obtain chocolate slabs, chocolate bars. Enrobed and other confectionary products. Composition, Structure and characteristics of cashew nut and other dry fruits.

Coconut - processing and preservation methods, Value added and shelf stable products viz., bottled coconut water, desiccated coconut powder, , processed products from cocoa like chocolate.

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 process spices, spice powders, essential oil and oleoresins.
CO2 learn about steps involved for different plantation products
CO3 process spices and plantation products

TEXTBOOKS/REFERENCES

1. ASTA, 1997. Official analytical methods of the American Spice Trade Association, Fourth Edition.
2. Pandey,P.H. 2002. Post Harvest Engineering of Horticultural Crops through Objectives. Saroj Prakasan, Allahabad.
3. Purthi, J. S. Minor Spices and Condiments: Crop Management and Post Harvest Technology, (ICAR publication, 2001)
4. Purthi, J. S. Major Spices of India: Crop Management and Post Harvest Technology, (ICAR publication, 2003J W Parry(1969). Spices : Morphology, History, Chemistry, Chemical Publishing Co., New York
5. Woodroof, J. G. Tree Nuts: Production, Processing, Products, (AVI Pub. Co., 1979)
6. Salunkhe, D. K. and Kadam, S. S. Handbook of Fruit Science and Technology: Production, Composition, Storage, and Processing, (CRC Press, 1995)
7. Jain, N. K. Global Advances in Tea Science, (Aravali Books International, 1999)
8. Clifford, M. N. and Willson, K. C. Coffee: Botany, Biochemistry and Production of Beans and Beverage, (AVI publishing Co., 1985)

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand the processing steps spices, spice powders, essential oil and oleoresins.	1	1	2	1	-	-	1	2	1	-	-	2
CO2	understand the processing steps involved for different plantation products	1	1	2	-	-	-	1	2	1	-	-	2
CO3	have practical knowledge on processing of spices and plantation products	1	1	2	1	1	-	1	2	1	-	-	2
Over all CO		1	1	2	1	1	-	1	2	1	-	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5015	BEVERAGE TECHNOLOGY	L T P C
		3 0 0 3

OBJECTIVES

The course aims to

- gain knowledge on basic ingredients used in production of alcoholic and non-alcoholic beverages
- familiarize students with regulations and quality control involved in beverage industry.

UNIT I BASIC INGREDIENTS IN BEVERAGES 10

Beverage-definition-why we drink beverages-ingredients- water, carbon dioxide, bulk and intense sweeteners, water miscible and water dispersible flavouring agents, colours – natural and artificial, Micro and nanoemulsions of flavours and colors in beverages, preservatives, emulsifiers and stabilizers.

UNIT II BEER AND WINE 9

Ingredients- Malt- hops- adjuncts- water, yeast. Beer manufacturing process, distillation, malting, preparation of sweet wort, brewing, fermentation, pasteurization and packaging. Beer defects and Spoilage. Wine-fermentation-types –red and white. Wine defects and spoilage

UNIT III CARBONATEDBEVERAGES 6

Procedures-carbonation equipment-ingredients-preparation of syrups-Filling system-packaging containers and closures

UNIT IV NON-CARBONATED BEVERAGES 10

Coffee bean preparation-processing-brewing-decaffeination- instant coffee-Tea types- black, green and oolong- fruit juices, nectars, quash, RTS beverages, isotonic Beverages. Flash pasteurization, Canning and Aseptic Packaging of beverages

UNIT V PACKAGING AND QUALITY CONTROL 10

Packaging of beverages – selection and effectiveness of pack, Effective application of quality controls, brix, acidity to brix ratio, single strength of juice- sanitation and hygiene in beverage industry-Quality of water used in beverages - threshold limits of various ingredients according to PFA, EFSA and FDA – Absolute requirements of Soluble solids and titrable acidity in beverages.

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand various concepts, principles and procedures involved in processing of beverages.

CO2 demonstrate various unit operations involved in the food beverage manufacturing.

CO3 list quality control steps in beverage preparation.

TEXT BOOKS/REFERENCES

1. Ashurst, P.R, “Chemistry and technology of Soft drink and fruit juices”, 2ndedition, Blackwell Publishing Ltd. 2005.
2. Steen, D.P and Ashurst, P.R, “Carbonated soft drinks – Formulation and manufacture”, Blackwell Publishing Ltd. 2000.
3. Shankunthala Manay, N. and Shadakdharaswamy, M, “Foods – Facts and Principles”, New Age International Pvt. Ltd, 3rd revised edition 2000.
4. Charles, W. Bamforth, “Food, fermentation and microorganisms”, Blackwell Science Publishing Ltd. 2005.
5. Amalendu Chakraverty et al, “Handbook of Post Harvest Technology”, Ed:.,Marcel Dekker Inc. (Special Indian edition) 2000.
6. Robert. W. Hutkins, “Microbiology and Technology of Fermented foods”, IFT Press, Blackwell Publishing Ltd. 2006.
7. “Brewing yeast and fermentation Chris Boulton and David Quain”, Blackwell Science Ltd Prevention of Food Adulteration Acts and Rules Manual”

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	understand various concepts, principles and procedures involved in processing of beverages.	2	1	1	1	2	1	-	-	1	1	-	2
CO2	demonstrate various unit operations involved in the food beverage manufacturing.	2	1	1	1	2	1	-	-	1	1	-	2
CO3	list the quality control steps in beverage preparation.	2	1	1	1	-	1	-	-	1	1	-	2
Over all CO		2	1	1	1	1	1	-	-	1	1	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5016 ADVANCED FOOD MICROBIAL ANALYSIS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- gain knowledge on significance of microbial metabolism in food
- understand application of food microbiology in preservation and safety of food

UNIT I MICROBIOLOGY OF FOODS 8

Fresh and fermented foods; common food borne bacteria and fungi – their general roles; parameters effecting microbial growth – extrinsic and intrinsic, combined intrinsic and extrinsic – lactic antagonism and hurdle concept; growth kinetics

UNIT II MICROBIAL METABOLISM AND THE FOOD MATRIX 10

CHO metabolism, chemiosmotic theory of ATP synthesis; degradation of aromatics, alicyclics, aliphatics,alkenes,aromatic; anaerobic respiration, fermentation, chemolithotrophy, phototrophy; synthesis of carbon compounds. Action of microbes on food components; nature of microbial growth in food; principles of structural, mechanical and dynamic characteristics of food systems; introduction to predictive microbiology.

UNIT III METHODS OF BACTERIAL IDENTIFICATION 8

Microbial genomics and the microbiome; morphological, physiological, biochemical, immunological/serological, phage typing, chemotaxonomic, numerical, molecular methods; genome sequencing, gene mapping.

UNIT IV APPLICATIONS OF FOOD MICROBIOLOGY 10

Beneficial uses of bacteria in food; intestinal probiotics; concept of prebiotics, synbiotics; techniques for characterizing functional properties; problems of the food matrix; technologies for encapsulation; food and beverages for certain target groups; modified foods; stability and preservation of microbe functionality during processing; biosensors.

UNIT V BIO-FUNCTIONALITY AND SAFETY OF FOOD 9

Toxicokinetics; mechanistic principles of toxic effects; genotoxicology and carcinogenesis; functionality and potential dangers of food ingredients; effect of food additives; structure and chemistry of the most important residues and contaminants in food and feed; modern methods for their determination; requirements for trace analysis; microbial examination of food – recommended and supplementary tests.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 understand microbial metabolism in the context of food industry
CO2 gain knowledge on identification of microbes
CO3 appreciate use of microbes for the development of superior foods

TEXT BOOKS/REFERENCES

1. Robert, E Levin. "Rapid detection and characterization of food borne pathogens by molecular techniques". 1st ed. CRC publications. 2009.
2. Gobbetti, Marco, Di Cagno, Raffaella. "Bacterial Communication in Foods". 1st ed. Springer. 2013.
3. Osman erkmen, T. faruk Bozoglu, "Food microbiology" John Wiley and sons, 1st ed., 2016.
4. Fernando- Perez- Rodriguez, Antonio Valero, "Predictive microbiology in foods", 5, 1st ed, Springer, 2013.
5. Bergey's Manual of Systematic Bacteriology. Springer. 2nd ed, 2012.
6. G.F. Stewart, Maynard. A. Amerine"Introduction to food science and technology" 2nd ed, Elsevier, 2012.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	understand microbial metabolism in the context of food industry	2	-	-	1	-	-	-	-	-	-	-	2
CO2	gain knowledge on the identification of microbes	3	2	2	2	1	-	-	-	-	-	-	3
CO3	appreciate the use of microbes for the development of superior foods.	2	3	3	2	2	-	--	-	2	1	2	3
Over all CO		2	2	3	2	2	--	-	-	2	1	2	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5017 APPLICATIONS OF ENZYMES IN FOOD INDUSTRY LT P C
3 0 0 3

OBJECTIVES

The course aims to

- develop an understanding on enzymes used in food product development
- understand the application of enzymes in purification and their impact on sensory and nutritional quality.

UNIT I INTRODUCTION TO ENZYMES USED IN FOOD INDUSTRY 12

Classification of enzymes, Objectives of using enzymes in food processing and in food product development, Merits and demerits of using enzymes, Sources of enzymes, Microbial enzymes and their advantages/ disadvantages, Commercially important enzymes used in Food industry and their mode of action, Overview of applications of enzymes in the Food industry, Newer enzymes and their actual and potential applications, fermentative production of enzymes (amylases, proteases, cellulases, pectinases, xylanases, lipases) used in food industry and their downstream processing

UNIT II ENZYMES IN PLANT PRODUCTS PROCESSING 9

Enzymes for production of protein hydrolysates and bioactive peptides, maltodextrins and corn syrup solids (liquefaction, saccharification, dextrinization, isomerization for production of high-fructose-corn-syrup), fructose and fructo-oligosaccharides. fruit juices (cell wall degrading enzymes for liquefaction, clarification, peeling, debittering, decolourization of very dark coloured juices such as anthocyanases); baking (fungal α-amylase for bread making; maltogenic α-amylases for anti-staling; xylanses and pentosanases as dough conditioners; lipases or dough conditioning; oxidases as replacers of chemical oxidants; synergistic effect of enzymes); Oilseeds processing, formation of TAGs.

