Course Description (Curriculum 2012) – B.Sc. Food Technology

Course Description

General Education Courses

1. Language Courses

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<thead>
<tr>
<th>Course Code</th>
<th>Course Title</th>
<th>Credits</th>
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<tbody>
<tr>
<td>BG 1001</td>
<td>English I</td>
<td>3 (3-3-7) Credits</td>
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<tr>
<td>BG 1002</td>
<td>English II</td>
<td>3 (3-3-7) Credits</td>
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<tr>
<td>BG 2000</td>
<td>English III</td>
<td>3 (3-3-7) Credits</td>
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<tr>
<td>BG 2001</td>
<td>English IV</td>
<td>3 (3-3-7) Credits</td>
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Lower intermediate academic English, with activities to foster reading, writing, listening and speaking skills in English through communicative activities in a meaningful academic context.

Intermediate academic English, reinforcing fluency and grammar with task-driven oral and writing exercises, developing vocabulary and sentence writing skills with combined reading comprehension exercises and writing practice.

Advanced English for academic and career purposes, emphasizing organization of ideas and clarity of expression and understanding.

2. Social Science Courses

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<tbody>
<tr>
<td>BG 2403</td>
<td>Introduction to Economics</td>
<td>3 (3-0-6) Credits</td>
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A study of the basic economic principles and analysis of the economic environment in which consumption, production and exchange activities take place. The course will cover the analysis of economic decision made by consumers and producers including the price mechanism, demand and supply analysis in product and factor markets, the Aggregate Demand and Aggregate Supply Analysis, GNP and NI measurement of the whole economy will be discussed.

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<tr>
<td>GE 2202</td>
<td>Ethics</td>
<td>3 (3-0-6) Credits</td>
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3. **Humanities Course**

**GE 1202**  
**General Psychology**  
3 (3-0-6) Credits

Various psychological theories and factors in order to know and understand the processes and conditions that form one’s characters, behaviors, attitudes, and emotions.

**GE 2101**  
**World Civilization**  
3 (3-0-6) Credits

Development of human society, rise and fall of civilizations, achievements and heritages of Western and Eastern civilizations since ancient time in order to understand their roots and their impacts on modern societies.

4. **Science and Mathematics Courses**

**BG 1201**  
**Statistics I**  
3 (3-0-6) Credits

Descriptive statistics, probability theory and inferential statistics, summarizing of data in tables and graphs, computation of descriptive statistics, rules of probability, probability distributions, confidence interval estimate of population parameters, and hypothesis testing.

**SC 2151**  
**Introduction to Microcomputer Application** 3 (3-0-6) Credits

Structure and characteristics of microcomputers, and the techniques of applying microcomputer technology, focus on software packages such as word processing, spreadsheet, database management systems, etc. The course will cover current technologies as well as future trends.

**Specialized Courses**

(a) **Core Courses**

**BS 1001**  
**General Chemistry**  
3 (3-0-6) Credits

Fundamental chemistry including atomic theory and electronic structure of atom, bonding theory, stoichiometry, periodic table as a survey of representative and transition elements and periodic properties, gas and kinetic theory of gas, acids/bases chemistry including acid base chemical equilibrium, oxidation-reduction and basic thermodynamics.

**BS 1002**  
**General Chemistry Laboratory**  
1 (0-3-1) Credit

Prerequisite or corequisite: BS 1001 General Chemistry
Safety in laboratory and use of basic chemical instrument, experimentation techniques in measurement and accuracy, molecular structure, chemical reactions, determination of pH of solution and titration, relative quantity, colligative properties of solution, techniques and basic theory in qualitative analysis.

**BS 1005**  **Principles of Biology**  **3 (3-0-6) Credits**

Life, prokaryotic and eukaryotic cell structure and functions of organelle in the cells, cell division, and gamete production, pattern of inheritance, gene expression, energy and photosynthesis, animal cells and plant cells, ecology, behavioral science and evolution.

**BS 1006**  **Biology Laboratory**  **1(0-3-1) Credit**

Prerequisite or corquisite: BS 1005 Principles of Biology

Laboratory corresponding to BS 1005 Principles of Biology, general concepts of microscope usage, plant and animal cell structure, somatic cell division including the production of reproductive cells, energy and photosynthesis.

**BS 1007**  **Organic Chemistry**  **3 (3-0-6) Credits**

Fundamental theories of organic chemistry involving the classification of organic compounds according to their functional groups, nomenclature and structure, reactions of organic molecules including synthesis and reaction mechanisms.

