आईएफटीएम विश्वविद्यालय, मुरादाबाद, उत्तर प्रदेश

IFTM University, Moradabad, Uttar Pradesh

NAAC ACCREDITED

SCHOOL OF AGRICULTURAL SCIENCES & ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

MASTER OF TECHNOLOGY

AGRICULTURAL ENGINEERING

(FARM MACHINERY AND POWER ENGINEERING)

[*w.e.f.* ACADEMIC SESSION 2018 – 19]

IFTM UNIVERSITY

N.H.-24, Lodhipur Rajput, Delhi Road, Moradabad, Uttar Pradesh-244102
Website: www.iftmuniversity.ac.in

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SCHOOL OF AGRICULTURAL SCIENCES & ENGINEERING

DEPARTMENT OF AGRICULTURAL ENGINEERING

Study and Evaluation Scheme

of

Master of Technology

Agricultural Engineering

(Farm Machinery and Power Engineering)

[*w.e.f.* Academic Session 2018 – 19]

Summary

Programme:	**Master of Technology** **Agricultural Engineering** **(Farm Machinery and Power Engineering)**
Programme Level:	**Degree (Post Graduation)**
Duration:	**Two Years (Four semesters) Full time**
Medium of Instruction:	**English**
Minimum Required Attendance:	**75%**
Maximum Credits:	**66**

IFTM UNIVERSITY
MORADABAD

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N.H-24 Lodhipur Rajput , Delhi Road, Moradabad, Uttar Pradesh-244102

www.iftmuniversity.ac.in

Effective from 2018-2019

Programme: M. Tech. Agricultural Engineering (Process and Food Engineering)

Programme Outcomes (POs):
Students completing this course will be able to:

1. Design solution for complex problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.
2. Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problem.
3. Capable of synthesizing, processing and post harvest management system in the field of agriculture.
4. Acquire the basic knowledge about constituents, pre-treatment and processing of food and milk
5. Demonstrate ability to Function Effectively Individually and also as a Team Member in Multidisciplinary activities.
6. Communicate Effectively in both Verbal and Written Forms
7. Understand packaging laws and regulations as per standards laid down by government agencies.
8. Understand the basic principles of refrigeration and air conditioning.

School of Agricultural Sciences & Engineering, IFTMU

STUDY & EVALUATION SCHEME

M. Tech. Agricultural Engineering (Process and Food Engineering)

YEAR - I, SEMESTER - I

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	**MAE101**	**Advanced Food Process Engineering**	3	0	0	20	10	30	70	100	3
2.	**MAE102**	**Food Plant Design**	3	0	0	20	10	30	70	100	3
3.	**MBT101**	**Food Chemistry**	3	0	0	20	10	30	70	100	3
4.	**MME104**	**Heat and Mass Transfer**	3	0	0	20	10	30	70	100	3
PRACTICALS / PROJECT											
						AI	AT				
5.	**MAE151**	**Food Process Engineering Lab**	0	0	2	40	10	50	50	100	1
6.	**MBT151**	**Food Chemistry Lab**	0	0	2	40	40	50	50	100	1
.		**TOTAL**	**12**	**00**	**04**					**600**	**14**

YEAR - I, SEMESTER - II

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	**MAE201**	**Unit Operations in Food Process Engineering**	3	0	0	20	10	30	70	100	3
2.	**MAE202**	**Engineering Properties of Food Materials**	3	0	0	20	10	30	70	100	3
3.	**MAE203**	**Elective I**	3	0	0	20	10	30	70	100	3
4.	**MMAG204**	**Agricultural Statistics and Experimental Designs**	3	0	0	20	10	30	70	100	3
PRACTICALS / PROJECT											
						AI	AT				
5	**MAE251**	**Unit operations Lab**	0	0	2	40	10	50	50	100	1
6	**MMAG254**	**Agricultural Statistics and Experimental Designs Lab**	0	0	2	40	40	50	50	100	1
		TOTAL	**12**	**00**	**04**					**600**	**14**

School of Agricultural Sciences & Engineering, IFTMU

STUDY & EVALUATION SCHEME

M. Tech. Agricultural Engineering (Process and Food Engineering)

YEAR - II, SEMESTER - III

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
THEORY											
1.	**MAE301**	**Food Quality and Safety Engineering**	3	0	0	20	10	30	70	100	3
2.	**MAE302**	**Food Packaging and Technologies**	3	0	0	20	10	30	70	100	3
3.	**MAE303**	**Elective II**	3	0	0	20	10	30	70	100	3
PRACTICALS / PROJECT											
4.						AI	AT				
5.	**MAE351**	**Food Quality and Safety Engineering Lab**	0	0	2	40	10	50	50	100	1
6.	**MAE352**	**Seminar**	0	0	4	-	100	100	-	100	4
7.	**MAE353**	**Pre-Dissertation**	0	0	4	-	50	50	50	100	4
		Total	**09**	**00**	**10**					**600**	**18**

YEAR - II, SEMESTER - IV

S.N.	Course Code	Course Name	Periods			EVALUATION SCHEME				Course Total	Credits
						Mid Term Exam			External Exam		
			L	T	P	CT	AS +AT	Total			
PRACTICALS / PROJECT											
1.	**MAE451**	**Dissertation Work**	**-**	**-**	20		300	300	300	600	20
		Total	**-**	**-**	**20**					**600**	**20**

School of Agricultural Sciences & Engineering, IFTMU

STUDY & EVALUATION SCHEME

M. Tech. Agricultural Engineering (Process and Food Engineering)

List of Electives

Group- A

Elective I

S.N.	CODE	Name of Elective
1.	MAE203 I	Fruits and Vegetables Process Engineering
2.	MAE203 II	Processing of Cereals, Pulses and oil Seed
3.	MAE203 III	Farm Structures and Environmental Control