UNIT III ENZYMES IN ANIMAL PRODUCTS PROCESSING 8

Enzymes as processing aids: Role of enzymes in cheese making and whey processing; meat and meat processing (meat tenderization); egg processing, extraction of fish oil, seafood (like surimi product), poultry, eggs, Animal feed

UNIT IV ENZYMES FOR PRODUCTION OF FOOD ADDITIVES 9

Enzyme processing for flavours through biotransformations (enzyme-aided extraction of plant materials for production of flavours, production of flavour enhancers such as nucleotides; flavours from hydrolyzed vegetable/animal protein); enzymatic approach to tailor- made fats, Enzymes as additives e.g. antioxidant or antimicrobial.

UNIT V ENZYMES FOR FOOD PACKAGING & OTHER APPLICATIONS 7

Novel food applications of enzymes, Enzymes in active packaging and in edible coatings and films, Safety of enzymes used in foods, food grade enzymes, Immobilization of enzymes for food applications, Recombinant enzymes from GMO

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 list different enzymes applied in processing of foods
CO2 understand the applications of enzymes in the production of various plant and animal products in food industries
CO3 have better understanding of role of enzymes in the production of food additives and novel applications on food packaging as sensors

TEXTBOOKS/REFERENCES

1. Flickinger MC & Drew SW. 1999. Encyclopedia of Bioprocess Technology. A Wiley-Inter Science Publ.
2. Kruger JE. et al. 1987. Enzymes and their Role in Cereal Technology. American Association of Cereal Chemists Inc.
3. Nagodawithana T & Reed G. 1993. Enzymes in Food Processing. Academic Press.
4. Tucker GA & Woods LFJ. 1991. Enzymes in Food Processing.
5. Whitehurst R & Law B. 2002. Enzymes in Food Technology. Blackwell Publ.
6. Novel Enzyme Technology for Food applications, Edited by: Robert Rastall, 1st ed., 2007,Woodhead Publication Limited, U. K.
7. Food Processing: Biotechnological Applications, Marwaha, 2015., Asiatic Publishers, New Delhi.
8. Patterson R.L.S. Charlwood B.V. MacLeod G. Williams A.A. Bioformation of Flavours. Royal Society of Chemistry,1992: 171-185.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	knowledge of different enzymes applied in processing of foods	3	1	2	1	1	1	2	3	2	1	1	2
CO2	applications of enzymes in the production of various plant and animal products in food industries	3	3	3	3	2	2	3	3	2	2	3	2
CO3	better understanding of role of enzymes in the production of food additives and novel applications on food packaging as sensors	3	3	3	3	3	2	3	3	3	2	3	2
Over all CO		3	3	3	3	3	2	3	3	2	2	3	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5018 ADVANCED FOOD FERMENTATION TECHNOLOGY L T P C
3 0 0 3

OBJECTIVES

The course aims to

- gain knowledge about fermentation technologies used in food industry
- learn role of microorganisms in fermentation
- gain skills to control of fermentation processes

UNIT I MEDIA FOR FERMENTATION & STRAIN DEVELOPMENT 8

Microbial culture, Screening and selection for fermentation processes; Preservation and improvement of industrially important microorganisms; Importance of media components for production of industrial products by fermentation; use of different sources of carbon, nitrogen, minerals and activators for commercial fermentation; optimization of fermentation media. Sterilization of media and air; Batch and Continuous sterilization, Thermal death kinetics

Strain Development -Various techniques of modifying the strains for increased production of industrial products. Use of chemicals, UV rays, genetic engineering to produce newer strains.

Strain development by mutagenesis, protoplast fusion and transformation of cloned genes

UNIT II TYPES AND DESIGN OF BIOREACTORS 10

Basic objective of fermenter design, aseptic operation & containment, body construction, agitator and sparger design, baffles. Process parameters and measurement techniques: measurement of temperature, pressure and pH, DO, foam etc.; flow rate of liquid and gases; Automation (processes computerization).

Bioreactor configurations and types- Bubble column, airlift reactor, packed bed, fluidized bed, trickle bed, Membrane reactor, Photobioreactor, Solid state fermenter, Animal and plant cell bioreactors. Scale up and Scale down studies of bioreactors.

UNIT III FERMENTATION PATHWAYS FOR INDUSTRIAL PRODUCTS 8

Biochemical pathways of metabolic reactions for utilization of carbon sources and formation of different metabolites by microorganisms; possibility of control of the reactions for the increased formation of useful metabolites.

UNIT IV ADVANCED FERMENTATION PROCESSES 10

Recombinant protein expression with E.coli and fermentation. Expression in yeast Pichia pastoris, production of recombinant vaccines, purification of recombinant proteins.

Animal cell culture, Plant cell culture; Cell culture practices, nutritional requirement of cultured cell, cell growth and propagation, prevention and eradication of contamination, Cell synchronization; Cell cloning. Scaling-up of animal and plant cell culture.

UNIT V DOWNSTREAM PROCESSING 9

Various equipment for product recovery; micro-filters and Ultra-filtration systems for separation of cells and fermentation medium and for concentration of medium containing product; chromatographic systems of separation; extraction of product with solvent; evaporation and crystallization; centrifugation, different types of centrifuges; drying techniques; instrumentation and controls.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 gain knowledge on principles of fermentation technology and operations of a fermenter.

CO2 familiarise control systems of a fermenter and isolation of products and its purification.

CO3 design fermentation system which can be exclusively used in industries

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

TEXTBOOKS/REFERENCES

1. Joshi, V.K. and Ashok Pandey "Biotechnology: Food Fermentation, Microbiology, Biochemistry and Technology", Vol. I & vol. II Educational Publisher, 1999.
2. Peppler, H.J. and D. Perlman "Microbial Technology: Fermentation Technology", 2nd Edition, Vol. II Academic Press / Elsevier, 2004.
3. Bioprocess Engineering, Basic Concepts, II Ed. Michael L Shuler, FikretKargi, Prentice Hall of India pvt. Ltd. 2002.
4. Stanbury, P.F., A. Whitaker and S.J. Hall "Principles of Fermentation Technology", 2nd Edition Aditya Books (P) Ltd., 1997.
5. Industrial Biotechnology by Rita Singh, S. Ghosh, Global Vision Publishing Ho, 2004
6. El-Mansi, E.M.T. et al "Fermentation Microbiology and Biotechnology" 2nd Edition, CRC Taylor & Francis, 2007.
7. Basic Cell Culture: A Practical Approach by J.M. Davis, 2nd ed. 2002 Oxford University press, oxford
8. Culture of Animal Cells: A Manual of Basic Technique 4th ed. By R. Ian Freshney Wiley-Liss, 2000
9. Animal Cell Culture Third Edition A Practical Approach Edited by John R. W. Masters Oxford University Press Great Clarendon Street, Oxford 0X2 6DP 2000.
10. Adams, M.R. and M.J.R. Nout "Fermentation and Food Safety", Aspen Publication, 2001.
11. Vogel, H.C. and C.L. Todaro "Fermentation and Biochemical Engineering Handbook Principles, Process Design and Equipment", 2nd Edition, Standard Publishers, 2005.
12. Comprehensive biotechnology, vol 1, 2, 3 and 4 Murray moo young, Pergamon press2004.
13. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press an Imprint of Elsevier.
14. Manual of Industrial Microbiology & biotechnology, Arnold Demain& Julian E. Davis, II Ed, ASM Press. Washington DC, 1999.
15. Current developments in Solid Substrate fermentation, Ashok Pandey, Carlos Ricardo Soccol, Christian Larroche – 2008.
16. .Animal Cell Technology: From Biopharmaceuticals to Gene Therapy, Edited by Leda R. Castilho Angela Maria Moraes, Elisabeth F.P. Augusto and Michael Butler. Taylor & Francis group 2008.
17. Cell and Tissue Culture: Laboratory procedures in Biotechnology Edited by Alan Doyle and J. Bryan Griffiths Wiley & Sons Ltd, The Atrium, Southern Gate, Chichester, West Sussex PO198SQ, England

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	gain knowledge on principles of fermentation technology and operations of a fermenter	3	3	3	3	3	1	3	3	2	2	2	2
CO2	familiarize with the control systems of a fermenter and isolation of products and its purification	3	3	3	3	3	1	3	3	2	2	2	2
CO3	better understanding of design of a fermentation system which can be exclusively used in industries	3	3	3	3	3	2	3	3	3	2	3	2
Over all CO		3	3	3	3	3	1	3	3	3	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5019 NANOTECHNOLOGY IN FOOD APPLICATIONS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- expose the students in the advanced knowledge in nanotechnology
- enable Students understand the use of nanotechnology in processing and packaging of foods

UNIT I NANOPARTICLES- INTRODUCTION AND PREPARATION 12

Classifications of nanostructured materials- Nanoparticles and nanofibers- quantum dots, nanowires, Length Scales involved and effect on properties: Mechanical, Electronic, Optical, Magnetic, Biological and Thermal properties.

General methods of preparation- Bottom-up Synthesis-Top-down Approach: Co-Precipitation, Ultrasonication, Mechanical Milling, Colloidal routes, Self-assembly, Vapour phase deposition, MOCVD, Sputtering, Evaporation, Molecular Beam Epitaxy, Atomic Layer Epitaxy, MOMBE

UNIT II CHARACTERIZATION TECHNIQUES 6

X-ray diffraction technique, Scanning Electron Microscopy - environmental techniques, Transmission Electron Microscopy including high-resolution imaging, Surface Analysis techniques- AFM, SPM, STM, SNOM, ESCA, SIMS-Nanoindentation

UNIT III NANOTECHNOLOGY IN FOOD PROCESSING 9

Nanoencapsulation & microencapsulation- flavour & aroma encapsulation- Nano formulations for the delivery of bioactive compounds- Nanocarriers- Lipid Nanocarriers for Phytochemical Delivery in Foods- Nano-emulsions- Nano-dispersions Characterization & stability- Bioavailability studies- limitations- Electrospinning and Electrospraying Technologies- Applications in the food Industry, Nano-filtration, Nanoclusters, Nanochelates

UNIT IV NANOPACKAGING 9

Nanopackaging for enhanced shelf life- Potential of nanomaterials in food packaging- Nanopolymers, Nanocomposites, Nanolaminates and Nanostructured Coatings in Food Packaging- Smart/Intelligent packaging- Nano antimicrobials in enhancement of shelf-life of foods

UNIT V NANO SENSORS 9

Nanotechnology in Microbial Food Safety & bio-security- Electrochemical sensors for food analysis and contaminant detection- Monitoring and separation of food-borne pathogens using nanoparticles- Safety Assessment for Use of Nanomaterials in Food and Food Production- Efficacy Evaluation and Risk Assessment- Regulatory Framework for Food Nanotechnology

TOTAL : 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand different methods for preparation and characterization of important properties of nanomaterials, commonly used in food sector

CO2 understand nanoparticles applications in different food technology operations like processing & packaging

CO3 gain knowledge on food safety components using nanomaterials

TEXT BOOKS/REFERENCES

1. V. Ravishankar Rai, Jamuna A Bai, “Nanotechnology applications in the food industry”, CRC Press, 2018
2. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).