**BS 1008**  **Organic Chemistry Laboratory**  **1 (0-3-1) Credit**

Prerequisite or corequisite: BS 1007 Organic Chemistry

Safety in laboratory and use of apparatus, physical characteristics of organic substances including melting point, boiling point, solubility, and analytical techniques of organic substances, separation, purification, and techniques used for the identification of functional groups in organic compounds.

**BS 1101**  **Calculus I for Bioscience**  **3 (3-0-6) Credits**

Changing of value with respect to factors, differentials, second and higher order differential, and basic differentiation, basic integration, definite and definite integration, and higher order integration, applications of basic calculus, sketching the curves, optimization, surrounded area by curves, volume of geometrics and calculus questions.

**BS 1102**  **Calculus II for Bioscience**  **3 (3-0-6) Credits**

Prerequisite: BS 1101 Calculus I for Bioscience

Multivariable function, changing of value of multivariable function with respect to factors, chain rules for multivariable function, partial derivative and its application, 3-D geometrics function by rectangular coordinate, cylindrical
coordinate and spherical coordinate, evaluation of the area and volume of those 3-D geometric shapes, principles of vector in mathematics including basic vector operations, transition of general vector and vector-valued function, velocity, acceleration, direction of an objects, tangent vector, and normal vector, described by vector-valued function, and line integral.

**BS 1201  Physics for Bioscience  3 (3-0-6) Credits**

Basic knowledge of physics including units, vector, force and motion, Newtonian motion, work and energy, conservation of energy and momentum, fluids mechanics, internal energy and fundamental heat transfer, thermodynamics, waves and sound, electricity and magnetism, light and color and introduction to advance physics for bioscience.

**BS 1202  Physics Laboratory for Bioscience  1 (0-3-1) Credit**

Prerequisite or corequisite: BS 1201 Physics for Bioscience

Laboratory corresponding to BS 1201 Physics for Bioscience.

**BS 2004  Analytical Chemistry  3 (3-0-6) Credits**

Prerequisite: BS 1001 General Chemistry

Quantitative chemical analysis, steps involved in the preparation and analysis of a sample, analysis techniques using gravimetric and volumetric methods, especially, acid-base titration, precipitation titration, redox titration as well as spectroscopy methods.

**BS 2005  Analytical Chemistry Laboratory  1 (0-3-1) Credit**

Prerequisite or corequisite: BS 2004 Analytical Chemistry

Chemistry analysis exercises emphasized on quantitative chemical analysis of chemical samples by combining theories and techniques, including chemical sample preparation and analysis techniques using gravimetric and volumetric methods, especially acid-base titration, precipitation titration, redox titration technique.

**BS 2006  Basic Biochemistry  3 (3-0-6) Credits**

Prerequisite: BS 1007 Organic Chemistry

Structure, function and metabolism of biomolecules including carbohydrates, lipids, amino acids, protein and nucleic acids, characteristics, classification and functions of proteins, enzymes and vitamins, the introduction to gene regulation and genetic engineering.

**BS 2007  Basic Biochemistry Laboratory  1 (0-3-1) Credit**
Prerequisite or corequisite: BS 2006 Basic Biochemistry

Laboratory corresponding to BS 2006 Basic Biochemistry, preparation of buffers, analysis of biomolecules properties, use of laboratory equipment and instruments.

**BS 2008 Physical Chemistry**
3 (3-0-6) Credits

Prerequisite: BS 1001 General Chemistry

Unit conversions, physical properties of gas and kinetic theory of gas, energy and work, the first law of thermodynamics, entropy, the second and third laws of thermodynamics, free energy and applications of thermodynamics.

**BS 2011 Introduction to Microbiology**
3 (2-3-5) Credits

Prerequisites: BS 1005 Principles of Biology and BS 1006 Biology Laboratory

Overview of microbiology in both theoretical and practical aspects, eukaryotic and prokaryotic microorganisms, viral biology, growth and metabolisms of microorganisms, microbial genetic, classification and identification of microbes, roles of microbes to human, environment and in the industries, and corresponding laboratory sessions.

**BS 2012 Genetics**
3 (2-3-5) Credits

Corequisite: BS 2011 Introduction to Microbiology

Principles of classical genetics, Mendel's principles, exception of Mendel, sex determination, sex linkage and chromosome mapping, molecular genetics which includes the structure and functions of DNA, DNA replication, transcription, translation, control of gene expression and extrachromosomal inheritance, and the study of evolutionary genetics, quantitative and qualitative genetics, and corresponding laboratory sessions.

