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<tr>
<td>DT 511*</td>
<td>ADVANCED DAIRY PROCESSING</td>
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<td>DT 512*</td>
<td>DAIRY PROCESS BIOTECHNOLOGY</td>
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<tr>
<td>DT 513</td>
<td>MEMBRANE TECHNOLOGY IN DAIRY PROCESSING</td>
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**Minor course**

Courses from other departments like dairy engineering/dairy chemistry/dairy microbiology will be offered as per the research need and background of the students

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<tr>
<td>DES 511</td>
<td>DAIRY BUSINESS MANAGEMENT</td>
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<td>DE 514</td>
<td>ENVIRONMENTAL ENGINEERING</td>
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<tr>
<td>PGS 501</td>
<td>LIBRARY AND INFORMATION SERVICES</td>
<td>0+1</td>
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<tr>
<td>PGS 505 (e-Course)</td>
<td>AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMER</td>
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**SECOND SEMESTER**

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<td>DT 521*</td>
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<tr>
<td>DT 522</td>
<td>TRADITIONAL AND VALUE-ADDED DAIRY PRODUCTS</td>
<td>2+1</td>
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<td>DT 523</td>
<td>RHEOLOGY OF DAIRY AND FOOD PRODUCTS</td>
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<tr>
<td>DT 524</td>
<td>ALTERNATIVE PROCESSES FOR THE DAIRY &amp; FOOD INDUSTRIES</td>
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<td>DT 598</td>
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<tr>
<td>DES 521</td>
<td>STATISTICS IN INDUSTRIAL APPLICATIONS</td>
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<td>DC 523</td>
<td>CHEMICAL QUALITY ASSURANCE</td>
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<td>RESEARCH TECHNIQUES</td>
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<td>BASIC CONCEPTS IN LABORATORY TECHNIQUES</td>
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<tr>
<td>PGS 506</td>
<td>DISASTER MANAGEMENT</td>
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**THIRD SEMESTER**

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<tr>
<td>DT 531*</td>
<td>FUNCTIONAL FOODS AND NEW PRODUCT DEVELOPMENT</td>
<td>3+1</td>
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<tr>
<td>DT 532</td>
<td>ADVANCED DAIRY AND FOOD PACKAGING</td>
<td>2+1</td>
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<tr>
<td>DT 533</td>
<td>TECHNOLOGY OF FOOD EMULSIONS, FOAMS &amp; GELS</td>
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<tr>
<td>DT 599</td>
<td>MASTER’S RESEARCH</td>
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<tr>
<td>DES 531</td>
<td>COMPUTER SOFTWARE</td>
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<tr>
<td>DM 531</td>
<td>MICROBIAL QUALITY &amp; SAFETY IN DAIRY INDUSTRY</td>
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<td>PGS 502 (e-Course)</td>
<td>TECHNICAL WRITING AND COMMUNICATIONS SKILLS</td>
<td>0+1</td>
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<tr>
<td>PGS 503 (e-Course)</td>
<td>INTELLECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE</td>
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**FORTH SEMESTER**

| DT-599               | Masters Research                                               | 18     |

* Compulsory
Objective
To provide in-depth knowledge in various unit operations and basic concepts in dairy processing.

Theory
UNIT I
Use of bio-protective factors for preservation of raw milk: effects on physicochemical, microbial and nutritional properties of milk and milk products, present status of preservation of raw milk by chemical preservatives; thermal processing for preservation.

UNIT II
Methods of determining lethality of thermal processing, UHT processed milk products, their properties and prospects, types of UHT plants, aseptic fillers, heat stability and deposit formation aspects, effect on milk quality; techno-economic considerations; retort processing.

UNIT III
Principles and equipment for bactofugation and Bactotherm processes, Microfluidization of milk: Principle, equipment, effects and applications, Homogenization and their applications in dairy industry.

UNIT IV
Dehydration: advances in drying of milk and milk products; freeze concentration, freeze dehydration: physicochemical changes during freeze drying and industrial developments.