Group- B

Elective I

S.N.	CODE	Name of Elective
1.	MAE303 I	Storage Engineering and Handling of Agricultural Products
2.	MAE303 II	Food Supply Chain Management
3.	MAE303 III	Agricultural Waste and by –Products Utilization

MAE101 Advanced Food Process Engineering L:T:P 3:0:0

Objectives:

- To enable the students to solve problems in Food Engineering process of value addition and quality improvement.
- To impart knowledge on the Advanced of Food Process Engineering and its importance for the Food Industry.
- To make the student to understand units and dimensions, ability to solve engineering problems related to food processing, and familiarization with some food processing unit operations.

UNIT I

Scope of food processing; historical developments; principles of food processing and preservation.

UNIT II

Processing and preservation by heat – blanching, pasteurization, sterilization and UHT processing, canning, extrusion cooking, dielectric heating, microwave heating, baking, roasting and frying, etc. Milk Processing

UNIT III

Processing and preservation by low-temperature- refrigeration, freezing, and de-hydro-freezing. Processing and preservation by drying, concentration and evaporation-types of dryers, ultra-filtration, reverse osmosis.

UNIT IV

Processing and preservation by non-thermal methods, irradiation, high pressure Processing (HPP), pulsed electric field, hurdle technology.

UNIT V

Use and application of enzymes and microorganisms in processing and preservation of foods; food fermentations, pickling, smoking, etc.; Food additives: definition, types and functions, permissible limits and safety aspects.

Course Outcomes:

- The students understand the principles in formulating solutions to solve problems in food industry.
- The students understood the importance of Food Process Engineering as one of the major pillars of Food Science and Technology discipline.
- The students acquired the required skills in dealing with units and dimensions, solving problems of Food Process Engineering.

References:

1. **Arsdel W B, Copley MJ & Morgan** AI. 1973. Food Dehydration. 2nd Ed. Vols. I, II. AVI Publ.
2. **Desrosier N W & James N.1977**. Technology of Food Preservation. 3th Ed. AVI. Publ.
3. **Fellows P J. 2005**. Food Processing Technology: Principle and Practice. 2nd Ed. CRC.
4. **Jelen P. 1985**. Introduction to Food Processing. Prentice Hall.
5. **Potter N N & Hotchkiss 1997**. Food Science. 5th Ed. CBS.
6. **Potty V H & Mulky M J**. 1993. Food Processing. Oxford & IBH.
7. **Ramaswamy H & Marcotte M. 2006**. Food Processing: Principles and Applications. Taylor & Francis.

Website Sources:

- https://ecourses.icar.gov.in/
- www.agrimoon.com

MAE151 **Food Process Engineering Lab** **L:T:P 0:0:1**

List of Experiments:

Minimum 08 experiments out of the following:

1. Measurement of Moisture Content in Food.
2. Drying and Drying characteristics of food Materials.
3. Post harvest handling of different fruits, vegetable and seed crops.
4. Preparation and evaluation of table butter, ice-cream, cheese and indigenous milk product such pioneer, Dahi, ghee, Lassi, Burfi etc.
5. Preparation of Fermented food products.
6. Evolution of Milk Quality.
7. Preparation of fruit beverage, i.e. Orange squash, grape squash, lime squash.
8. Preparation of fruit juices- orange, pineapple, apple, lemon etc.
9. Studies on of different types of freezers.
10. Studies on Low Temperature Preservation Techniques.
11. Studies on Concentration of Liquid Food.
12. Studies on extrusion cooking of foods.
13. Study on basics of reception of milk at the plant; platform tests on milk.
14. Use of chemicals in preservation of foods.
15. Visit to a food processing plant.

MAE102 **Food Plant Design** **L:T:P 3:0:0**

Objectives:

- To enable the students to solve problems in hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment,
- To impart knowledge on the design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation.
- To make the student to understand design considerations of layout and equipment.

UNIT I

Design considerations of layout and equipment.

UNIT II

Plant design concepts and general design considerations: plant location, location factors and their interaction with plant location, location theory models, Computer aided selection of the location.

UNIT III

Design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation. Human factors in design, selection of materials of construction and standard component, design standards and testing standards.

UNIT IV

Feasibility analysis and preparation of feasibility report: plant size, factors affecting plant size and their interactions, estimation of break-even and economic plant size; Product and process design, process selection, process flow charts, and computer aided development of flow charts.

UNIT V

Hygienic design aspects and worker's safety, functional design of plant building and selection of building materials, estimation of capital investment, analysis of plant costs and profit abilities, management techniques in plant design including applications of network analysis, preparation of project report and its appraisal.

Course Outcomes:

- The students understand the principles in design considerations of layout and equipment.
- The students understood the importance on the design of machinery for drying, milling, separation, grinding, mixing, evaporation, condensation, membrane separation.
- The students acquired the required skills in dealing with units and dimensions, design solving problems of Food Process Engineering.

References:

1. **Ahmed T. 1997.** Dairy Plant Engineering and Management. 3th Ed. Kitab Mahal.
2. **Chakraverty A & De DS**. 1981. Post-harvest Technology of Cereals.
3. **Hall CW & Davis DC. 1979**. Processing Equipment for Agricultural Products. AVI Publ.
4. **Henderson S & Perry SM. 1976.** Agricultural Process Engineering. 5th Ed. AVI Publ.
5. **Johnson AJ. 1986**. Process Control Instrumentation Technology. 2nd Ed. Wiley International & ELBS.
6. **Richey CB. (Ed.). 1961**. Agricultural Engineers' Hand Book. Mc Graw Hill.
7. **Romeo T Toledo. 1997.** Fundamentals of Food Process Engineering. CBS.