3. Lynn J. Frewer, Willehm Norde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, (2011).
4. Alexandra Elena Oprea & Alexandru Mihai Grumezescu," Nanotechnology applications in food: Flavour, stability, Nutrition & Safety", Academic Press, 2017.
5. Mick Wilson, Kamali Kannangara, Geof smith, "Nanotechnology: Basic Science & emerging technologies" , Overseas press.
6. W. Goddard, 2007, "Handbook of Nanoscience Engineering & Technology", CRC Press
7. Erika – Rogers and Christopher J B, 2001, "Instrumentation and Sensors for Food Industry", CRC press.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	will be familiar with the methods for preparation and characterization of important properties of nanomaterials, commonly used in food sector	3	3	3	3	3	2	3	3	2	2	3	1
CO2	know these nanoparticles applications in different food technology operations like processing & packaging	3	3	3	3	3	2	3	3	2	2	2	1
CO3	will be able to gain the knowledge on food safety components using nanomaterials	3	3	3	3	3	2	3	3	3	2	3	1
Over all CO		3	3	3	3	3	2	3	3	2	2	3	1

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5020 FOOD NUTRIGENOMICS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- familiarize students with the basic concepts in nutritional genomics and to develop an understanding of genomics and gene regulation with respect to diet
- obtain an appreciation for the role and importance of nutrition in prevention of polygenic diseases.

UNIT I GENE-DIET INTERACTIONS 9

Nutrigenomics: Scope and Importance to Human Health and Industry Transporter gene polymorphisms -interaction with effects of micronutrients in humans. Polymorphisms in genes affecting the uptake and transport of omega-6 and omega-3 polyunsaturated fatty acids: interactions with dietary lipids and chronic disease risk. Nutrigenomics approaches to unraveling physiological effects of complex foods. The intestinal microbiota - role in nutrigenomics.

UNIT II MODULATING DISEASE RISK 9

Modulating the risk of cardiovascular disease through nutrigenomics; Modulating the risk of diabetes through nutrigenomics; Modulating the risk of inflammatory bowel diseases through nutrigenomics; Modulating the risk of obesity through nutrigenomics; Modulating the risk of cancer through nutrigenomics; Modulating the malnutrition through nutrigenomics

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT III GENOMICS AND PROTEOMICS TECHNIQUES 9

GENOMICS TECHNIQUES: Different sequencing approaches, Microarray, Massarray, SNP genotyping, PCR and RT-PCR techniques

PROTEOMICS TECHNIQUES: 1-D, 2-D gel electrophoresis, DIGE, novel peptide identification, peptide sequencing methods

UNIT IV METABOLOMICS AND COMPUTATIONAL APPROACHES 9

Metabolomics techniques: Chromatography and mass spectrometry techniques, Discovery and validation of biomarkers for important diseases and disorders

Computational approaches: Introduction to different types of public domain databases, data mining strategies, primer designing.

UNIT V NUTRIGENOMICS 9

Bringing nutrigenomics to the food industry: Industry-Academia partnerships as an important challenge; Bringing nutrigenomics to the public: direct-to-consumer testing and future of nutritional genomics, Interaction with health professionals in bringing nutrigenomics to the public; status of contemporary society for nutrigenomic science, Public health significance of nutrigenomics and nutrigenetics

TOTAL: 45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 analyse how diet and underlying genetics interact to increase susceptibility to disease

CO2 list out various methods and strategies used to study complex trait genetics and nutrition**.**

CO3 apply omics scale approaches to measure the effect of diet

REFERENCES:

1. Journal Nutrients 2012, 4, 1898-1944; Molecular Nutrition Research—The Modern Way Of Performing Nutritional Science.
2. Journal Nutrients 2013, 5, 32-57; Nutrigenetics and Metabolic Disease: Current Status and Implications for Personalized Nutrition
3. J Nutrigenetics Nutrigenomics 2011;4:69–89; Nutrigenetics and Nutrigenomics: Viewpoints on the Current Status and Applications in Nutrition Research and Practice.
4. J Am Diet Assoc. 2006;106:569-576; Nutrigenomics: From Molecular Nutrition to Prevention of Disease.
5. The Journal of Nutrition; Nutritional “Omics” Technologies for Elucidating the Role(s) of Bioactive Food Components in Colon Cancer Prevention.
6. Nutrition 25 (2009) 1085–1093; Proteomics at the center of nutrigenomics: Comprehensive molecular understanding of dietary health effects

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	knowledge of how diet and underlying genetics interact to increase susceptibility to disease	3	3	3	3	3	1	-	2	3	-	1	2
CO2	appreciation for the methods and strategies used to study complex trait genetics and nutrition.	2	3	2	3	2	-	-	2	3	-	1	2
CO3	understanding of the application of -omics scale approaches to measure the effect of diet	2	3	2	3	3	-	-	2	3	-	1	2
Over all CO		2	3	2	3	2	1	-	2	3	-	1	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5021	FOOD INFORMATICS	L T P C 2 0 2 3

OBJECTIVES

The course aims to

- know the basics of bioinformatics and structural modelling of food ingredients.
- familiarize the biological sequences including next generation sequencing data, tools and analysis and applications in food relevant topics.

UNIT I INTRODUCTION TO BIOINFORMATICS AND SEQUENCE ANALYSIS 12

Molecular sequences, Biological databases, Food specific Databases, Plant Databases, Sequence Alignment, Local and Global Alignment, BLAST family of programs, Multiple sequence alignment and its applications, Introduction to Phylogenetics, Building UPGMA, Neighbour Joining, Parsimonious and Maximum Likelihood trees

UNIT II OMICS TECHNIQUES, NEXT GENERATION SEQUENCING DATA AND APPLICATIONS 12

Genome sequencing, Sequencing Pipeline, Genome sequences of fermentation related microorganisms, Lactic Acid Bacteria, Comparative genomics and tool, NGS Data Resources, GEO and SRA databases, RNA-Seq Data Analysis, Differential Gene expression analysis

UNIT III PROTEIN STRUCTURE, MODELING AND DOCKING 12

Protein Structure Basics, Visualization, Prediction of Secondary Structure and Tertiary Structure, Homology Modeling, Taste receptors and their structures, Molecular docking and applications, Ligand interactions with taste receptors.

UNIT IV MICROBIOME, MICROARRAYS AND OTHER ADVANCED TOPICS 12

Microbiome; Beneficial effects of diet and microbiome modulation; Microarrays, Clustering techniques for microarray analysis; Introduction to Systems Biology; Metabolic networks; Metabolomic data resources, Building Stoichiometric matrices; Metabolic modeling

UNIT V APPLICATIONS OF INFORMATICS IN FOOD INDUSTRY 12

Enzymes in food industry, Systems Biology applications of metabolic modeling for strain improvement in fermentation, NGS data analysis for detection of food related pathogens, Comparative Genomics of food related pathogens.

Laboratory Demonstrations for Biological Databases, Sequence alignment: BLAST family of programs, Clustal Omega for multiple sequence alignment, Phylogenetics software, Homology Modeling and Model evaluation, AutoDock, NGS Data resources

TOTAL :60 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 assess and utilize various food specific databases and tools.

CO2 understand the Sequencing of microorganisms using NGS data resources and tools

CO3 impart the knowledge of proteins, ligand and their interactions using informatics tools.

CO4 assess and perform various molecular modeling techniques

TEXTBOOKS/REFERENCES

1) Dan Gusfield. Algorithms on Strings Trees and Sequences, 1997, Cambridge University Press.
2) David W. Mount Bioinformatics: Sequence and Genome Analysis, 2004, Cold Spring Harbor Laboratory Press
3) Arthur M. Lesk, Introduction to Bioinformatics, 2014, Oxford University Press
4) Andrew R. Leach, Molecular Modeling Principles And Applications, 2009, Prentice Hall.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

5) Durbin, R. Eddy S., Krogh A., Mitchison G. Biological Sequence Analysis: Probabilistic Models of Proteins and Nucleic Acids, 2013, Cambridge University Press
6) Shui Qing Ye, Big Data Analysis for Bioinformatics and Biomedical Discoveries, 2016, Edited, CRC Press, Taylor and Francis Group
7) Uri Alon, An Introduction to System Biology Design Principles of Biological Circuits, 2006, Chapman and Hall / CRC
8) Ravishankar Rai V (edited by) , Advances in Food Biotechnology, 2015, Wiley Blackwell

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	assess and utilize various food specific databases and tools.	3	-	-	2	3	-	-	-	2	-	2	2
CO2	understand the Sequencing of microorganisms using NGS data resources and tools	3	-	3	2	3	-	-	-	2	2	2	3
CO3	impart the knowledge of proteins, ligand and their interactions using informatics tools.	2	2	1	1	3	-	-	-	-	-	2	2
CO4	assess and perform various molecular modeling techniques	3	2	1	1	3	-	3	-	2	-	3	3
Over all CO		3	2	2	2	3	-	3	-	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5022 BY-PRODUCT UTILIZATION IN FOOD INDUSTRIES LT P C
3 0 0 3

OBJECTIVES

The course aims to

- study about Origin and type of waste and by products, waste identification, classification and composition.
- understand the Need for treatment and utilization, impact of waste disposal on environment.
- study about Food waste water treatments.
- understand about utilization of waste in food industries.