UNIT V
Water activity; sorption behaviour of foods, energy of binding water, control of water activity of different milk products in relation to their chemical; microbiological and textural properties; hurdle technology and its application in development of shelf-stable and intermediate-moisture foods, Use of carbonation in extending the shelf life of dairy products.

UNIT VI
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.

Practical
LP system for extension of keeping quality raw milk, determination of pH
HCT profile of milk systems, measurement of thiocyanate in milk system
Determination of water activity and sorption isotherms of milk products
Determination of thermal load during retort processing of milk and milk products; heat classification of milk powders; functional properties of powders: porosity, interstitial air content, occluded air content, flowability;
Determination of degree of browning-chemical/physical methods
freeze drying of milk/milk products, and heat sensitive products.
Homogenization efficiency; cleaning efficiency in dairy equipment
Visit to a UHT Processing plant.
Thermal process calculations.

Suggested Readings
DT 512  DAIRY PROCESS BIOTECHNOLOGY  2+1

Objective
To project the importance of biotechnology in dairy processing and impart knowledge on all aspects of dairy process biotechnology in production and preservation of dairy products employing the principles of biotechnology.

Theory
UNIT I
Definition of biotechnology; development and impact of biotechnology on food and dairy industry.

UNIT II
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.

UNIT 3
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; protein hydrolysates – their physicochemical, therapeutic properties, production and application in food formulations; production of bio-yoghurt, pro-biotic cheese and fermented milks; bifidus factors in infant food formulations.

UNIT IV
Protein hydrolysates-production, their physicochemical, therapeutic properties, de-bittering and application in food formulations; Enzymatic hydrolysis of lactose for preparation of whey and UF-permeate beverages.

UNIT V
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 VI
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 hydrolysates; visit to a bio-processing unit.

Suggested Readings

DT 513  MEMBRANE TECHNOLOGY IN DAIRY PROCESSING  2+1

Objective
To explain the basics of membrane technology and its applications in dairy processing.

Theory
UNIT I
Membrane techniques: classification and characteristics of filtration processes; types of membranes commercially available; membrane hardware, design of membrane plants, modeling of ultrafiltration (UF) processes, mass transfer model, resistance model; membrane flouling-problem and treatment, cleaning and sanitization of different types of membranes.
UNIT II
Factors affecting permeate flux during ultrafiltration and reverse osmosis of milk and sweet and sour whey, energy requirements for processing of milk and whey.

UNIT III
Applications of ultrafiltration, reverse osmosis, nenofiltration and micro-filtration in the dairy industry. Developments in the manufacture and utilization of food and pharmaceutical grade lactose from UF permeate. Preparation of special foods like low lactose powder and dairy whiteners using UF retentate, whey protein concentrates, casein and coprecipitates.

UNIT IV
Demineralization: Importance of demineralization, different processes available for demineralization: their principle, plant and operation.

UNIT V

Practical
Study of the effect of types of milk, temperature of milk and trans membrane pressure on the permeate flux during ultrafiltration process.
Performance of ultrafiltration membrane with respect to permeate flux and volume concentration ratio during processing of acid and sweet whey
Study the effect of types of milk, temperature and applied pressure on the permeate flux during the reverse osmosis process of milk, whey and permeate
Microfiltration of skim milk and whey
Preparation of whey protein concentrate and its utilization in dairy products Measurement of different functional properties of casein and whey protein: whipping ability; water binding; emulsification properties; gelling; viscosity and solubility.

Suggested Readings

DT 521 ADVANCED FOOD PROCESSING 3+1
Objectives
To provide in-depth understanding of advances in theoretical and practical aspects of food processing.

Theory
UNIT I
Status of food processing industry in India and abroad; prospects and constraints in development of Indian food industry.

UNIT II
Post harvest management of fruits and vegetables, Harvesting indices, Biochemical and physical changes during ripening of fruits & vegetables, respiration and factors affecting it, role of ethylene in accelerated ripening, post harvest treatments for extension of shelf-life of fresh produce, Strategic interventions to minimize post harvest losses including vapour heat treatment, wax coating, chemicals, etc.