**BS 2013 Engineering Drawing for Bioscience**
1 (0-3-1) Credit

Basic and standard of drawing, lettering, applied geometry, theory and technique of orthographic drawing, pictorial drawing, dimensioning, section view, and assembly drawing.

**BT 2011 Introduction to Biotechnology**
3 (3-0-6) Credits

Prerequisite: BS 2006 Basic Biochemistry or Corequisite: BS 2011 Introduction to Microbiology
Introduction and historical perspective of biotechnology, the relationship between traditional biotechnology and modern biotechnology, examples of application drawn from agriculture, medicine, and molecular biotechnology, commercial dimension of the discipline of biotechnology in market place.

**BT 3013**  
Introduction to Bioprocessing Engineering  3 (3-0-6) Credits

Prerequisites: BS 1102 Calculus II for Bioscience and BS 2008 Physical Chemistry

Introduction to chemical engineering principles, importance of understanding bioprocess operation and bioreactor design, unit conversions, material and energy balances, fluid flow, heat and mass transfer, reaction kinetics, and bioreactor operation.

**BT 3015**  
Industrial Fermentation  3 (2-3-5) Credits

Prerequisite: BS 2011 Introduction to Microbiology

Selection of microbial culture, and the use of microorganism for the production of industrial products, food products, enzymes, antibiotics and organic compounds, cultural improvement, emphasizing on the metabolic regulation of the pathways that generate fermentation products from yeast and other microbial fermentations, and genetic manipulation of industrial microorganisms, and corresponding laboratory sessions.

**BT 3016**  
Enzyme Technology  3 (2-3-5) Credits

Prerequisite: BS 2006 Basic Biochemistry

Structure and functions of enzymes, including enzyme kinetics, regulation and inhibition, effect of pH and temperature, production and extraction of enzymes by means of mechanical, physical or chemical disruption of plant, animal or microbial cells, techniques such as purification, immobilization and isolation of enzymes as catalysts, and corresponding laboratory sessions.

**BT 3017**  
Principles of Research  3 (3-0-6) Credits

Introduction to research methodology, experimental design, hypothesis generation, literature review, collection and analysis of the data, use of spread sheet packages to perform statistical analysis, summarizing and writing a research report, presentation, and ethical principles of a researcher.

(b) Major Required Courses

**FT 3101**  
Introduction to Food Technology  2 (2-0-4) Credits

Prerequisite: BS 2006 Basic Biochemistry

Roles of food industry in relation to modern societies, scientific principles and operations involved in the preservation and manufacture of foods, food composition, nutrition labeling and marketing of a representative range of commercial
foods, current consumer issues such as the safety of food additives, food irradiation, consumer protection, new product development, food regulations and future trends in food supplies.

**FT 3102  Food Engineering  3 (2-3-5) Credits**

Prerequisite: BT 3013 Introduction to Bioprocessing Engineering

Concepts and principles of engineering for various unit operations in food-industry, including pumps, heat exchangers, evaporators, dryers, refrigerators, boilers, retorts, and size reduction equipment, and corresponding laboratory sessions.

**FT 3103  Food Microbiology  3 (2-3-5) Credits**

Prerequisite: BS 2011 Introduction to Microbiology

Microorganisms in food safety and spoilage, their growth parameters, main characteristics of common food-borne pathogens e.g. bacteria, viruses, parasites and fungi, contamination routes and surviving in foods, subsequent diseases and possible means for controlling, a background to practically identify and examine the organisms, and corresponding laboratory sessions.

**FT 3104  Human Nutrition  3 (3-0-6) Credits**

Prerequisite: BS 2006 Basic Biochemistry

Importance of nutrition in daily life, dietary nutrients, chemical composition, food sources, roles and functions in human body, the digestion, absorption, and metabolism of nutrients, diseases associated with nutrient deficiency, and appropriate nutrition for people through the life cycle for example pregnancy and lactation, infancy, childhood, and adolescence, adulthood and the later years.

**FT 3106  Industrial Food Processing I  3 (2-3-5) Credits**

Prerequisite: FT 3101 Introduction to Food Technology

Fundamental knowledge of commercial food processing, thermal processing, low temperature processing, freezing, dehydration, irradiation and chemical preservation, food variables, food quality and raw material preparation, minimal process and waste treatment in food factory, and corresponding laboratory sessions.