Website Sources:

- https://ecourses.icar.gov.in/
- www.agrimoon.com

MBT-101 **Food Chemistry** **L:T:P 3:0:0**

Objectives:

- To understand the chemistry of food constituents
- To apply fool molecules interaction in developing technologies / processes
- To develop skills for experimenting with food systems and to test various approaches for manipulating
- The chemical and/or functional properties of foods.

Unit-I

Food chemistry: definition and importance; Water: functions, physical properties, types of water, water activity and shelf life of food; Carbohydrates: definition, nomenclature, classification, physical and chemical properties of sugar, functional properties of polysaccharides, modified starch, starch hydrolysates, polyols, glycogen, fiber.

Unit-II

Proteins; physical and chemical properties of amino acids, proteins, classification and structure, function and properties of protein, animal and plant proteins, effect of processing; Lipids: classification, estimation of fatty acids, physical properties, Fat constant: saponification number, acid number, iodine value, acetyl value, Reichert Meissel number, effect of freezing, flavourre version.

Unit-III

Oxidative and hydrolytic rancidity, hydrogenation, interesterification, different types of fats, uses in food processing, food emulsions, fat replacers.

Unit-IV

Minerals: classification, minerals in meat, milk, plants and their interaction with other components, losses of minerals during processing, metal uptake in canned foods; Vitamins: fat soluble and water soluble vitamins, their food sources, effect of food processing.

Unit-V

Enzymes: nature and functions, enzymes in food processing, immobilized enzymes; Natural pigments and flavoring agents; chlorophyll, carotenoids, anthocyanins, anthoxanthins,

flavonoids, tannins, natural flavour constituents; Additives and contaminants: intentional additives, incidental additives, anti-nutritional factors.

Course Outcomes:

- To name and describe the general chemical structures of the major components of foods (water, proteins,
- Carbohydrates, and lipids) and selected minor components (vitamins and minerals).
- To relate the chemical composition of foods to their functional properties
- To understand, plan, perform and analyse a range of chemical investigations with an emphasis on food Analysis
- To give a molecular rationalization for the observed physical properties and reactivity of major food components.
- To predict how changes in overall composition are likely to change the reactivity of individual food components.

References:

1. **John DeMan**, Principles of Food Chemistry, 3rded,Springer-Verlag, 1999.
2. **C.M.Weaver and J.R.Daniel**, The Food Chemistry Laboratory: A Manual for Experimental
3. foods, Dietetics, Food Scientists. CRC Press, 1996.
4. **S. Damodaran**, S., K.L. Parkin, O.R. Fennema, Fennema's Food Chemistry. CRC, 2007.
5. **O. R. Fennema**, Principles of Food Science Part I: Food Chemistry, Marcel Dekker, 1996.
6. **H.D.Belitz, W.Grosch and P.Schieberle**, Food Chemistry, 3rded, Springer-Verlag, 2003.

Website Sources:

1. https://ecourses.icar.gov.in/
2. www.agrimoon.com

MBT-151 **Food Chemistry Lab** **L:T:P 0:0:1**

List of Experiments:

Minimum 08 experiments out of the following:

1. Deduction of Adulterants in Fat and Oils.
2. Deduction of Adulterants in Milk, Water and Starch.
3. Determination of ash content.
4. Determination of gluten content in Wheat.
5. Determination of minerals: calcium, phosphorous and iron.
6. Determination of proteins.
7. Determination of total sugar (Reducing and Non reducing).
8. Estimation of vitamins: ascorbic acid, carotene and thiamine.
9. Moisture and Total Solids in Fluids.
10. Study of Detection and estimation of amino acids by chromatographic techniques.
11. Study of enzymatic and nonenzymatic browning in food.
12. Study of phosphorus and iron; anti-nutritional factors in foods.

MME-104 **Heat and Mass Transfer** **L:T:P 3:0:0**

Objectives:

- To enable the student to basic study of the phenomena of heat and mass transfer, to develop methodologies for solving food engineering problems
- To understand the information concerning the performance and design of Heat exchangers
- To develop processes with better heat efficiency and economics

UNIT I

Introduction to heat and mass transfer and their analogous behavior, steady and unsteady state heat conduction, analytical and numerical solution of unsteady state heat conduction equations, use of Gurnie-Lurie and Heisler Charts in solving heat conduction problems. Applications in food processing including freezing and thawing of foods.

UNIT II

Convective heat transfer in food processing systems involving laminar and turbulent flow heat transfer in boiling liquids, heat transfer between fluids and solid foods. Functional design of heat exchangers: Shell and tube, plate and scraped surface heat exchangers, Jacketed vessels.

UNIT III

Radiation heat transfer and its governing laws, its applications in food processing.

UNIT IV

Molecular diffusion in gases, liquids and solids; molecular diffusion in biological solutions and suspensions molecular diffusion in solids.

UNIT V

Unsteady state mass transfer and mass transfer coefficients, molecular diffusion with convection and chemical reaction, diffusion of gases in porous solids and capillaries, mass transfer applications in food processing.

Course Outcomes: To understand the basic laws of heat transfer and account for the consequence of heat transfer in thermal analyses of engineering systems.