UNIT III
Principles of chilling & refrigeration storage of foods, quality changes in cold stored products, controlled and modified atmospheric storage. Freezing of foods, principle and equipments for freezing, defects in frozen foods, re-crystallization, freezing of fruits and vegetables, freeze concentration of fruit juices.

UNIT IV
Application of heat energy to foods for preservation and processing, concept of drying rate of foods, industrial drying processes of foods; changes during drying, advanced drying processes (Freeze drying, infra red drying and microwave drying). Canning of fruits & vegetables, unit processes involved in canning, types of cans for thermal processing of foods.
UNIT V
Basic principles involved in fermentation, Technological aspects of pickled vegetables like sauerkraut, cucumbers, Technology of wine, beer and distilled alcoholic beverages, defects in alcoholic beverages.

UNIT VI
Conversion of muscle into meat, rigor mortis, freezing and canning of meat, curing & smoking of meat, fermented sausages, cooking of poultry, utilization of milk ingredients in processed meat and poultry products.

UNIT VII
Advances in milling of rice (solvent extractive milling) and Turbo milling of wheat. Bakery products; role of ingredients, Developments in manufacturing processes for bakery products such as breads; biscuits; pizza bases, cake etc; changes during processing of bakery products. Utilization and importance of dairy ingredients in bakery products.

UNIT VIII
Definition, classification and technologies of fabricated and formulated foods and their nutritional aspects. Imitation dairy products and dairy analogues. Principle of extrusion processing, design and working of extruder, classification, application in food and dairy processing. Food additives, including stabilizers, emulsifiers, antioxidants, preservatives, etc. for formulated foods.

UNIT IX
Important group of enzymes involved in food processing; Application of enzymes in food processes like enzymes juice extraction, juice clarification, in bread manufacture, meat tenderization, ice cream manufacture, desugaring of egg, etc.

UNIT X
Newer concepts in food processing including organic foods, processing of organic raw material, genetically modified foods.

Practical
MAP and its effect on shelf-life of fresh fruits and vegetables.
Preparation of squash, cordial, nectar and whey beverages, whey based soups.
Manufacture of bread, pizza base, biscuits and cake.
Application of milk ingredients in caramel, egg-less cake, mayonnaise, canning of fruits & vegetables, manufacture of chicken soup, comminuted meat products, enzymatic extraction and clarification of fruit juices.
Preparation of soymilk and tofu, Drying of fruits & vegetables, efficacy of blanching treatment.
Manufacture of sauerkraut/fermented vegetables.

Suggested Readings

DT 522 TRADITIONAL AND VALUE ADDED PRODUCTS 2+1
Objective
To project the significance and status of traditional and value added dairy products in Indian dairy industry.
Theory
UNIT I
Present status of traditional dairy products; globalization of traditional dairy products; plans and policies of the Government and developmental agencies.

UNIT II
Process schedule of heat-desiccated, coagulated and fermented traditional dairy products; process improvement in production of milk sweets.

UNIT III
New products based on fruits, vegetables and cereals; application of membrane technology; microwave heating for industrial production of traditional dairy products.

UNIT IV
Advances in industrial production of ghee, flavour and texture simulation.

UNIT V
Techno-economic aspects for establishing commercial units for traditional products.

UNIT VI
Convenience traditional dairy products; use of natural and permitted synthetic preservatives and new packaging systems.

Practical
Microwave heating of traditional milk delicacies for shelf life extension
Application of membrane technology for improving the quality of traditional products from cow and buffalo milk
Preparation of feasibility report for establishing commercial units for traditional products.

Suggested Readings

DT 523 RHEOLOGY OF DAIRY & FOOD PRODUCTS 2+1

Objective
To explain the basics of food rheology, and to familiarize the students with rheological instruments and their use in relation to dairy and food products.

Theory
UNIT I
Introduction to rheology of foods: Definition of ‘texture’, ‘rheology’ and ‘psychophysics’ – their structural basis; physical considerations in study of foods; salient definitions – Stress tensor and different kinds of stresses.