UNIT I FOOD INDUSTRY BY-PRODUCTS AND WASTE 10

Status in India, definition, origin and types of waste and by-products, their identification, classification, composition and characterization, need for treatment and utilization, impact on environment, food waste as source of biogenic raw material and energetic utilization, legal and statutory requirements for food waste handling, treatment & disposal.

UNIT II INTRODUCTION TO FOOD WASTE TREATMENT 12

Basic unit operations, techniques & equipment for treatment, primary treatments like screening, sedimentation, skimming, floatation coagulation & flocculation, flow equalization, filtration, adsorption, chemical oxidation, membrane separation, ion exchange. Anaerobic & aerobic digestion of organic wastes, activated sludge process, biomass generation & its utilization.

UNIT III FOOD WASTES AND BY-PRODUCTS RELATED TO SPECIFIC PROCESSING INDUSTRIES 9

Fruit and vegetables, dairy industry, oil and oil seeds industry, sugar industry, grains and milling industry, fermentation industry, livestock and poultry, fish, meat processing industries, Spice processing industries etc.

UNIT IV WASTE UTILIZATION AND CASE STUDIES 8

Utilization of whey for protein extraction and beverages from dairy industry, Utilization of specific plant by-products for recovery of proteins, pectins, dietary fibres, antioxidants, colorants etc., Utilization of biomass for production of animal feed, Extraction of leaf protein, banana fibre, pectin from waste of fruits, lycopene from tomato waste, starch manufacture, production of gelatin, utilization of egg shell, extraction of oil from wheat germ, corn germ and rice bran, Extraction of protein from oil cake, deoiled rice bran etc., soap formation, toffee/pinni from ghee residue.

UNIT V AGRO WASTE 6

Farm wastes, solid waste management and its disposal, Biogas generation, Biofuel, production of food packaging materials from agro waste, Compost/Vermicompost, Future Trends

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 understand the basics of by-products generated in various food processing industries

CO2 know the importance of wastes generated and the methods to dispose or to treat the wastes

CO3 familiarise with the concepts of conversion of waste to value added products

TEXTBOOKS/REFERENCES

1. Waste Management for the Food Industries, by Ioannis S. Arvanitoyannis, First edition 2008, Elsevier Inc, USA.
2. Food and Agricultural Wastewater Utilization and Treatment, Sean X. Liu, First edition 2007Blackwell Publishing, Iowa 50014, USA.
3. Managing Food Industry Waste, ROBERT R. ZALL, First edition, 2004, Blackwell Publishing Professional, Iowa, USA.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	2	3	4	5	6	7	8	9	10	11	12
CO1	know the basics of by-products generated in various food processing industries	3	2	2	3	3	2	3	3	2	2	2	2
CO2	know the importance of wastes generated and the methods to dispose or to treat the wastes	3	3	3	3	3	2	3	3	2	2	2	2
CO3	familiarize with the concepts of conversion of waste to value added products	3	3	3	3	3	1	3	3	3	2	3	2
Over all CO		3	3	3	3	3	2	3	3	2	2	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5023 FOOD LEGISLATION AND STANDARDS L T P C
3 0 0 3

OBJECTIVES

The course aims to

- provide in-depth knowledge in topics related to food legislation and standardization.
- provide an insight for the students in food manufacture and in food trade.

UNIT I INDIAN FOOD REGULATIONS 9

Need for food regulation, Food Safety and Food Standards Act 2006, Food Safety and Standards Authority of India (FSSAI) structure and functions, scientific committees and panels under FSSAI, Rule and Regulation making process

Food Safety and Standards Act, 2006 and the regulations made thereunder like Licensing and Registration, Packaging and Labelling Regulation, Food Products Standards and Food Additives Regulation, Nutraceutical Regulation, Claim Regulation, Contaminants and Toxins Regulation

UNIT II PRODUCT SPECIFIC INDIAN REGULATIONS 9

Indian Food Regulation - Food product categorization, Use of food additives in different products, Processing aid regulation New product /additive approval Food Product Recall, BIS mandatory certified products, Packaged Commodity Rules, AGMARK, etc including latest amendments

UNIT III INTERNATIONAL FOOD REGULATIONS 9

Concepts and trends in food legislation, Information-Domination in the European Food Industry, Agriculture, Ethics and Law, WHO in Global Food Safety Governance, The Right to Food in International Law with Case Studies

Intellectual Property and Food Labelling: Trademarks and Geographical Indications, Agricultural Innovation: Patenting and Plant Variety Rights Protection, Cross-Contamination, Genetic Drift, and GMO Co-existence with Non-GM Crops, Legal Barriers to International Food Trade, food policies

UNIT IV PUBLIC HEALTH AND NUTRITION REGULATION 9

Roles on Nutrition Goals and Outcomes: Connecting of Food and Public Health Systems, Planetary Boundaries in Food and Agriculture Law, Food and Nutrition in Cancer Prevention and Treatment, Pesticides and Cancer in Conventionally-Grown Versus Organic Food

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT V FOOD SECURITY AND SAFETY LEGISLATION 9

Internalizing Externalities: Techniques to Reduce Ecological Impacts of Food Production, Cooperatives and Producer Organizations Roles in Achieving Food Security, Governing the Global Food System Towards the Sustenance with Artificial Photosynthesis

Food Safety and Policy, Trade, Labelling Law - European Food Law, United States and Canada, Australia and New Zealand, Africa, Asia, Association of Southeast Asian Nations (ASEAN)

TOTAL:45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 identify the Agency responsible for legislation & implementation when facing a problem concerning a food

CO2 pinpoint the relevant legislation/standard for a certain food product

CO3 assess the meaning of what is written in the relevant legislation when facing a problem concerning a food

CO4 propose to pertinent Authorities amendments to existing legislation/standard whenever it seems justifiable

TEXTBOOK/REFERENCES

1. Understanding the Codex Alimentarius, By Food and Agriculture Organization of the United Nations, World Health Organization, 2016
2. International Food Law and Policy, edited by Gabriela Steier, Kiran K. Patel, Food Law International, Springer, 2016.
3. Singal RS. 1997. Handbook of Indices of Food Quality and Authenticity; Woodhead Publ. Cambridge, UK.
4. H J Heinz, David A. Shapton, Norah F. Shapton.2013, Principles and Practices of Safe Processing of Foods; Butterworth Publication, London.
5. Jacob MB.1999. The Chemical Analysis of Foods and Food Products; CBS Publ. New Delhi
6. FSSAI Regulations
7. ISO standards
8. Early R.1995.Guide to Quality Management Systems for Food Industries. Blackie Academic.
9. Furia TE.2018. Regulatory status of Direct Food Additives. CRC Press.

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	identify the Agency responsible for legislation & implementation when facing a problem concerning a food	-	3	-	3	3	3	2	3	3	-	-	3
CO2	pinpoint the relevant legislation/standard for a certain food product	-	3	-	3	3	3	2	3	3	-	-	3
CO3	assess the meaning of what is written in the relevant legislation when facing a problem concerning a food	-	3	-	3	3	3	2	3	3	-	-	3
CO4	propose to pertinent Authorities amendments to existing legislation/standard whenever it seems justifiable	-	3	-	3	3	3	2	3	3	-	-	3
Over all CO		-	3	-	3	3	3	2	3	3	-	-	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5024 **CONTROL OF FOOD INFESTATIONS** **L T P C**
3 0 0 3

OBJECTIVES

The course aims to

- develop the knowledge about pest infestation and its associated risk
- enable students to understand the methods involved in prevention an control of pests

UNIT I FOOD INFESTATION 9

Post harvest problems of infestation in stored food grains, spices and processed foods and food processing units; Economic losses and safety issues.

UNIT II COMMON PESTS 9

Common pests involved in food storage and handling: pests and their habits: rodents, cockroaches, flies, ants, stored product insects – beetles, weevils, moths; birds and other vertebrates

UNIT III RISK FROM PESTS 9

Risk posed by pests to foods, food handlers and public; contamination, toxicology and microbiology, transmission of pathogens, food infection and food poisoning. Food hygiene: regulations, GHP and GMP relevant to pest control

UNIT IV PEST PREVENTION 9

Pest prevention- E-R-D Exclusion, restriction, destruction in food operations; building design and pest proofing, warehousing and storage areas, water and drains. Waste collection and disposal

UNIT V PEST CONTROL 9

Inspection and auditing, physical methods: use of monitoring traps/detectors – electric fly control units, pheromone traps; Chemical control methods – use of insecticides, pesticides and rodenticides, safety and environmental consideration of chemicals used for control, biopesticides; fumigation and disinfection; Pest awareness training and education. Integrated Pest Management in the food industry, Regulatory aspects of pest management

TOTAL :45 PERIODS

OUTCOMES:

At the end of the course the students will be able to

CO1 have awareness about post-harvest issues in stored grains and processed foods caused by pests

CO 2 improve the analysing and problem-solving capabilities on risk assessments and prevention and control of pests.

CO3 learn the importance of pest management and its regulatory aspects.

TEXTBOOKS/REFERENCES

1. Dennis, S. H. “Pests of Stored Foodstuffs and their Control”, Springer, 2002
2. Hall, F.R and Menn, J.J. “Biopesticides: Use and Delivery”, Humana Press, 1999
3. Rami, H., et al. “Integrated Pest Management: Potential, Constraints and Challenges Insect Pest Management: Field and Protected Crops”, 2004
4. David Pimentel, Encyclopedia of Pest Management, Volume 2, CRC Press, 2007

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	have awareness about post-harvest issues in stored grains and processed foods caused by pests	-	3	3	2	3	2	1	3	3	-	-	2
CO2	improve the analysing and problem-solving capabilities on risk assessments and prevention and control of pests	-	3	3	2	3	2	1	3	3	-	-	2
CO3	learn the importance of pest management and its regulatory aspects.	-	3	3	2	3	2	1	3	3	-	-	2
Over all CO		-	3	3	2	3	2	1	3	3	-	-	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

FD5025 FOOD PRODUCT DESIGN AND DEVELOPMENT L T P C
3 0 0 3

OBJECTIVES

The course aims to

- familiarize Students with design, development and scale up of food products
- understand the regulations in quality, safety and marketing of food products

UNIT I FOOD NEEDS & CONSUMER PREFERENCE 9

Market survey and its importance in; designing a questionnaire to find consumer needs for a product or a concept; advantages of processed foods in urbanised Modern Society; why people buy processed foods. Developing a Product to Meet the Requirements

UNIT II DESIGNING NEW FOOD PRODUCTS 9

New Food Product Development (NPD) process and activities, NPD success factors, new product design, food innovation case studies, market-oriented NPD methodologies, organization for successful NPD; Recipe Development; use of traditional recipe and modification; recent developments in food ingredients/additives flavourings, colorings, emulsifiers, stabilizer and sweeteners; involvement of consumers, chefs and recipe experts; selection of materials/ingredients for specific purposes; modifications for production on large scale, cost effectiveness, nutritional needs or uniqueness; use of novel food ingredients and novel processing technologies.