- To analyze problems involving steady state heat conduction in simple geometries.
- To evaluate heat transfer coefficients for natural convection.
- To analyze heat exchanger performance by using the method of log means temperature difference.
- To analyze heat exchanger performance by using the method of heat exchanger effectiveness.
- To understand the influence of radiation in food processing operations

References:

1. **Benjamin G. 1971.** Heat Transfer. 2nd Ed. Tata McGraw Hill. Coulson JM & Richardson JF. 1999. Chemical Engineering. Vol. II, IV. The Pergamon Press.
2. **Earle R L. 1985.** Unit Operations in Food Processing. Pergamon Press.
3. **Geankoplis J Christie 1999**. Transport Process and Unit Operations. Allyn & Bacon.
4. **Holman J P. 1992.** Heat Transfer. McGraw Hill.
5. **Kreith Frank 1976**. Principles of Heat Transfer. 3rd Ed. Harper & Row.
6. **McCabe W L & Smith J C. 1999**. Unit Operations of Chemical Engineering. McGraw Hill.
7. **Treybal R E. 1981**. Mass Transfer Operations. Mc Graw Hill.
8. **Warren Gredt H. 1987.** Principles of Engineering Heat Transfer. Affiliated East-West Press.

Website Sources:

- https://ecourses.icar.gov.in/
- www.agrimoon.com

MAE201 Unit Operations in Food Process Engineering L:T:P 3:0:0

Objectives:

- To know the various types of equipments used in the food industry.
- To learn the operation and utilization of equipments involved.
- To choose suitable techniques for the food processing operation.

UNIT I

Preservation of foods – physical and chemical methods-microbiological aspects thermo bacteriology. Principles of fluid flow, methods of heat transfer, heat exchangers and their designs. Evaporation and distillation: Blanching, pasteurization-LTLT, HTST and UHT process. Evaporation – definition single and multiple effect evaporator, mass and enthalpy balance, liquid characteristics – single and multiple effect evaporation-performances of evaporators.

UNIT II

Psychrometry, dehydration, EMC, Thermal processing operations; Evaporation, dehydration/drying, types of dryers, blanching, steam requirements in food processing. Homogenization; Mixing- mixers, kneaders and blenders. Extrusion, Extrusion cooking - recent developments, methods, equipment, Membrane technology. Nonthermal processing techniques. Hurdle technology - hydrostatic pressure treatment of food - equipment, processing

UNIT III

Refrigeration principles and Food freezing. Mechanical separation techniques, size separation equipments; Filtration, sieving, centrifugation, sedimentation. Conveyors and elevators; Size reduction processes; Grinding and milling. Milling of food Materials & Its Equipments.

UNIT IV

Material handling equipments- screw conveyor, bucket elevator, belt conveyor, chain conveyor, pneumatic conveyor-size reduction process- energy and power requirements in commenting- Rittinger's, Bond's and Kick's laws of crushing - principles of milling equipments - hammer mill, ball mill.

UNIT V

Application of heat energy and ultrasound - inactivation of microorganisms and enzymes - electrical resistance heating of food - heat generation, ohmic heater, heating models - pulsed electric field preservation- principles and application.

Course Outcomes:

- To define the various unit operations in food processing.
- To compute the moisture content of food materials.
- To describe and demonstrate the various process equipments.
- To evaluate the different operations in food processing.
- To estimate the energy requirement for the different unit operations.
- To develop unit operation system for food processing.

References:

1. **Earle R L. 1985**. Unit Operations in Food Processing. Pergamon Press.
2. **Fellows P. 1988.** Food Processing Technology: Principle and Practice. VCH Publ.
3. **McCabe, W L & Smith, J C. 1999.** Unit Operations of Chemical Engineering. McGraw Hill.
4. **Sahay K M & Singh K K.** 1993. Unit Operation of Agricultural Processing. Vikas Publ. House.

Website Sources:

- https://ecourses.icar.gov.in/
- www.agrimoon.com

MAE251 **Unit Operations Lab** **L:T:P 0:0:1**

List of Experiments:

Minimum 08 experiments out of the following:

1. Design and layout of seed processing plant and its economics.
2. Determination of size, shape, density and area-volume-mass relationship of fruits and vegetables.
3. Experiments for the determination of physical properties like, length, breadth, thickness, surface area, bulk density, porosity, true density, coefficient of friction, angle of repose and color for various food grains,
4. Study of different types of dryers.
5. Study of driers, elevating and conveying equipments, size reduction equipments, cleaning and sorting equipments, mixing equipments.
6. Study of Drying Characteristics of food materials.
7. Study of Operation and performance evaluation of various seed processing equipments such as pre cleaner, scalpers, air screen cleaner, indented cylinder, gravity separator, pneumatic separator, conveyors.
8. Study of paddy, wheat, pulses and oilseeds milling equipments; planning and layout of various milling plants.
9. Study of thermal properties like thermal conductivity, thermal diffusivity and specific heat.
10. Study on CAP and MAP.
11. To study the heat exchanger process in double pipe heat exchanger under parallel and counter current flow condition.
12. Visit to a food processing plant.

MAE202 Engineering Properties of Food Materials L:T:P 3:0:0

Objectives:

- To study about the different methods of determining the quality and properties of different foods
- To gain knowledge of engineering properties during processing, packing, storage and transport.
- To impart knowledge about electrical properties of food and its applications in food engineering.

UNIT I

Physical characteristics of different food grains, fruits and vegetables; Shape and size, description of shape and size, volume and density, porosity, surface area. Rheology; terms, physical states of materials, classical ideal material, rheological models and equations, visco elasticity, creep-stress relaxation, Non Newtonian fluid and viscometer, rheological properties, force, deformation, stress, strain, elastic, plastic behavior.