UNIT II
Rheological classification of Fluid Foods: Shear-rate dependence and time dependence of the flow-curve; Non-Newtonian fluids; thixotropy; Mechanisms and relevant models for non-Newtonian flow; Effect of temperature; Compositional factors affecting flow behavior; Viscosity of food dispersions – dilute and semi-dilute systems, concentration effects.

UNIT III
Comparative assessment of different types of Viscometers, and their Merits and Limitations: Co-axial cylinders, Spindle- or Impeller-type viscometers, Cone-plate viscometer, Capillary viscometers, Falling-sphere viscometer, Vibratory viscometers, Extrusion viscometer, Orifice viscometer.

UNIT IV
Rheology of semi-solid and solid food; Rheological characterization of foods in terms of stress-strain relationship; Visco elasticity; Transient tests - Creep Compliance and Stress Relaxation; mechanical models for visco elastic foods: Maxwell, Kelvin, Burgers and generalized models and their application; Dynamic measurement of visco elasticity.

UNIT V
Large Deformations and failure in foods: Definitions of fracture, rupture and other related phenomena; Texture Profile Analysis; Instrumental measurements – Empirical and Fundamental methods; Rheometers and Texture Analyzers; Measurement of Extensional viscosity; Acoustic measurements on crunchy foods.

UNIT VI
Rheological and textural properties of selected dairy products: Measurement modes and techniques; Effect of processing and additives (stabilizers and emulsifiers) on food product rheology; Relationship between instrumental and sensory data.

Practical
Study of different types of viscometers viz., co-axial cylinder viscometer, spindle viscometer, falling-ball viscometer, extrusion viscometer, impeller viscometer, orifice viscometer
Flow behavior of fluid dairy products
Thixotropy in ice-cream mix; force-deformation study in selected dairy products using Texture Analyzer; Back extrusion.
Effect of test conditions on the texture profile parameters of cheese and similar products; stress relaxation studies in solid foods
Use of Cone Penetrometer and FIRANIRD extruder for measurement of butter texture.
Use of a Viscoamylograph for study on the gelatinization behaviour of starch/cereals flours.

Suggested Readings

**DT 524 ALTERNATIVE PROCESSES FOR DAIRY AND FOOD INDUSTRY**

2+1

Objective
To develop an understanding of the basic principles underlying the novel/non-conventional food processing techniques, equipment required features and actual and potential applications.

Theory
UNIT I
Irradiation: sources and properties of ionizing radiation; mechanism of interaction with microorganisms and food components microbial inactivation in dairy and food products, chemical effects, packaging, industrial irradiation systems, benefits and limitations; safety aspects, national and international regulations.

UNIT II
High frequency heating: Principles of dielectric heating and factors affecting it, design and working of microwave oven, continuous microwave heating units, applications in dairy and food processing, microwavable packaging safety aspects of microwaves, merits and demerits of dielectric heating.

UNIT III
Infra-red heating: Interaction of infra-red (IR) radiation with penetration properties, equipment; dairy and food application, advantages and disadvantages of IR heating.

UNIT IV
Ohmic heating: Principle of electric resistance heating, design of an ohmic heater, operational variables, power considerations, factors affecting heating efficiency, merits and limitations, food applications and future scope.

UNIT V
Ultrasonic treatment of food: Mechanism of ultrasound induced cell damage, generation of ultrasound equipment, design of power ultrasonic system, types of ultrasonic reactors, application of power ultrasound in food processing, effects on food constituents, ultrasound in consideration with other process alternatives - thermosonica tion, advantages and future prospects.

UNIT VI
High hydrostatic pressure processing: Principle of microbial inactivation, barotolerance of microorganisms, effect on food constituents, equipment, dairy and food application, merit and demerits.

UNIT VII
Pulsed electric field processing: Description/ mechanism and factors affecting microbial inactivation effects on food components; present status and future scope for food applications.