**FT 3108  Food Chemistry I  3 (2-3-5) Credits**

Prerequisites: BS 2004 Analytical Chemistry and BS 2006 Basic Biochemistry

Basic food components, water, carbohydrate, protein and lipid, their chemistry governing properties and functions in different foods, changes of food components during processing and storing, chemical spoilages and prevention, and corresponding laboratory sessions.
FT 3109  Food Chemistry II  3 (2-3-5) Credits

Prerequisite: FT 3108 Food Chemistry I
Chemistry of pigments, odor and food additives, factors affecting properties, functions, sources and mechanism in different foods, chemical reaction of enzymes, changes and contamination of toxic substances in foods, theory, selection, analysis techniques of food with scientific instrument, and corresponding laboratory sessions.

FT 4108  Industrial Food Processing II  3 (2-3-5) Credits

Prerequisite: FT 3106 Industrial Food Processing I
Processing technologies of food products, fruit and vegetable, cereal, meat and poultry, fishery, bakery, confectionery, dairy, appropriated packaging, and factors affecting product qualities during storage and transportation, basic plant layout, advanced food processing, and corresponding laboratory sessions.

FT 4110  Food Marketing and Management  3 (3-0-6) Credits

Prerequisite: BG 2403 Introduction to Economics
Basic principles of marketing and management of food products, environmental factors in food industry, consumer’s buying behavior, food marketing research, product development, pricing strategy, distribution channel, and promotion strategy with examples and case studies of food products.

FT 4112  Food Quality Control  3 (2-3-5) Credits

Prerequisites: BG 1201 Statistics I and FT 3106 Industrial Food Processing I
Food production as a systematic and controlling process, acceptance sampling plans for analysis and control of quality, quality management, quality control, quality assurance and quality improvement, quality assurance systems such as Total Quality Management and ISO series within food factory; and corresponding laboratory sessions.

FT 4113  Food Product Development  3 (2-3-5) Credits

Prerequisite: FT 4108 Industrial Food Processing II
New products and new product development process for food industry, how to generate and convert product idea concept into actual product ready for commercialization which include idea screening, product concept development, product formulation and process development, product quality testing, shelf life evaluation, product launching and evaluation, and corresponding laboratory sessions.

FT 4123  Food Sanitation  3 (2-3-5) Credits

Prerequisite: FT 3103 Food Microbiology
Principles of cGMPs of food processing, plant layout, receiving raw material, food handling, warehouse controlling, cleaning, pest controlling, water treatment and personnel hygiene; theory and practices on principles of Hazard Analysis of Critical Control Points (HACCP) to produce safe food products; and corresponding laboratory sessions.

**FT 4190  Special Project  3 (0-9-4) Credits**

A project involving an aspect of food technology, design of study, collection and analysis of experimental data will be done under the faculty member’s supervision. A written report and presentation of the research work in a seminar is compulsory.

**FT 4191  Field Trip  1 (0-3-1) Credit**

Visit to food and agro-industrial production facilities to view specific aspects of processing and management. A written report of the tour is required.

**FT 4192  Seminar  1 (1-0-2) Credit**

Method in preparing and performing a scientific presentation, demonstration of scientific research paper presentation from veteran speakers in the field of biotechnology, food technology and agro-industry, and student presentation of a selected paper of interest from scientific journals.

**FT 4193  Internship  Non-credit**

Practical experience from training in food technology or biotechnology related industry, government sector and/or academic institute of no less than 300 hours to develop skills and confidence after graduation.

**AI 3208  Standards and Regulations of Agricultural Products  2 (2-0-4) Credits**

Prerequisite: AI 3202 Introduction to Agro-Industry or FT 3101 Introduction to Food Technology

Legal and scientific issues involved in the national and international regulations of agricultural products and foods, philosophy underpinning the application of regulation statutes, roles and responsibilities of Thai FDA and international organizations e.g. WTO and its agreements etc., Food Act B.E. 2522, food standards, Codex, risk analysis, and nutrition labeling, and sources of information necessary for communication with government and public.

**(2) Major Elective Courses**

**BS 4001  Ecology, Conservation and Environmentalism  3 (3-0-6) Credits**

Prerequisite: BS 1005 Principles of Biology

Biological productivity in ecosystem and limiting productivity and perturbation, interaction between species, factors in population growth and the ecological balance, protection activities of the environment from pollution or destruction concerning conservation, improvement and sustainability of natural resources.
BT 3014  Microbial Physiology  3 (2-3-5) Credits

Prerequisite: BS 2012 Genetics

Microbial structures and functions to understand how physiology relates to microbial growth and survival; bacteria are used as the primary model and are focused on the molecular aspect of cell growth, structure and functions, cell envelope, cellular metabolism and genetics, and corresponding laboratory sessions.