UNIT III STANDARDIZATION & LARGE SCALE PRODUCTION 9

Process design, equipment needed and Design; establishing process parameters for optimum quality; Sensory Evaluation; Lab requirements; different techniques and tests; statistical analysis; application in product development and comparison of market samples; stages of the integration of market and sensory analysis.

UNIT IV QUALITY, SAFETY & REGULATORY ASPECTS 9

Product Stability; evaluation of shelf life; changes in sensory attributes and effects of environmental conditions; accelerated shelf life determination; developing packaging systems for maximum stability and cost effectiveness; interaction of package with food; Regulatory Aspects; whether standard product and conformation to standards; Approval for Proprietary Product.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT V ADVERTISEMENT, MARKETING & CASE STUDIES 9

Product performance testing; market positioning, Marketing: developing test market strategies; various tools and methodologies to evaluate consumer attitudes, preferences and market acceptance factors; Case Studies of some successes and failures- Factors that influence NPD success, innovation case studies to highlight best practice in terms of the integration of technological and marketing approaches to NPD; food choice models and new product trends.

TOTAL: 45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 gain knowledge on various aspects of Creativity, Innovation and New Product Development

CO2 understand the process of development of food products

CO3 develop ideas for new food products which are nutritious, cost effective, functional and marketable

TEXTBOOKS/REFERENCES

1. Brody, A. L. and John B. L. "Developing New Food Products for a Changing Marketplace", 2nd Edition, CRC / Taylor & Francis, 2008
2. Fuller, G.W. "New Food Product Development: From Concept to Marketplace", CRC, 2004
3. Macfie, H. "Consumer-led Food Product Development", CRC/Wood Head, 2007
4. Side, C. "Food Product Development: Based on Experience", Iowa State Press/Blackwell, 2002
5. Gupta, R. "Food Retailing: Emerging Trends", ICFAI University, Press, 2005
6. Chakraborty, A. "Food Processing: Opportunities and Challenges", ICFAI University Press, 2006

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	knowledge of various aspects of Creativity, Innovation and New Product Development	-	3	3	2	2	2	-	3	3	2	3	3
CO2	understand the process of development of food products	-	3	3	2	2	2	-	3	3	2	3	3
CO3	develop ideas for new food products which are nutritious, cost effective, functional and marketable	-	3	3	2	2	2	-	3	3	2	3	3
Over all CO		-	3	3	2	2	2	-	3	3	2	3	3

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

FD5026 **ESTABLISHMENT AND MANAGEMENT OF FOOD INDUSTRY SYSTEMS** **L T P C 3 0 0 3**

OBJECTIVES

The course aims to

- enlighten the students with the various steps involved in start-up of the food industry
- inculcate students with management skills that's required for the start-up of the food industry.

UNIT I OVERALL DESIGN OF AN ENTERPRISE 9

Plant design, sales planning for plant design. Plant Location, levels of Plant location. Location of layout: location factors, plant site selection. Location theory and models, industrial buildings and grounds. farm level collection and Chilling center. Space requirement.

UNIT II PREPARATION OF A PLANT LAYOUT 9

Plant Layout problem, importance, objectives, classical types of layouts. Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms. Development and Presentation of Layout : Development of the pilot layout, constructing the detailed layout: Functional de sign : Sitting of different sections in a plant, Layout installations. Quantitative analysis for Plant Layout: Engineering economy. Linear programming. Queing theory. Common Problems in Plant Layout and Process scheduling.

UNIT III PRACTICAL ASPECTS OF DESIGNING PLANT LAYOUT 9

Siting of Process sections, Equipment selection and capacity determination, Arrangement of process, and service equipment.Estimation of Services and Utilities.Office layout, line balancing, Flexibility.Practical Layouts.Common materials of construction of Food plant, building.Maintenance of Food Plant Building, Illumination and ventilation, Cleaning & sanitization, painting and colour coding, Fly and insect control.

UNIT IV LICENSING AND REGISTRATION 9

FSSAI regulations: Central Licensing Authority- Registration of Petty Food Business- License for food business- Conditions of License- Sanitary and hygienic requirements- food operations and controls - Management and Supervision - Food Testing Facilities - Audit, Documentation and Records

UNIT V FUNDING AGENCIES 9

Technology development funds-NRDC, DSIR; Funds for patent protection- Ministry of MSME, NIF; Technology in licensing funds- DSIR; Technology scale- up/ validation/ de-risking funds- DST, SIDBI, DIT; Market entry funds- NIF, KITVEN, Ministry of new and renewable energy, Angel network; Expansion funds- Venture capitalists, NABARD, Small and medium stock exchanges, Venture Funds with Govt. of India involvement.

TOTAL:45 PERIODS

OUTCOMES

At the end of the course the students will be able to

CO1 apply their knowledge on development and management of food industries.
CO2 have knowledge on registration and obtaining license from FSSAI
CO3 have knowledge on raising funds from different agencies' to establish the plant

TEXTBOOKS/REFERENCES

1. J. Andres Vasconcellos, "Quality Assurance for the Food Industry: A Practical Approach, Quality Assurance for the Food Industry: A Practical Approach", CRC Press, 2003, ISBN 0203498100, 9780203498101.
2. R. Bruce Tompkin, "Microbiological Testing in Food Safety Management", Springer Science & Business Media, 2002, ISBN 0306472627

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Course Articulation Matrix

Course outcome Statement		Programme outcome(PO)											
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
CO1	impeccable knowledge on the development and management of food industries	3	3	3	2	2	2	2	2	3	-	2	2
CO2	knowledge on registration and obtaining license from FSSAI	3	3	3	2	2	2	2	2	3	-	2	2
CO3	knowledge on raising funds from different agencies' to establish the plant	3	3	3	2	2	2	2	2	3	-	2	2
Over all CO		3	3	3	2	2	2	2	2	3	-	2	2

1, 2 and 3 are correlation levels with weightings as Slight (Low), Moderate (Medium) and Substantial (High) respectively

OPEN ELECTIVE COURSES (OEC)

OE5091 BUSINESS DATA ANALYTICS L T P C
3 0 0 3

OBJECTIVES:

- To understand the basics of business analytics and its life cycle.
- To gain knowledge about fundamental business analytics.
- To learn modeling for uncertainty and statistical inference.
- To understand analytics using Hadoop and Map Reduce frameworks.
- To acquire insight on other analytical frameworks.

UNIT I OVERVIEW OF BUSINESS ANALYTICS 9

Introduction – Drivers for Business Analytics – Applications of Business Analytics: Marketing and Sales, Human Resource, Healthcare, Product Design, Service Design, Customer Service and Support – Skills Required for a Business Analyst – Framework for Business Analytics Life Cycle for Business Analytics Process.

Suggested Activities:

- Case studies on applications involving business analytics.
- Converting real time decision making problems into hypothesis.
- Group discussion on entrepreneurial opportunities in Business Analytics.

Suggested Evaluation Methods:

- Assignment on business scenario and business analytical life cycle process.
- Group presentation on big data applications with societal need.
- Quiz on case studies.

UNIT II ESSENTIALS OF BUSINESS ANALYTICS 9

Descriptive Statistics – Using Data – Types of Data – Data Distribution Metrics: Frequency, Mean, Median, Mode, Range, Variance, Standard Deviation, Percentile, Quartile, z-Score, Covariance, Correlation – Data Visualization: Tables, Charts, Line Charts, Bar and Column Chart, Bubble Chart, Heat Map – Data Dashboards.

Suggested Activities:

- Solve numerical problems on basic statistics.
- Explore chart wizard in MS Excel Case using sample real time data for data visualization.
- Use R tool for data visualization.

Suggested Evaluation Methods:

- Assignment on descriptive analytics using benchmark data.
- Quiz on data visualization for univariate, bivariate data.

UNIT III MODELING UNCERTAINTY AND STATISTICAL INFERENCE 9

Modeling Uncertainty: Events and Probabilities – Conditional Probability – Random Variables – Discrete Probability Distributions – Continuous Probability Distribution – Statistical Inference: Data Sampling – Selecting a Sample – Point Estimation – Sampling Distributions – Interval Estimation – Hypothesis Testing.

Suggested Activities:

- Solving numerical problems in sampling, probability, probability distributions and hypothesis testing.
- Converting real time decision making problems into hypothesis.

Suggested Evaluation Methods:

- Assignments on hypothesis testing.
- Group presentation on real time applications involving data sampling and hypothesis testing.
- Quizzes on topics like sampling and probability.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

UNIT IV ANALYTICS USING HADOOP AND MAPREDUCE FRAMEWORK 9

Introducing Hadoop– RDBMS versus Hadoop–Hadoop Overview – HDFS (Hadoop Distributed File System) – Processing Data with Hadoop– Introduction to MapReduce – Features of MapReduce – Algorithms Using Map-Reduce: Matrix-Vector Multiplication, Relational Algebra Operations, Grouping and Aggregation – Extensions to MapReduce.

Suggested Activities:

- Practical – Install and configure Hadoop.
- Practical – Use web based tools to monitor Hadoop setup.
- Practical – Design and develop MapReduce tasks for word count, searching involving text corpus etc.

Suggested Evaluation Methods:

- Evaluation of the practical implementations.
- Quizzes on topics like HDFS and extensions to MapReduce.