Practical
Study of a microwave oven
Determination of power output of a microwave oven
Temperature profile in a microwave oven cavity
Microwave absorption by various food packaging materials
Heating behaviour of water, milk, cream and other milk products – effect of composition
Shelf-life extension of pasteurized milk employing microwave heating
Effect of shape and size of water/milk container on microwave heating
Cooking of ‘instant’ products in a microwave oven
Drying of casein, ‘instant’ wheat, ‘instant’ rice, etc. in a microwave oven
Miscellaneous food processing/heating applications of microwaves
Visit to a commercial food irradiation facility.

Suggested Readings

DT 531 FUNCTIONAL FOODS AND NEW PRODUCT DEVELOPMENT 3+1

Objective
To impart the knowledge of functional ingredients, nutraceuticals and their utilization in development of new food products including health foods, functional foods and specialty foods.

Theory
UNIT I
Definition, classes of functional foods, status of functional foods in world and India. Concept of new product development, classes 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 dairy product.

UNIT II
Nutritional status and dietary requirement of different target group and deficiency diseases, in special reference to micronutrients. Dietary and therapeutic significance of dairy nutrients, bioactive components in dairy products like lactose, whey proteins, milk minerals, CLA, fermented milks etc.

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

UNIT IV
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 V
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.

UNIT VI
UNIT VII
Sports foods, ingredients for sports foods, dairy components in sports foods, sports drinks, design consideration, ergogenic aids in sports nutrition.

UNIT VIII
Herbs, various classes of herbs, their therapeutic potential and application in foods with special reference to dairy products like functional drinks, herbal ghee etc.

UNIT IX
Prebiotic substances and their utilization in functional foods, symbiotic foods, technological aspects and recent development in probiotics, prebiotics and synbiotics.

UNIT X
Definition and various classes of phytochemicals, their role in CVD, Cancer and immune system enhancer, utilization in functional foods, phytosterol, phytoestrogens, glucosinolates, organosulphur compounds, flavonoids, carotenoids, etc.

UNIT XI
Special foods/nutrients for CVD, cancer, IBD, diabetics, persons suffering with milk allergy and lactose intolerance with special emphasis on dairy nutrients and foods.

Practical
1. Determination of total fiber, neutral detergent fiber in foods
2. Manufacture of fiber enriched milk beverage
3. Manufacture of low calorie burfi/ice cream
4. Preparation of flavoured milk using artificial sweetener and its estimation
5. Determination of antioxidant activity of food/food components
6. Determination of bioavailability of nutrients
7. Development of malted milk food and weaning food
8. Determination of β-galactosidase activity and application of lactases for lactose free dairy products
9. Determination of prebiotic potential of certain plant/milk components and their application in synbiotics dairy foods
10. Preparation of sports beverage, herbal dairy drinks
11. Preparation of high protein products

Suggested Readings
DT 532  ADVANCED DAIRY AND FOOD PACKAGING  2+1

**Objective**
To impart basic and advanced knowledge of dairy and food packaging.

**Theory**

**UNIT I**
Status of current packaging; types of packaging materials; criteria for selection of proper packaging; testing of packaging materials.

**UNIT II**
Adhesives; graphics; coding, and labeling used in food packaging.

**UNIT III**
Protective packaging of foods; packaging of food products sensitive to oxygen, light, moisture; active packaging; special problems in canned foods.

**UNIT IV**
Packaging of dairy products; packaging of convenience foods, packaging of fruits, vegetables, and fruit juices.

**UNIT V**
Packaging of fats and oils; packaging of spices; packaging of meat and poultry; packaging of fish and other seafoods.

**UNIT VI**
Modified atmosphere packaging, controlled atmosphere packaging, shrink and stretch packaging.

**UNIT VII**
Retort pouch technology, microwavable, biodegradable, and edible packages.

**UNIT VIII**
Industrial packaging: unitizing, palletizing, containerising, distribution systems for packaged foods including prevention of shock damage to articles during transportation.

**UNIT IX**
Safety aspects of packaging materials; sources of toxic materials and migration of toxins into food materials.