UNIT II

Contact stresses between bodies, Hertz problems, firmness and hardness, friction, effect of load, sliding velocity, water film and surface roughness. Friction in agricultural materials, rolling resistance, angle of internal friction, angle of repose, flow of bulk granular materials, aerodynamics of agricultural products, drag coefficients.

UNIT III

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity, methods of determination, steady state and transient heat flow.

UNIT IV

Electrical properties; Dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant, method of determination, energy absorption from high-frequency electric field.

UNIT V

Application of engineering properties in design and operation of agricultural equipment and structures.

Course Outcomes:

- To understand Engineering properties of food materials.
- To identify the structure and chemical composition of foods.
- To determine the physical properties of food materials.
- To calculate the water activity, food stability sorption and desorption isotherm of food materials.
- To study the difference between Newtonian and non-Newtonian fluids.
- To examine the thermal properties, electrical and magnetic properties of food.
- To measure the aero- and hydrodynamic characteristics and the application of frictional properties in grain handling, processing and conveying.

References:

1. **Mohesenin N N. 1980**. Thermal Properties of Foods and Agricultural Materials. Gordon & Breach Science Publ.
2. **Mohesenin N N. 1980**. Physical Properties of Plant and Animal Materials. Gordon & Breach Science Publ.
3. **Peleg M & Bagelay E B**. 1983. Physical Properties of Foods. AVI Publ. Co.
4. **Rao MA & Rizvi SSH. (Eds).** 1986. Engineering Properties of Foods. Marcel Dekker.
5. **Singhal OP & Samuel DVK**. 2003. Engineering Properties of Biological Materials. Saroj Prakasan.

Website Sources:

- https://ecourses.icar.gov.in/
- www.agrimoon.com

MMAG 204 Agricultural Statistics and Experimental Design L:T:P : 3:0:0

Objective: The main aims of this course are to provide comprehensive knowledge of the basic information of agriculture statistics and experimental design.

Unit I

Presentation of Data: Frequency distributions; graphical presentation of data by histogram, frequency polygon, frequency curve and cumulative frequency curves Measures of Locations and Dispersion: Mean, median, mode and their simple properties (with-out derivation) and calculations of median by graphs; range, mean deviation, standard deviation, standard error, coefficient of variation.

Unit II

Probability and Distributions: Random distributions; events exhaustive, mutually exclusive and equally likely; definition of probability (with simple exercises); definitions of binomial, Poisson's and normal distributions; and simple properties of the above distributions (without derivation)

Unit III

Correlation and Regression: Bivariate data-simple correlation and regression coefficients and their relation; Spearman rank correlation; limits of correlation coefficient; effect of change of origin and scale on correlation coefficient; linear regression and equations of line of regression; association and independence of attributes.

Unit IV

Sampling: Concept of population and sample; random samples; methods of taking a simple random sample. Tests of significance: sampling distribution of mean and standard error; z and t-test (equality of means; paired and unpaired t-test); t-test for comparison of means when variances of two populations differ; Chi- square test for goodness of fit; independence of attributes, and homogeneity of samples; interrelation between t-test and F-Test.

Unit V

Experimental Designs**:** Principles of experimental designs; completely randomized, randomized complete block design (missing plot value in RBD); latin square designs; augmented block design; simple factorial experiments including split and strip plot design (mathematical derivations not required); analysis of variance (ANOVA) and its use including estimation of LSD (CD).

Course Outcomes:

The student is able to

- Understand basic theoretical and applied principles of agricultural statistics needed to enter in agriculture.
- Demonstrate an understanding of the basic concepts of probability and random variables.
- Understand and interpret the concepts of descriptive statistics from the obtained data.
- Utilize and apply regression and other statistical methods to analyze commodity markets and economic data.
- Gain proficiency in using statistical software for data analysis.

References:

1. J, Medhi: Statistical Methods, New age International (P) Ltd.
2. J.K. Goyal & J.N. Sharma, Mathematical Statistics.
3. J.K. Ghosh, Mathematical Statistics, John Wiley & Sons, New York.
4. S.C. Gupta & V.K. Kapoor .Advanced Statistics, S. Chand.
5. M. Ray, Mathematical Statistics, R.P & Sons, Agra.
6. Goulden, C.H. (1952). Methods of Statistical Analysis, 2/e, John Wiley, New York
7. Kempton RA and Fox PN (1997). Statistical Methods for Plant Variety Evaluation.
8. Chapman and Hall.
9. Panse, V.C. and Sukhatme, P.V. (1967). Statistical Methods for Agricultural Workers,
10. I.C.A.R., New Delhi.

Website Sources:

- www.pdfdrive.com
- www.dmi.gov.in

- www.yourarticlelibrary.com
- www.onlinecourses.nptel.ac.in
- www.en.wikipedia.org

MMAG 254 Agricultural Statistics and Experimental Design Lab L:T:P 0:0:1

List of Experiments:

1. Measurement of central tendency and dispersion
2. Standard deviation and standard error
3. Principle uses of χ^2 , F and T- test.
4. Correlation Coefficient, Regression coefficient and Regression equation.
5. Analysis of data generated from completely randomized design, randomized block design.
6. Analysis of data generated from Latin square design, factorial experiments in 2^2, 2^3 Split plot designs
7. Missing plot techniques.
8. Analysis of covariance.
9. Sampling in field experiments.
10. Analysis of variance (ANOVA).

MAE301 Food Quality and Safety Engineering L:T:P 3:0:0

Objectives:

- Introduce the Food safety, need for quality control and safety
- Explain designing safety in products and processes.
- Describe Personnel hygienic standards, preventative pest control

UNIT I

Food safety, need for quality control and safety, strategy and criteria, microbiological criteria for safety and quality, scope of food toxicology, toxic potential and food toxicants, biological and chemical contaminants.