UNIT V OTHER DATA ANALYTICAL FRAMEWORKS 9

Overview of Application development Languages for Hadoop – PigLatin – Hive – Hive Query Language (HQL) – Introduction to Pentaho, JAQL – Introduction to Apache: Sqoop, Drill and Spark, Cloudera Impala – Introduction to NoSQL Databases – Hbase and MongoDB.

Suggested Activities:

- Practical – Installation of NoSQL database like MongoDB.
- Practical – Demonstration on Sharding in MongoDB.
- Practical – Install and run Pig
- Practical – Write PigLatin scripts to sort, group, join, project, and filter data.
- Design and develop algorithms to be executed in MapReduce involving numerical methods for analytics.

Suggested Evaluation Methods:

- Mini Project (Group) – Real time data collection, saving in NoSQL, implement analytical techniques using Map-Reduce Tasks and Result Projection.

TOTAL: 45 PERIODS

OUTCOMES:

On completion of the course, the student will be able to:

- Identify the real world business problems and model with analytical solutions.
- Solve analytical problem with relevant mathematics background knowledge.
- Convert any real world decision making problem to hypothesis and apply suitable statistical testing.
- Write and Demonstrate simple applications involving analytics using Hadoop and MapReduce
- Use open source frameworks for modeling and storing data.
- Apply suitable visualization technique using R for visualizing voluminous data.

REFERENCES:

1. VigneshPrajapati, “Big Data Analytics with R and Hadoop”, Packt Publishing, 2013.
2. Umesh R Hodeghatta, UmeshaNayak, “Business Analytics Using R – A Practical Approach”, Apress, 2017.
3. AnandRajaraman, Jeffrey David Ullman, “Mining of Massive Datasets”, Cambridge University Press, 2012.
4. Jeffrey D. Camm, James J. Cochran, Michael J. Fry, Jeffrey W. Ohlmann, David R. Anderson, “Essentials of Business Analytics”, Cengage Learning, second Edition, 2016.
5. U. Dinesh Kumar, “Business Analytics: The Science of Data-Driven Decision Making”, Wiley, 2017.
6. A. Ohri, “R for Business Analytics”, Springer, 2012
7. Rui Miguel Forte, “Mastering Predictive Analytics with R”, Packt Publication, 2015.

	PO1	PO2	PO3	PO4	PO5	PO6
CO1	1	1	1	2	3	1
CO2	2	1	1	2	1	1
CO3	1	1	2	3	3	1
CO4	2	2	1	2	1	1
CO5	1	1	2	2	1	1
CO6	1	1	1	3	2	1

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OE5092 **INDUSTRIAL SAFETY** **LT P C**
3 0 0 3

OBJECTIVES:

- Summarize basics of industrial safety
- Describe fundamentals of maintenance engineering
- Explain wear and corrosion
- Illustrate fault tracing
- Identify preventive and periodic maintenance

UNIT I INTRODUCTION 9

Accident, causes, types, results and control, mechanical and electrical hazards, types, causes and preventive steps/procedure, describe salient points of factories act 1948 for health and safety, wash rooms, drinking water layouts, light, cleanliness, fire, guarding, pressure vessels, etc, Safety color codes. Fire prevention and firefighting, equipment and methods.

UNIT II FUNDAMENTALS OF MAINTENANCE ENGINEERING 9

Definition and aim of maintenance engineering, Primary and secondary functions and responsibility of maintenance department, Types of maintenance, Types and applications of tools used for maintenance, Maintenance cost & its relation with replacement economy, Service life of equipment.

UNIT III WEAR AND CORROSION AND THEIR PREVENTION 9

Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working and applications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV FAULT TRACING 9

Fault tracing-concept and importance, decision tree concept, need and applications, sequence of fault finding activities, show as decision tree, draw decision tree for problems in machine tools, hydraulic, pneumatic, automotive, thermal and electrical equipment's like, I. Any one machine tool, ii. Pump iii. Air compressor, iv. Internal combustion engine, v. Boiler, vi. Electrical motors, Types of faults in machine tools and their general causes.

UNIT V PERIODIC AND PREVENTIVE MAINTENANCE 9

Periodic inspection-concept and need, degreasing, cleaning and repairing schemes, overhauling of mechanical components, overhauling of electrical motor, common troubles and remedies of electric motor, repair complexities and its use, definition, need, steps and advantages of preventive maintenance. Steps/procedure for periodic and preventive maintenance of: I. Machine tools, ii. Pumps, iii. Air compressors, iv. Diesel generating (DG) sets, Program and schedule of preventive maintenance of mechanical and electrical equipment, advantages of preventive maintenance. Repair cycle concept and importance

TOTAL: 45 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of industrial safety
CO2: Ability to describe fundamentals of maintenance engineering
CO3: Ability to explain wear and corrosion
CO4: Ability to illustrate fault tracing
CO5: Ability to identify preventive and periodic maintenance

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Audels, Pump-hydraulic Compressors, Mcgrew Hill Publication, 1978.
2. Garg H P,Maintenance Engineering, S. Chand and Company,1987.
3. Hans F. Winterkorn ,Foundation Engineering Handbook, Chapman & Hall London,2013.
4. Higgins & Morrow , Maintenance Engineering Handbook,Eighth Edition,2008

OE5093 OPERATIONS RESEARCH LT P C
3 0 0 3

OBJECTIVES:

- Solve linear programming problem and solve using graphical method.
- Solve LPP using simplex method
- Solve transportation , assignment problems
- Solve project management problems
- Solve scheduling problems

UNIT I LINEAR PROGRAMMING 9

Introduction to Operations Research – assumptions of linear programming problems - Formulations of linear programming problem – Graphical method

UNIT II ADVANCES IN LINEAR PROGRAMMING 9

Solutions to LPP using simplex algorithm- Revised simplex method - primal dual relationships – Dual simplex algorithm - Sensitivity analysis

UNIT III NETWORK ANALYSIS – I 9

Transportation problems -Northwest corner rule, least cost method,Voges's approximation method - Assignment problem -Hungarian algorithm

UNIT IV NETWORK ANALYSIS – II 9

Shortest path problem: Dijkstra' s algorithms, Floyds algorithm, systematic method - CPM/PERT

UNIT V NETWORK ANALYSIS – III 9

Scheduling and sequencing - single server and multiple server models - deterministic inventory
models - Probabilistic inventory control models

TOTAL: 45 PERIODS

OUTCOMES:

CO1: To formulate linear programming problem and solve using graphical method.
CO2: To solve LPP using simplex method
CO3: To formulate and solve transportation, assignment problems
CO4: To solve project management problems
CO5: To solve scheduling problems

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

REFERENCES:

1. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010
2. Hitler Libermann, Operations Research: McGraw Hill Pub. 2009
3. Pant J C, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Pannerselvam, Operations Research: Prentice Hall of India 2010
5. Taha H A, Operations Research, An Introduction, PHI, 2008

OE5094 COST MANAGEMENTOF ENGINEERING PROJECTS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the costing concepts and their role in decision making
- Infer the project management concepts and their various aspects in selection
- Interpret costing concepts with project execution
- Develop knowledge of costing techniques in service sector and various budgetary control techniques
- Illustrate with quantitative techniques in cost management

UNIT I INTRODUCTION TO COSTING CONCEPTS 9

Objectives of a Costing System; Cost concepts in decision-making; Relevant cost, Differential cost, Incremental cost and Opportunity cost; Creation of a Database for operational control.

UNIT II INTRODUCTION TO PROJECT MANAGEMENT 9

Project: meaning, Different types, why to manage, cost overruns centres, various stages of project execution: conception to commissioning. Project execution as conglomeration of technical and nontechnical activities, Detailed Engineering activities, Pre project execution main clearances and documents, Project team: Role of each member,Importance Project site: Data required with significance, Project contracts.

UNIT III PROJECT EXECUTION AND COSTING CONCEPTS 9

Project execution Project cost control, Bar charts and Network diagram, Project commissioning: mechanical and process, Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis, Various decision-making problems, Pricing strategies: Pareto Analysis, Target costing, Life Cycle Costing.

UNIT IV COSTING OF SERVICE SECTOR AND BUDGETERY CONTROL 9

Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis, Budgetary Control: Flexible Budgets; Performance budgets; Zero-based budgets.

UNIT V QUANTITATIVE TECHNIQUES FOR COST MANAGEMENT 9

Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Learning Curve Theory.

TOTAL: 45 PERIODS

OUTCOMES

CO1 – Understand the costing concepts and their role in decision making CO2– Understand the project management concepts and their various aspects in selection

CO3–Interpret costing concepts with project execution

CO4–Gain knowledge of costing techniques in service sector and various budgetary control techniques

CO5 - Become familiar with quantitative techniques in cost management

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓	✓	✓		✓			✓	✓		✓	✓
CO2	✓	✓	✓		✓				✓		✓	✓
CO3	✓	✓	✓		✓	✓					✓	✓
CO4	✓	✓	✓		✓		✓				✓	✓
CO5	✓	✓	✓		✓	✓	✓				✓	✓

REFERENCES:

1. Ashish K. Bhattacharya, Principles & Practices of Cost Accounting A. H. Wheeler publisher, 1991
2. Charles T. Horngren and George Foster, Advanced Management Accounting, 1988
3. Charles T. Horngren et al Cost Accounting A Managerial Emphasis, Prentice Hall of India, New Delhi, 2011
4. Robert S Kaplan Anthony A. Alkinson, Management & Cost Accounting, 2003
5. Vohra N.D., Quantitative Techniques in Management, Tata McGraw Hill Book Co. Ltd, 2007

OE5095 COMPOSITE MATERIALS L T P C
3 0 0 3

OBJECTIVES:

- Summarize the characteristics of composite materials and effect of reinforcement in composite materials.
- Identifythe various reinforcements used in composite materials.
- Compare the manufacturing process of metal matrix composites.
- Understand the manufacturing processes of polymer matrix composites.
- Analyze the strength of composite materials.

UNIT I INTRODUCTION 9

Definition – Classification and characteristics of Composite materials - Advantages and application of composites - Functional requirements of reinforcement and matrix - Effect of reinforcement (size, shape, distribution, volume fraction) on overall composite performance.