**Practical**
Testing of packaging materials for quality assurance like determination of thickness, GSM, grease resistance, bursting strength, tearing resistance, WVTR, puncture resistance.
Estimation of shelf life of vegetables and seasonal fresh fruits.
Packaging of turmeric powder and ground red chilli powder, vacuum packaging of dairy products.

**Suggested Readings**

DT 533  TECHNOLOGY OF FOOD EMULSIONS, FOAMS AND GELS  2+1

**Objective**
To impart basic knowledge regarding food dispersion systems, their formation, behaviour, and factors affecting their stability.

**Theory**

**UNIT I**
Food dispersions, their characteristics and factors affecting food dispersions.

**UNIT II**
Food emulsions; emulsifiers and their functions in foods; the HLB concept in food emulsifiers; emulsion formation and stability; polymers and surfactants.

UNIT III
Milk foams and their applications, structure of foams, egg foams and uses, foam formation and stability.

UNIT IV
Theory of gel formation; pectic substances and jellies; fruit pectin gels; milk jellies.

UNIT V
Structure of dairy foods representing emulsions, foams and gels; physical structure of fat rich, concentrated, fermented, coagulated and dried products.

UNIT VI
Techniques for evaluation of structure for food emulsions, foams and gels.

Practical
Determination of the rate of formation and stability of emulsions
Emulsifying properties of milk proteins and other food ingredients
Properties of different types of emulsifiers and their role in food emulsions
Examination of foam formation and determination of foam stability
Milk proteins and other food ingredients in food foams
Foaming in dairy systems
Studies on gel formation and gel properties
Food gels – Gelatin-based, pectin-based, etc.
Properties of various gelling agents for foods.

Suggested Readings
Supportive Courses

DES 511 Dairy Business Management 2 + 1

Concept of dairy business management, managerial decision making, functions of management. Planning- objectives, classification of plans, planning related to finance, production and personnel aspects of the dairy. Organising- Fundamentals of organizational design, documentation, principles and delegation of authority, responsibility and accountability. Staff- Personnel management, planning, selection, introduction, orientation and training of unskilled and skilled personnel in dairy organizations. Control- Purpose and types of control, steps in control, characteristics of effective controls, control techniques and methods, programme evaluation review technique (PERT), inventory control. Project appraisal and monitoring- Standards and norms of appraisal, monitoring and its tools, management information systems, net present value and internal rate of return. Demand analysis- Determinants of demand of dairy products, responsiveness of demand, estimation of product and factor demand, types and approaches for demand forecasting. Cost analysis- Application of different cost concepts and functions in managerial decisions. Pricing- Determinants of price of dairy products, pricing under different objectives and market structures, product differentiation and product-mix decisions. Profit planning and control - Concept, profit planning and break even analysis in dairy industry.

Practical
Delineation of milk shed area
Case studies for solving problem situations; Demand forecasting
Estimation of cost of milk procurement and processing
Break-even analysis and breakeven charts; Use of PERT in dairy industry
Optimization of product-mix; Estimation of cost of inventory
Economic lot size and other quantity standards

Suggested Readings

DES 521 Statistics in Industrial Applications 2 + 1

Statistical methods in industrial applications; analysis of variance; transformations; partial and multiple correlation and regression; Ranking techniques; introduction to discriminant analysis; statistical basis for drawing scientific inferences from experimental data; principles of experimental design-industrial experimentation; basic designs-CRD; RBD & LSD; missing plot technique; factorial experiments-main effects and interactions; 2n series and mixed factorial experiments; experimental designs in sensory evaluation; introduction to statistical quality control; control charts for variables; mean and range charts; statistical basis; rational sub-group; control charts for attributes 'np'; 'p' and 'c' charts; fundamental concepts of acceptance sampling plans; single; double and sequential sampling plans; use of sampling inspection tables for selection of single and double sampling plans; introduction to sampling techniques and their application to consumer preference studies.