UNIT II

Food additives and derived substances, factors affecting toxicity, designing safety in products and processes, intrinsic factors, establishing a safe raw material supply, safe and achievable shelf life.

UNIT III

Process equipment and machinery auditing, consideration of risk, environmental consideration, mechanical quality control.

UNIT IV

Personnel hygienic standards, preventative pest control, cleaning and disinfesting system, biological factors underlying food safety.

UNIT V

Preservation and stability, contaminants of processed foods, adulteration, prevention and control, FPO, PFA, Codex, GMP, BIS and HACCP; Practices, principles, standards, specifications, application establishment and implementation; HACCP and quality management system**.**

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

- Apply the fundamental concepts of Food safety, need for quality control and safety, strategy and criteria, microbiological criteria for safety and quality,

- Derive prevention and control, FPO, PFA, Codex, GMP, BIS and HACCP; Practices
- HACCP and quality management system**.**

References:

1. Chesworth N. 1997. Food Hygiene Auditing. Blackie Academic Professional, Chapman & Hall.
2. David A Shapton & Norah F Shapton. 1991. Principles and Practices for the Safe Processing of Foods. Butterworth-Heinemann.
3. Jacob M 2004. Safe Food Handling. CBS.
4. Jose M Concon. 1988. Food Toxicology, Part A. Principles and Concepts, Part B. Contaminants and Additives. Marcel Dekker.
5. Sara Mortimore & Carol Wallace. 1997. HACCP - A Practical Approach. Chapman & Hall.

Website Sources:

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MAE351 Food Quality and Safety Engineering Lab L:T:P 0:0:1

List of Experiments:

1. Microbiological examination of food.
2. HACCP case studies.
3. CCP & CCP Decision tree.
4. HACCP control chart.
5. Codex standards and specifications.
6. Visits to food industries to study the various quality and safety aspects adopted.
7. Preparation of quality policy & documentation,
8. Visit to Units with HACCP certification
9. Visit to Units with ISO systems
10. GMP, GAP documentation.

MAE302 Food Packaging and Technologies L:T:P 3:0:0

Objectives:

- To impart knowledge of the objectives of food packaging and Technologies its role in food preservation during storage, transportation and distribution
- To provide knowledge to the students about the types of packaging materials their properties and packaging systems.

UNIT I

Introduction of packaging: Package, functions and design. Principle in the development of protective packaging. Deteriorative changes in foodstuff and packaging methods of prevention.

UNIT II

Food containers: Rigid containers, glass, wooden boxes, crates, plywood and wire bound boxes, corrugated and fiber board boxes, textile and paper sacks, corrosion of containers (tin plate); Flexible packaging materials and their properties; Aluminum as packaging material; Evaluation of packaging material and package performance.

UNIT III

Packaging equipments: Food packages, bags, types of pouches, wrappers, carton and other traditional package; Retortablepouches; Shelf life of packaged foodstuff.

UNIT IV

Methods to extend shelf life; Packaging equipment and machinery: Vacuum, CA and MA packaging machine; gas packaging machine; seal and shrink packaging machine; form and fill sealing machine; aseptic packaging systems; bottling machines; carton making machines.

UNIT V

Package standards and regulation; Shrink packaging; Aseptic packaging, CA and MAP, Active packaging; Biodegradable packaging.

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

- Apply the fundamental concepts of Flexible packaging materials and their properties

- Derive prevention and control, gas packaging machine; seal and shrink packaging machine; form and fill sealing machine;
- Determine methods to extend shelf life; Packaging and Technologies equipment and machinery

References:

1. Crosby NT.1981. Food Packaging: Aspects of Analysis and Migration Contaminants. App. Sci. Publ.
2. Kadoya T. (Ed). 1990. Food Packaging. Academic Press.
3. Mahadeviah M & Gowramma RV. 1996. Food Packaging Materials. Tata McGraw Hill.
4. Palling SJ. (Ed). 1980. Developments in Food Packaging. App. Sci. Publ.
5. Painy FA. 1992. A Handbook of Food Packaging. Blackie Academic.
6. Sacharow S & Griffin RC. 1980. Principles of Food Packaging. AVI Publ.
7. Stanley S & Roger CG.1970. Food Packaging. AVI Publ.

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MAE203 I Fruits and Vegetables Process Engineering L:T:P 3:0:0

Objectives:

- To enable the students to understand the processing of fruits and vegetables
- To impart technical knowledge of about how to develop products and preservation
- To understand the methods of dehydration

UNIT I

Importance of post harvest technology of fruits and vegetables, structure, cellular components, composition and nutritive value of fruits and vegetables, fruit ripening, spoilage of fruits and vegetables.

UNIT II

Harvesting and washing, pre-cooling, preservation of fruits and vegetables, blanching, commercial canning of fruits and vegetables, minimal processing of fruits and vegetables.

UNIT III

Cold storage of fruits and vegetables, controlled atmosphere packaging of fruits and vegetables, gas composition, quality of storage.

UNIT IV

Dehydration of fruits and vegetables, methods, osmotic dehydration, foam mat drying, freeze drying, microwave heating, applications, radiation preservation of fruits and vegetables, irradiation sources.

UNIT V

Intermediate moisture foods, ohmic heating principle, high pressure processing of fruits and vegetables, applications, sensory evaluation of fruit and vegetable products, packaging technology for fruits and vegetables, general principles of quality standards and control, FPO, quality attributes.