UNIT II REINFORCEMENTS 9

Preparation-layup, curing, properties and applications of glass fibers, carbon fibers, Kevlar fibers and Boron fibers - Properties and applications of whiskers, particle reinforcements - Mechanical Behavior of composites: Rule of mixtures, Inverse rule of mixtures - Isostrain and Isostress conditions.

UNIT III MANUFACTURING OF METAL MATRIX COMPOSITES 9

Casting – Solid State diffusion technique - Cladding – Hot isostatic pressing - Properties and applications. Manufacturing of Ceramic Matrix Composites: Liquid Metal Infiltration – Liquid phase sintering. Manufacturing of Carbon – Carbon composites: Knitting, Braiding, Weaving - Properties and applications.

UNIT IV MANUFACTURING OF POLYMER MATRIX COMPOSITES 9

Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method –Filament winding method – Compression moulding – Reaction injection moulding - Properties and applications.

UNIT V STRENGTH 9

Laminar Failure Criteria-strength ratio, maximum stress criteria, maximum strain criteria, interacting failure criteria, hygrothermal failure. Laminate first play failure-insight strength; Laminate strength-ply discount truncated maximum strain criterion; strength design using caplet plots; stress concentrations.

TOTAL:45 PERIODS

OUTCOMES:

- CO1 - Know the characteristics of composite materials and effect of reinforcement in composite materials.
- CO2 – Know the various reinforcements used in composite materials.
- CO3 – Understand the manufacturing processes of metal matrix composites.
- CO4 – Understand the manufacturing processes of polymer matrix composites.
- CO5 – Analyze the strength of composite materials.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1		✓	✓	✓								
CO2		✓✓	✓	✓	✓						✓	
CO3			✓	✓	✓		✓				✓	
CO4			✓	✓	✓		✓				✓	
CO5				✓	✓		✓					

REFERENCES:

1. Cahn R.W. - Material Science and Technology – Vol 13 – Composites, VCH, WestGermany.
2. Callister, W.D Jr., Adapted by Balasubramaniam R, Materials Science and Engineering, An introduction, John Wiley & Sons, NY, Indian edition, 2007.
3. Chawla K.K., Composite Materials, 2013.
4. Lubin.G, Hand Book of Composite Materials, 2013.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

OE5096 **WASTE TO ENERGY** **L T P C**
3 0 0 3

OBJECTIVES:

- Interpret the various types of wastes from which energy can be generated
- Develop knowledge on biomass pyrolysis process and its applications
- Develop knowledge on various types of biomass gasifiers and their operations
- Invent knowledge on biomass combustors and its applications on generating energy
- Summarize the principles of bio-energy systems and their features

UNITI INTRODUCTION TO EXTRACTION OF ENERGY FROM WASTE 9

Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

UNITIIBIOMASS PYROLYSIS 9

Pyrolysis – Types, slow fast – Manufacture of charcoal – Methods - Yields and application – Manufacture of pyrolytic oils and gases, yields and applications.

UNITIII BIOMASS GASIFICATION 9

Gasifiers – Fixed bed system – Downdraft and updraft gasifiers – Fluidized bed gasifiers – Design, construction and operation – Gasifier burner arrangement for thermal heating – Gasifier engine arrangement and electrical power – Equilibrium and kinetic consideration in gasifier operation.

UNITIV BIOMASS COMBUSTION 9

Biomass stoves – Improved chullahs, types, some exotic designs, Fixed bed combustors, Types, inclined grate combustors, Fluidized bed combustors, Design, construction and operation - Operation of all the above biomass combustors.

UNITV BIO ENERGY 9

Properties of biogas (Calorific value and composition), Biogas plant technology and status - Bio energy system - Design and constructional features - Biomass resources and their classification - Biomass conversion processes - Thermo chemical conversion - Direct combustion - biomass gasification - pyrolysis and liquefaction - biochemical conversion - anaerobic digestion - Types of biogas Plants – Applications - Alcohol production from biomass - Bio diesel production -Urban waste to energy conversion - Biomass energy programme in India.

TOTAL: 45 PERIODS

OUTCOMES:

CO1 – Understand the various types of wastes from which energy can be generated
CO2 – Gain knowledge on biomass pyrolysis process and its applications
CO3 – Develop knowledge on various types of biomass gasifiers and their operations
CO4 – Gain knowledge on biomass combustors and its applications on generating energy
CO5 – Understand the principles of bio-energy systems and their features

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓		✓									✓
CO2	✓		✓									✓
CO3	✓	✓	✓		✓							✓
CO4	✓	✓	✓		✓		✓					✓
CO5	✓	✓	✓		✓							✓

REFERENCES:

1. Biogas Technology - A Practical Hand Book - Khandelwal, K. C. and Mahdi, S. S., Vol. I & II, Tata McGraw Hill Publishing Co. Ltd., 1983.
2. Biomass Conversion and Technology, C. Y. WereKo-Brobby and E. B. Hagan, John Wiley & Sons, 1996.
3. Food, Feed and Fuel from Biomass, Challal, D. S., IBH Publishing Co. Pvt. Ltd., 1991.
4. Non Conventional Energy, Desai, Ashok V., Wiley Eastern Ltd., 1990.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AUDIT COURSES (AC)

AX5091 ENGLISH FOR RESEARCH PAPER WRITING L T P C
2 0 0 0

OB ECTIVES

- Teach how to improve writing skills and level of readability
- Tell about what to write in each section
- Summarize the skills needed when writing a Title
- Infer the skills needed when writing the Conclusion
- Ensure the quality of paper at very first-time submission

UNITI INTRODUCTION TO RESEARCH PAPER WRITING 6

Planning and Preparation, Word Order, Breaking up long sentences, Structuring Paragraphs and Sentences, Being Concise and Removing Redundancy, Avoiding Ambiguity and Vagueness

UNIT II PRESENTATION SKILLS 6

Clarifying Who Did What, Highlighting Your Findings, Hedging and Criticizing, Paraphrasing and Plagiarism, Sections of a Paper, Abstracts, Introduction

UNIT III TITLE WRITING SKILLS 6

Key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check

UNIT IV RESULT WRITING SKILLS 6

Skills are needed when writing the Methods, skills needed when writing the Results, skills are needed when writing the Discussion, skills are needed when writing the Conclusions

UNIT V VERIFICATION SKILLS 6

Useful phrases, checking Plagiarism, how to ensure paper is as good as it could possibly be the first- time submission

TOTAL: 30 PERIODS

OUTCOMES

CO1 –Understand that how to improve your writing skills and level of readability
CO2 –Learn about what to write in each section
CO3 –Understand the skills needed when writing a Title
CO4 – Understand the skills needed when writing the Conclusion
CO5 – Ensure the good quality of paper at very first-time submission

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3										✓		✓
CO4										✓		✓
CO5										✓		✓

REFERENCES

1. Adrian Wallwork , English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011
2. Day R How to Write and Publish a Scientific Paper, Cambridge University Press 2006
3. Goldbort R Writing for Science, Yale University Press (available on Google Books) 2006
4. Highman N, Handbook of Writing for the Mathematical Sciences, SIAM. Highman's book 1998.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5092 **DISASTER MANAGEMENT** **L T P C**
2 0 0 0

OBJECTIVES

- Summarize basics of disaster
- Explain a critical understanding of key concepts in disaster risk reduction and humanitarian response.
- Illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
- Describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
- Develop the strengths and weaknesses of disaster management approaches

UNIT I INTRODUCTION 6

Disaster: Definition, Factors and Significance; Difference between Hazard And Disaster; Natural and Manmade Disasters: Difference, Nature, Types and Magnitude.

UNIT II REPERCUSSIONS OF DISASTERS AND HAZARDS 6

Economic Damage, Loss of Human and Animal Life, Destruction Of Ecosystem. Natural Disasters: Earthquakes, Volcanisms, Cyclones, Tsunamis, Floods, Droughts And Famines, Landslides And Avalanches, Man-made disaster: Nuclear Reactor Meltdown, Industrial Accidents, Oil Slicks And Spills, Outbreaks Of Disease And Epidemics, War And Conflicts.

UNIT III DISASTER PRONE AREAS IN INDIA 6

Study of Seismic Zones; Areas Prone To Floods and Droughts, Landslides And Avalanches; Areas Prone To Cyclonic and Coastal Hazards with Special Reference To Tsunami; Post-Disaster Diseases and Epidemics

UNIT IV DISASTER PREPAREDNESS AND MANAGEMENT 6

Preparedness: Monitoring Of Phenomena Triggering a Disaster or Hazard; Evaluation of Risk: Application of Remote Sensing, Data from Meteorological And Other Agencies, Media Reports: Governmental and Community Preparedness.

UNIT V RISK ASSESSMENT 6

Disaster Risk: Concept and Elements, Disaster Risk Reduction, Global and National Disaster Risk Situation. Techniques of Risk Assessment, Global Co-Operation in Risk Assessment and Warning, People's Participation in Risk Assessment. Strategies for Survival

TOTAL :30 PERIODS

OUTCOMES:

CO1: Ability to summarize basics of disaster

CO2: Ability to explain critical understanding of key concepts in disaster risk reduction and humanitarian response.

CO3: Ability to illustrate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.

CO4: Ability to describe an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.

CO5: Ability to develop the strengths and weaknesses of disaster management approaches

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1	✓											
CO2	✓											
CO3	✓	✓	✓									
CO4	✓	✓	✓									
CO5	✓	✓	✓									

REFERENCES

1. Goel S. L., Disaster Administration And Management Text And Case Studies", Deep & Deep Publication Pvt. Ltd., New Delhi,2009.
2. Nishitha Rai, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company,2007.
3. Sahni, Pardeep Et.Al. ," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi,2001.

AX5093 SANSKRIT FOR TECHNICAL KNOWLEDGE L T P C
2 0 0 0

OBJECTIVES

- Illustrate the basic sanskrit language.
- Recognize sanskrit, the scientific language in the world.
- Appraise learning of sanskrit to improve brain functioning.
- Relate sanskrit to develop the logic in mathematics, science & other subjects enhancing the memory power.
- Extract huge knowledge from ancient literature.