Practical
Analysis of variance-one way and two way classification; partial and multiple correlation and regression; rank correlation and coefficient of concordance; analysis of industrial experiments - Use of CRD; RBD and LSD; missing plot technique; factorial experiments - 22 and 23; mixed factorial experiments; control charts for
variables; control charts for attributes; single sampling plan- OC and AOQ curves; sequential sampling plan; use of sampling inspection tables; and different methods of selecting samples;

**Suggested Readings**

Grant and Leavenworth 1972 Statistical Quality Control, McGraw Hill, New Delhi

**DES 531 Computer Software**

2 + 1

General data analysis requirements in dairy research; introduction to statistical and other standard software packages (SYSTAT; SPSS; MS-Excel); data preparation and job control commands for statistical analysis of data pertaining to t-test; Chi-square test; analysis of variance (ANOVA); basic experimental designs - CRD; RBD & LSD; factorial designs; partial and multiple correlation and regression; discriminant analysis; linear programming; (using LINDO/ LINGO) software packages; least-squares analysis

**Practical**

Statistical software packages and their operations; data preparation and data generation; import and export of data from spreadsheet and database packages; application of software packages to the problems related to: tests of significance (t; Chi-square and F-test); analysis of variance (ANOVA); partial and multiple correlation and regression; discriminant analysis; linear programming problem; and least-squares analysis.

**Suggested Readings**

Compulsory Non-credit Courses

PGS- 501 LIBRARY AND INFORMATION SERVICES 0+1

Objective

To equip the library users with skills to trace information from libraries efficiently, to apprise them of information and knowledge resources, to carry out literature survey, to formulate information search strategies, and to use modern tools (Internet, OPAC, search engines, etc.) of information search.

Practical

Introduction to library and its services; Role of libraries in education, research and technology transfer; Classification systems and organization of library; Sources of information- Primary Sources, Secondary Sources and Tertiary Sources; Intricacies of abstracting and indexing services (Science Citation Index, Biological Abstracts, Chemical Abstracts, CABI Abstracts, etc.); Tracing information from reference sources; Literature survey; Citation techniques/Preparation of bibliography; Use of CD-ROM Databases, Online Public Access Catalogue and other computerized library services; Use of Internet including search engines and its resources; eresources access methods.

PGS- 505 AGRICULTURAL RESEARCH, RESEARCH ETHICS AND RURAL DEVELOPMENT PROGRAMMES 1+0

Objective

To enlighten the students about the organization and functioning of agricultural research systems at national and international levels, research ethics, and rural development programmes and policies of Government.

Theory

UNIT I

History of agriculture in brief; Global agricultural research system: need, scope, opportunities; Role in promoting food security, reducing poverty and protecting the environment; National Agricultural Research Systems (NARS) and Regional Agricultural Research Institutions; Consultative Group on International Agricultural Research (CGIAR): International Agricultural Research Centres (IARC), partnership with NARS, role as a partner in the global agricultural research system, strengthening capacities at national and regional levels; International fellowships for scientific mobility.

UNIT II

Research ethics: research integrity, research safety in laboratories, welfare of animals used in research, computer ethics, standards and problems in research ethics.

UNIT III

Concept and connotations of rural development, rural development policies and strategies. Rural development programmes: Community Development Programme, Intensive Agricultural District Programme, Special group – Area Specific Programme, Integrated Rural Development Programme (IRDP) Panchayati Raj Institutions, Cooperatives, Voluntary Agencies/Non-Governmental Organisations. Critical evaluation of rural development policies and programmes. Constraints in implementation of rural policies and programmes.