Course Outcomes:

- To understand the production status and post harvest handling methods of fruits and vegetables
- To learn the methods of processing and preservation of freshly harvested and cut fruits and vegetables.
- To enumerate the processing and preservation of fruits and vegetables by heat treatment.
- To understand the dehydration methods and design of driers used for drying fruit and vegetables.
- To describe the aseptic technology for product preservation.

References:

1. **Cruesss W V. 2000**. Commercial Fruit and Vegetable Products. Agrobios.
2. **Mircea Enachesca Danthy. 1997.** Fruit and Vegetable Processing. International Book Publ.
3. **Srivastava RP & Sanjeev Kumar. 1993.** Fruit and Vegetable Preservation. Principles and Practices. International Book Distr.
4. **Sumanbhatti & Uma Varma.** 1995. Fruit and Vegetable Processing. CBS.
5. **Thompson AK. 1996.** Post Harvest Technology of Fruits and Vegetables. Blackwell.
6. **Verma L R & Joshi V K. 2000**. Post Harvest Technology of Fruits and Vegetables. Vols. I-II. Indus Publ.

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MAE203 II Processing of Cereals, Pulses and Oil Seeds L:T:P 3:0:0

Objectives:

- Introduce the properties of Cereals, Pulses and Oil Seeds
- Provide the knowledge on Cereals, Pulses used in food industry
- Introduce the role of Cereals, Pulses additives and phytochemicals

UNIT I

Production and utilization of cereals and pulses, grain structure of major cereals, pulses and oilseeds and their milling fractions; grain quality standards and physico-chemical methods for evaluation of quality of flours.

UNIT II

Pre-milling treatments and their effects on milling quality; parboiling and drying, conventional, modern and integrated rice milling operations; wheat roller flour milling; processes for milling of corn, oats, barley, gram, pulses, paddy and flour milling equipments.

UNIT III

Dal mills, handling and storage of by-products and their utilization. Storage of milled products, Expeller and solvent extraction processing, assessment of processed product quality.

UNIT IV

Packaging of processed products, design characteristics of milling equipments; selection, installation and their performance, BIS standards for various processed products.

Outcomes: After completing this unit, the student will be able:

- To understand various physical properties of Cereals, Pulses
- Discuss principles Pre-milling treatments and their effects on milling quality
- Explain the concepts of Storage of milled products, Expeller and solvent extraction processing Understand concepts paddy and flour milling equipments.

References:

1. **Asiedu J J.1990**. Processing Tropical Crops. ELBS/MacMillan.
2. **Chakraverty A. 1995**. Post-harvest Technology of Cereals, Pulses and Oilseeds. Oxford & IBH.

3. **Morris Lieberman**. 1983. Post-harvest Physiology and Crop Preservation. Plenum Press.
4. **Pandey P H. 1993**. Principles of Agricultural Processing. Kalyani.
5. **Pillaiyar P. 1988.** Rice - Post Production Manual. Wiley Eastern.
6. **Sahay K M & Singh KK. 1993.** Unit Operations in Agricultural Processing. Vikas Publ. House.

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MAE203 III Farm Structures and Environmental Control L:T:P 3:0:0

Objectives:

- Introduce the different Farm Structures
- Explain thermodynamic properties.
- Describe Instruments and measurements

UNIT I

Thermodynamic properties of moist air, psychorometric chart and computer programmers for thermodynamic properties.

UNIT II

Farm structures, their design, constructional details and design of low cost structures. Heating, ventilating and exhaust systems, air distribution and air cleaning, combustion of fuels and equipment.

UNIT III

Drying and dehumidification system, air-water contact operations and evaporation, process and product air conditioning, energy efficient environmental control practices.

UNIT IV

Instruments and measurements; codes and standards.

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

- Apply the fundamental concepts computer programmers for thermodynamic properties.
- Derive farm structures, their design, constructional details and design of low cost structures.
- Determine Instruments and measurements; codes and standards

References:

1. **Esmay M L & Dixon J E. 1986.** Environmental Control for Agricultural Buildings. The AVI Corp.
2. **Gaudy A F & Gaudy E T. 1988**. Elements of Bioenvironmental Engineering. Engineering Press.

3. **Moore F F. 1994**. Environmental Control Systems: Heating, Cooling, Lighting. Chapman & Hall.
4. **Threlkeld J L. 1970**. Thermal Environmental Engineering. Prentice Hall.

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MAE303 I Storage Engineering and Handling of Agricultural Products L:T:P 3:0:0

Objectives: To impart knowledge of Storage of grains, Grain markets, cold storage, Physical factors influencing flow characteristics, and recent advances in handling of food materials.

UNIT I

Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models, storage capacity models, ecology, storage factors affecting losses, storage requirements.

UNIT II

Bag and bulk storage, godowns, bins and silos, rat proof godowns and rodent control, method of stacking, preventive method, bio-engineering properties of stored products, function, structural and thermal design of structures, aeration system.

UNIT III

Grain markets, cold storage, controlled and modified atmosphere storage, effects of nitrogen, oxygen, and carbon dioxide on storage of durable and perishable commodities, irradiation, storage of dehydrated products, food spoilage and preservation, BIS standards.

UNIT IV

Physical factors influencing flow characteristics, mechanics of bulk solids, flow through hoppers, openings and ducts; design of belt, chain, screw, roller, pneumatic conveyors and bucket elevators; principles of fluidization; recent advances in handling of food materials.