BT 3018  Genetic Engineering  3 (2-3-5) Credits

Prerequisites: BS 2006 Basic Biochemistry

BS 2007 Basic Biochemistry Laboratory and

BS 2012 Genetics

Molecular biology and techniques of genetic engineering, application of enzymes, vectors, and host gene isolation, detection of recombinant genes, strategies of gene cloning, genomic libraries, cDNA synthesis, gene identification, application of genetic engineering, ethical issue in genetic engineering, and corresponding laboratory sessions.

FT 4114  Bakery Technology  3 (2-3-5) Credits

Science and technology in the production of safe and nutritious bakery products, properties and quality of ingredients, production methods of different bakery products, equipment, quality control, causes of product spoilage, storage methods to maintain good quality of bakery products, plant sanitation, packaging of bakery products, and corresponding laboratory sessions.

FT 4115  Fruit and Vegetable Technology  3 (2-3-5) Credits

Prerequisite: FT 4108 Industrial Food Processing II or

AI 4208 Processing of Agricultural Products II

Chemical and physical structure of fruits and vegetables, post harvest changes and handling methods of fresh fruits and vegetables, and commercial processing methods for preservation of fruits and vegetables, advanced technologies in fruit and vegetable processing, and corresponding laboratory sessions.

FT 4116  Food Toxicology  3 (2-3-5) Credits

Prerequisites: FT 3103 Food Microbiology

FT 3104 Human Nutrition and

FT 3109 Food Chemistry II
Chemistry and biochemistry of toxins naturally occurring in food from plants and animals, toxins from microorganism, food additives, and chemical contaminants, routes of entry, metabolism, manifestation of the toxin in body, and corresponding laboratory sessions.

**FT 4117 Dairy Technology**
3 (2-3-5) Credits
Prerequisite: FT 4108 Industrial Food Processing II or AI 4208 Processing of Agricultural Products II

Milk production and quality in terms of composition, structure, properties and microbiology of milk, principles of commercial practices in processing of milk and dairy products, advanced technology used in dairy industries, and corresponding laboratory sessions.

**FT 4120 Food Additives**
3 (2-3-5) Credits
Prerequisite: FT 3109 Food Chemistry II

Types of food additives from nature and synthesis, amino acids, antioxidants, antimicrobial agents, enzymes, polysaccharides, food colors, and food flavor, functional food ingredients, phytochemicals, flavonoids, phenolic compounds, laws and regulations, their significant in commercial food processing, and corresponding laboratory session.

**FT 4121 Meat Poultry and Fishery Technology**
3 (2-3-5) Credits
Prerequisites: BS 2011 Introduction to Microbiology and FT 4108 Industrial Food Processing II or AI 4208 Processing of Agricultural Product II

Chemical and physical structure of animal muscles used for human consumption, postmortem changes in muscles and factors affecting the quality of muscle products, pigment development and changes in animal tissues, deterioration and spoilage of animal tissues during processing and storage, and production of different meat, poultry and fishery products, and corresponding laboratory sessions.

**FT 4122 Confectionery Technology**
3 (2-3-5) Credits
Prerequisite: FT 4108 Industrial Food Processing II

Impact qualities and properties of raw materials used in confectionery products, characteristics and manufacturing processes of various confections, quality control, spoilage, packaging, storage of the confectionery, and corresponding laboratory sessions.

**FT 4124 Lipid Technology**
3 (2-3-5) Credits
Prerequisites: BS 2006 Basic Biochemistry and

FT 4108 Industrial Food Processing II or

AI 4208 Processing of Agricultural Product II

Chemistry and biochemistry of triglycerides and related lipid substances, biosynthesis and degradation of lipids, industrial production of fats and oils including extraction, degumming, and refining, deodorization, crystallization, and hydrogenation, microbial and enzymatic modification of lipids, corresponding laboratory sessions involving with analytical methods and quality control of the edible fats and oils and their products.

**FT 4125 Beverage Technology 3 (2-3-5) Credits**

Prerequisite: FT 4108 Industrial Food Processing II

Technology for the production of carbonated and non-carbonated, alcoholic and non-alcoholic beverages, the roles of beverages in human life, the manufacturing processes, quality control for production of safe beverages, packaging and beverage packages, and corresponding laboratory sessions.