UNIT I ALPHABETS 6

Alphabets in Sanskrit

UNIT II TENSES AND SENTENCES 6

Past/Present/Future Tense - Simple Sentences

UNIT III ORDER AND ROOTS 6

Order - Introduction of roots

UNIT IV SANSKRIT LITERATURE 6

Technical information about Sanskrit Literature

UNIT V TECHNICAL CONCEPTS OF ENGINEERING 6

Technical concepts of Engineering-Electrical, Mechanical, Architecture, Mathematics

TOTAL:30 PERIODS

OUTCOMES:

- CO1 - Understanding basic Sanskrit language.
- CO2 - Write sentences.
- CO3 - Know the order and roots of Sanskrit.
- CO4 - Know about technical information about Sanskrit literature.
- CO5 - Understand the technical concepts of Engineering.

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12
CO1										✓		✓
CO2										✓		✓
CO3												✓
CO4												✓
CO5												✓

REFERENCES

1. "Abhyaspustakam" – Dr.Vishwas, Samskrita-Bharti Publication, New Delhi
2. "Teach Yourself Sanskrit" Prathama Deeksha-Vempati Kutumbshastri, Rashtriya Sanskrit Sansthanam, New Delhi Publication
3. "India's Glorious Scientific Tradition" Suresh Soni, Ocean books (P) Ltd., New Delhi, 2017.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5094	VALUE EDUCATION	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to

- Understand value of education and self-development
- Imbibe good values in students
- Let the should know about the importance of character

UNIT I

Values and self-development–Social values and individual attitudes. Workethics,Indianvisionofhumanism.Moralandnon-moralvaluation.Standards and principles. Value judgements

UNIT II

Importance of cultivation of values. Sense of duty. Devotion, Self-reliance. Confidence, Concentration. Truthfulness, Cleanliness. Honesty, Humanity. Power of faith, National Unity. Patriotism. Love fornature, Discipline

UNIT III

Personality and Behavior Development-Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour.

Universal brother hood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

Character and Competence–Holy books vs Blind faith. Self-management and Good health. Science of reincarnation. Equality, Nonviolence, Humility, Role of Women. All religions and same message. Mind your Mind, Self-control. Honesty, Studying effectively.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Knowledge of self-development.
- Learn the importance of Human values.
- Developing the over all personality.

Suggested reading

1. Chakroborty, S.K.“Values and Ethics for organizations Theory and practice”, Oxford University Press, New Delhi

AX5095	CONSTITUTION OF INDIA	L T P C 2 0 0 0

OBJECTIVES

Students will be able to:

- Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
- To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional
- Role and entitlement to civil and economic rights as well as the emergence nation hood in the early years of Indian nationalism.
- To address the role of socialism in India after the commencement of the Bolshevik Revolutionin1917and its impact on the initial drafting of the Indian Constitution.

UNIT I HISTORY OF MAKING OF THE INDIAN CONSTITUTION:

History, Drafting Committee, (Composition &Working)

UNIT II PHILOSOPHYOFTHE INDIANCONSTITUTION:

Preamble, Salient Features

UNIT III CONTOURS OF CONSTITUTIONAL RIGHTS AND DUTIES:

Fundamental Rights, Right to Equality, Right to Freedom, Right against Exploitation, Right to Freedom of Religion, Cultural and Educational Rights, Right to Constitutional Remedies, Directive Principles of State Policy, Fundamental Duties.

UNIT IV ORGANS OF GOVERNANCE:

Parliament, Composition, Qualifications and Disqualifications, Powers and Functions, Executive, President, Governor, Council of Ministers, Judiciary, Appointment and Transfer of Judges, Qualifications, Powers and Functions.

UNIT V LOCAL ADMINISTRATION:

District's Administration head: Role and Importance, • Municipalities: Introduction, Mayor and role of Elected Representative, CEO, Municipal Corporation. Pachayati raj: Introduction, PRI: Zila Pachayat. Elected officials and their roles, CEO Zila Pachayat: Position and role. Block level: Organizational Hierarchy(Different departments), Village level:Role of Elected and Appointed officials, Importance of grass root democracy.

UNIT VI ELECTION COMMISSION:

Election Commission: Role and Functioning. Chief Election Commissioner and Election Commissioners - Institute and Bodies for the welfare of SC/ST/OBC and women.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- DiscussthegrowthofthedemandforcivilrightsinIndiaforthebulkofIndiansbeforethe arrival of Gandhi in Indian politics.
- Discusstheintellectualoriginsoftheframeworkofargumentthatinformedtheconceptualizati on
- of social reform sliding to revolution in India.
- DiscussthecircumstancessurroundingthefoundationoftheCongressSocialistParty[CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.
- DiscussthepassageoftheHinduCodeBillof1956.

Suggested reading

1. TheConstitutionofIndia,1950(BareAct), Government Publication.
2. Dr. S. N. Busi, Dr. B. R.AmbedkarframingofIndianConstitution,1st Edition,2015.
3. M.P. Jain,IndianConstitutionLaw,7th Edn.,Lexis Nexis,2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis,2015.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5096	PEDAGOGY STUDIES	L T P C
		2 0 0 0

OBJECTIVES

Students will be able to:

- Review existing evidence on there view topic to inform programme design and policy
- Making under taken by the DfID, other agencies and researchers.
- Identify critical evidence gaps to guide the development.

UNIT I INTRODUCTION AND METHODOLOGY:

Aims and rationale, Policy background, Conceptual framework and terminology - Theories of learning, Curriculum, Teacher education - Conceptual framework, Research questions **-** Overview of methodology and Searching.

UNIT II THEMATIC OVERVIEW

Pedagogical practices are being used by teachers in formal and informal classrooms in developing countries - Curriculum, Teacher education.

UNIT III EVIDENCE ON THE EFFECTIVENESS OFPEDAGOGICALPRACTICES

Methodology for the in depth stage: quality assessment of included studies - How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy? - Theory of change - Strength and nature of the body of evidence for effective pedagogical practices - Pedagogic theory and pedagogical approaches - Teachers' attitudes and beliefs and Pedagogic strategies.

UNIT IV PROFESSIONAL DEVELOPMENT

Professional development: alignment with classroom practices and follow up support - Peer support - Support from the head teacher and the community - Curriculum and assessment - Barriers to learning: limited resources and large class sizes

UNIT V RESEARCH GAPS AND FUTURE DIRECTIONS

Research design – Contexts – Pedagogy - Teacher education - Curriculum and assessment - Dissemination and research impact.

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to understand:

- Whatpedagogicalpracticesarebeingusedbyteachersinformalandinformalclassrooms in developing countries?
- What is the evidence on the effectiveness soft he sepedagogical practices, in what conditions, and with what population of learners?
- How can teacher education(curriculum and practicum)and the school curriculum and guidance materials best support effective pedagogy?

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

Suggested reading

1. Ackers, HardmanF(2001)ClassroominteractioninKenyanprimaryschools,Compare,31(2): 245-261.
2. AgrawalM (2004)Curricular reform in schools: The importance of evaluation, JournalofCurriculumStudies,36(3):361-379.
3. AkyeampongK(2003)TeachertraininginGhana-doesitcount?Multi-siteteachereducationresearchproject(MUSTER) country report 1.London:DFID.
4. Akyeampong K,LussierK, PryorJ, WestbrookJ (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33(3): 272–282.
5. Alexander RJ(2001) Culture and pedagogy: International comparisons in primary education. Oxford and Boston: Blackwell.
6. ChavanM (2003) Read India: Amass scale, rapid, 'learningtoread 'campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf

AX5097 **STRESS MANAGEMENT BY YOGA** **L T P C**
2 0 0 0

OBJECTIVES

- To achieve overall health of body and mind
- To overcome stress

UNIT I

Definitions of Eight parts of yoga.(Ashtanga)

UNIT II

Yam and Niyam - Do's and Don't'sin life - i) Ahinsa, satya, astheya, bramhacharya and aparigraha, ii) Ahinsa, satya, astheya, bramhacharya and aparigraha.

UNIT III

Asan and Pranayam - Various yog poses and their benefits for mind & body - Regularization of breathing techniques and its effects-Types of pranayam

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to:

- Develop healthy mind in a healthy body thus improving social health also
- Improve efficiency

SUGGESTEDREADING

1. 'YogicAsanasforGroupTarining-Part-I":JanardanSwamiYogabhyasiMandal, Nagpur
2. "Rajayogaorconquering the Internal Nature" by Swami Vivekananda, Advaita Ashrama (Publication Department),Kolkata

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025

AX5098	PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS	L T P C 2 0 0 0

OBJECTIVES

- To learn to achieve the highest goal happily
- To become a person with stable mind, pleasing personality and determination
- To a waken wisdom in students

UNIT I

Neetishatakam-holistic development of personality - Verses- 19,20,21,22 (wisdom) - Verses- 29,31,32 (pride & heroism) – Verses- 26,28,63,65 (virtue) - Verses- 52,53,59 (dont's) - Verses- 71,73,75,78 (do's)

UNIT II

Approach to day to day work and duties - Shrimad BhagwadGeeta: Chapter 2-Verses 41, 47,48 - Chapter 3-Verses 13, 21, 27, 35 Chapter 6-Verses 5,13,17,23, 35 - Chapter 18-Verses 45, 46, 48.

UNIT III

Statements of basic knowledge - Shrimad BhagwadGeeta: Chapter2-Verses 56, 62, 68 Chapter 12 -Verses 13, 14, 15, 16,17, 18 -Personality of role model - shrimadbhagwadgeeta - Chapter2-Verses 17, Chapter 3-Verses 36,37,42 - Chapter 4-Verses 18, 38,39 Chapter18 – Verses 37,38,63

TOTAL: 30 PERIODS

OUTCOMES

Students will be able to

- Study of Shrimad- Bhagwad- Geeta will help the student in developing his personality and achieve the highest goal in life
- The person who has studied Geeta will lead the nation and man kind to peace and prosperity
- Study of Neetishatakam will help in developing versatile personality of students.

Suggested reading

1. Gopinath, Rashtriya Sanskrit Sansthanam P, Bhartrihari's Three Satakam, Niti-sringar-vairagya, New Delhi,2010
2. Swami Swarupananda , Srimad Bhagavad Gita, Advaita Ashram, Publication Department, Kolkata, 2016.

Attested

DIRECTOR
Centre for Academic Courses
Anna University, Chennai-600 025