Outcomes: After the completion of the course the students will be able to:

- Acquire the basic knowledge about Storage of grains, biochemical changes during storage, production, distribution and storage capacity estimate models,
- Identify with the different types of method of stacking,
- Learn about various Grain markets, cold storage, controlled and modified atmosphere storage,

- Understand the different food spoilage and preservation, BIS standards.
- Principles of fluidization; recent advances in handling of food materials.

References:

1. FAO. 1984. Design and Operation of Cold Stores in Developing Countries. FAO.
2. Hall CW. 1970. Handling and Storage of Food Grains in Tropical and Sub-tropical Areas. FAO Publ. Oxford & IBH.
3. Henderson S & Perry SM. 1976. Agricultural Process Engineering. 5thEd. AVI Publ.
4. McFarlane Ian. 1983. Automatic Control of Food Manufacturing Processes. Applied Science Publ.
5. Multon JL. (Ed). 1989. Preservation and Storage of Grains, Seeds and their By-products. CBS.
6. Ripp BE. 1984. Controlled Atmosphere and Fumigation in Grain Storage. Elsevier.
7. Shefelt RL & Prussi SE. 1992. Post Harvest Handling – A System Approach. Academic Press.
8. Shejbal J. (Ed). 1980. Controlled Atmosphere Storage of Grains. Elsevier.
9. Vijayaraghavan S. 1993. Grain Storage Engineering and Technology. Batra Book Service

Website Sources:

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MAE303 II **Food Supply Chain Management** **L:T:P 3:0:0**

Objectives: To impart knowledge of Food Supply Chain Management, Building blocks of supply chain network, performance measures, decisions in supply world and models.

UNIT I

Building blocks of supply chain network, performance measures, decisions in supply world and models.

UNIT II

Supply chain inventory management, economic order quantity models, recorder point models, multi echelon inventory systems.

UNIT III

Use of stochastic models and combinatorial optimization in SC planning, layout, capacity planning, inventory optimization, dynamic routing and scheduling.

UNIT IV

Internet technologies and electronic commerce in SCM related to ERP, Q-procurement, e-logistics, internet auctions, e-market, electronic, business process optimization.

Outcomes: After the completion of the course the students will be able to:

- Acquire the basic knowledge about of Food Supply Chain Management, Building blocks of supply chain network, performance measures, decisions in supply world and models.
- Learn about various Supply chain inventory management
- Understand the different Internet technologies and electronic commerce in SCM related to ERP,
- Use of stochastic models and combinatorial optimization in SC planning,

References:

1. Chopra S & Meindel P. 2002. Supply Chain Management: Strategy, Planning and Operation. Prentice Hall.
2. Handfield RB & Nochols EL.1999. Introduction to Supply Chain Management. Prentice Hall.

3. Hopp WJ & Spearman ML. 1996. Factory Physics: Foundations of Manufacturing Management. McGraw Hill.
4. Levi DS, Kaminsky P & Levi ES. 2000. Designing and Managing the Supply Chain: Concepts, Strategies and Case Studies. Mc Graw Hill.
5. Shapiro JF. 2001. Modeling the Supply Chain. Duxbury Thomson Learning.
6. Tayur S, Ganeshan R & Magazine M.1999. Quantitative Models for Supply Chain Management. Kluwer Academic Publ.
7. Viswanadham N. 2000. Analysis of Manufacturing Enterprises. Kluwer.
8. Viswanadham N & Narahari Y. 1998. Performance Modeling of Automated Manufacturing Systems. Prentice Hall.

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MAE303 III Agricultural Waste and by –Products Utilization L:T:P 3:0:0

Objectives:

- Imparting knowledge on recycling and management of different agricultural waste
- Demonstrating integrated agricultural waste management
- Sharing knowledge on methods of conversion of waste into farm inputs

UNIT I

Generation of by-products, agricultural and agro industrial by-products/wastes, properties, on site handling, storage and processing.

UNIT II

Collection of wastes, utilization pattern as fuel, agricultural waste fired furnaces: Mechanism, construction and efficiency, suitability of wastes as fuel, fuel briquettes, briquetting process, equipment, factors affecting briquetting.

UNIT III

Utilization of wastes for paper production, production of particle board, utilization, by-products from rice mill, rice husk, rice bran, utilization.

UNIT IV

Thermo-chemical conversions, densification, combustion and gasification, extraction, biological conversions, anaerobic digestion.

UNIT V

Biochemical digestion process, digestion systems, energy from anaerobic digestion, cellulose degradation, fermentation process

Course Outcomes: At the end of the course the student should be able to

- Gain knowledge on agricultural wastes and decide on techniques to convert waste to inputs
- Practice varied composting techniques of agricultural waste
- Recommend processes to recycle agricultural wastes
- Manage and utilize animal waste

- Comprehend management of waste from food processing industries
- Understand sludge and waste water treatment and its applications

References:

1. ASAE Standards. 1984. Manure Production and Characteristics. Bor S Luh (Ed.). 1980. Rice: Production and Utilization. AVI Publ.
2. Chahal DS.1991. Food, Feed and Fuel from Biomass. Oxford & IBH.
3. Chakraverty A. 1989. Biotechnology and other Alternative Technologies for Utilization of Biomass/ Agricultural Wastes. Oxford & IBH.
4. David C Wilson. 1981. Waste Management - Planning, Evaluation, Technologies. Oxford.
5. Donald L Klass & Emert H George 1981. Fuels from Biomass and Wastes. Ann. Arbor. Science Publ.
6. Srivastava P K, Maheswari RC & Ohja T P. 1995. Biomass Briquetting and Utilization. Jain Bros.
7. USDA 1992. Agricultural Waste Management Field Handbook. USDA.
8. Wilfred A Cote.1983. Biomass Utilization. Plenum Press.

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