Suggested Readings

**PGS-504 BASIC CONCEPTS IN LABORATORY TECHNIQUES 0+1**

**Objective**
To acquaint the students about the basics of commonly used techniques in laboratory.

**Practical**
Safety measures while in Lab; Handling of chemical substances; Use of burettes, pipettes, measuring cylinders, flasks, separatory funnel, condensers, micropipettes and vaccupets; washing, drying and sterilization of glassware; Drying of solvents/chemicals. Weighing and preparation of solutions of different strengths and their dilution; Handling techniques of solutions; Preparation of different agro-chemical doses in field and pot applications; Preparation of solutions of acids; Neutralisation of acid and bases; Preparation of buffers of different strengths and pH values. Use and handling of microscope, laminar flow, vacuum pumps, viscometer, thermometer, magnetic stirrer, micro-ovens, incubators, sandbath, waterbath, oilbath; Electric wiring and earthing. Preparation of media and methods of sterilization; Seed viability testing, testing of pollen viability; Tissue culture of crop plants; Description of flowering plants in botanical terms in relation to taxonomy

**Suggested Readings**

**PGS -506 DISASTER MANAGEMENT 1+0 (e-Course)**

**Objective**
To introduce learners to the key concepts and practices of natural disaster management; to equip them to conduct thorough assessment of hazards, and risks vulnerability; and capacity building.

**Theory**

UNIT I
Natural Disasters- Meaning and nature of natural disasters, their types and effects. Floods, Drought, Cyclone, Earthquakes, Landslides, Avalanches, Volcanic eruptions, Heat and cold Waves, Climatic Change: Global warming, Sea Level rise, Ozone Depletion

UNIT II
Man Made Disasters- Nuclear disasters, chemical disasters, biological disasters, building fire, coal fire, forest fire. Oil fire, air pollution, water pollution, deforestation, Industrial wastewater pollution, road accidents, rail accidents, air accidents, sea accidents.

UNIT III
Disaster Management- Efforts to mitigate natural disasters at national and global levels. International Strategy for Disaster reduction. Concept of disaster management, national disaster management framework; financial arrangements; role of NGOs, Community-based organizations, and media. Central, State, District and local Administration; Armed forces in Disaster response; Disaster response: Police and other organizations.

**Suggested Readings**
PGS - 502 TECHNICAL WRITING AND COMMUNICATIONS SKILLS  0+1

Objective

To equip the students/scholars with skills to write dissertations, research papers, etc.
To equip the students/scholars with skills to communicate and articulate in English (verbal as well as writing).

Practical

Technical Writing - Various forms of scientific writings - theses, technical papers, reviews, manuals, etc; Various parts of thesis and research communications (title page, authorship contents page, preface, introduction, review of literature, material and methods, experimental results and discussion); Writing of abstracts, summaries, précis, citations etc.; commonly used abbreviations in the theses and research communications; illustrations, photographs and drawings with suitable captions; pagination, numbering of tables and illustrations; Writing of numbers and dates in scientific write-ups; Editing and proof-reading; Writing of a review article.

Communication Skills - Grammar (Tenses, parts of speech, clauses, punctuation marks); Error analysis (Common errors); Concord; Collocation; Phonetic symbols and transcription; Accidental pattern: Weak forms in connected speech: Participation in group discussion: Facing an interview; presentation of scientific papers.

Suggested Readings


PGS -503  INTELECTUAL PROPERTY AND ITS MANAGEMENT IN AGRICULTURE  1+0

(e-Course)

Objective

The main objective of this course is to equip students and stakeholders with knowledge of intellectual property rights (IPR) related protection systems, their significance and use of IPR as a tool for wealth and value creation in a knowledge-based economy.

Theory

Historical perspectives and need for the introduction of Intellectual Property Right regime; TRIPs and various provisions in TRIPS Agreement; Intellectual Property and Intellectual Property Rights (IPR), benefits of securing IPRs; Indian Legislations for the protection of various types of Intellectual Properties; Fundamentals of patents, copyrights, geographical indications, designs and layout, trade secrets and traditional knowledge, trademarks, protection of plant varieties and farmers’ rights and biodiversity
protection; Protectable subject matters, protection in biotechnology, protection of other biological materials, ownership and period of protection; National Biodiversity protection initiatives; Convention on Biological Diversity; International Treaty on Plant Genetic Resources for Food and Agriculture; Licensing of technologies, Material transfer agreements, Research collaboration Agreement, License Agreement.

Suggested Readings