**FT 4126 Food Packaging 3 (3-0-6) Credits**

Prerequisite: FT 4108 Industrial Food Processing II or

AI 4208 Processing of Agricultural Products II

Chemical, physical and biological properties of packaging materials, production techniques and quality control of food packages, paper, glass, tin plate, plastic films, aluminum foil, laminates and composite materials, criteria in selecting proper package to extend shelf life of different types of food and current trends in development of food package.

**FT 4127 Cereal Technology 3 (2-3-5) Credits**

Prerequisite: FT 4108 Industrial Food Processing II or

AI 4208 Processing of Agricultural Products II

Composition, structure and significance of various kinds of cereals, manufacturing technologies, quality control, storage of cereal and cereal products, and development of new products from cereal, and corresponding laboratory sessions.

**FT 4131 Selected Topic 3 (2-3-5) Credits**

Discussion and advanced study of a selected topic in the field of food technology including corresponding laboratory sessions.
FT 4132  Color and Flavor Technology  3 (2-3-5) Credits

Prerequisites: BS 2004 Analytical Chemistry and
BS 1005 Analytical Chemistry Laboratory

Chemistry of various food colorants, their properties, physiological changes, measurement methods, and affecting factors, flavor chemistry, properties of flavor, development and extraction process of flavor from plants, animals, and via food processing, and application of color and flavor in foods, and corresponding laboratory sessions.

AI 3201  Biological Material and Biodegradation  3 (2-3-5) Credits

Prerequisites: BS 1005 Principles of Biology and
BS 1006 Biology Laboratory

Properties and mechanisms of biodeterioration in natural materials important in Agro-industry, techniques used in assessing the extent and causes of deterioration, damage reduction strategy and technique, including biodeterioration in the environment, and corresponding laboratory sessions.

AI 3205  Biochemical Engineering  3 (3-0-6) Credits

Prerequisites: BS 2006 Basic Biochemistry and
BS 2011 Introduction to Microbiology

Applications of biological organisms and their enzymes in the bioprocesses and the enzyme technology, bioprocess economics, applied enzyme kinetics, fermentation kinetics, metabolic stoichiometry, transport phenomena, sterilization techniques, bioreactor design and operation, upstream and downstream processes and optimization in the process scale up.

AI 4211  Fermentation Process  3 (2-3-5) Credits

Prerequisite: AI 3205 Biochemical Engineering

Principles of isolation, modification and storage techniques of industrial microorganisms, nutrients needed for microbial growth and media optimization, optimization and control processes during upstream, fermentation and downstream processes in batch, continuous, and fed batch bioreactors, and corresponding laboratory sessions.

AI 4219  Sugar Technology  3 (2-3-5) Credits

Prerequisites: BS 2006 Basic Biochemistry and
AI 4208 Processing of Agricultural Product II or
FT 4108 Industrial Food Processing II
Chemical and physical properties of sugar, sugar processing and by-products from sugar industry, quality control and development of new sugar products to be used in other industries, and corresponding laboratory sessions.

**AI 4220 Post Harvest Technology 3 (2-3-5) Credits**

Prerequisites: BS 2006 Basic Biochemistry and
AI 4208 Processing of Agricultural Products II or
FT 4108 Industrial Food Processing II

Principles underlying physiological changes in fresh agricultural produces, harvesting methods and post harvest technology to handle the post harvested crops in order to maintain the crop qualities or to delay changes involved in deterioration of crop qualities, and corresponding laboratory sessions.

**AI 4221 Alcoholic Beverage Technology 3 (2-3-5) Credits**

Prerequisite: BT 3015 Industrial Fermentation

Current technologies used in production of alcoholic beverage, and monitoring of impact of fermentation variables on microbial performance and product quality, distillation principles and practices, production technology of brandy, whiskey, rum, vodka, gins, and other distilled beverages, characteristics of raw materials, fermentation, distillation, and aging, manufacturing processes used in alcoholic beverages production, research development involving the use of biotechnology for the purpose of yield, solving quality related problems and stimulation innovation, an introduction to management, marketing and economics of most of the alcoholic beverages, review market segmentation and explore alternatives, social policy formation, and corresponding laboratory sessions.

**AI 4222 Water and Waste Management 3 (2-3-5) Credits**

Prerequisite: BS 2011 Introduction to Microbiology

Water and waste management starting from good preparation of raw material for industry, clean technology, waste controlling, and water management of downstream process to reduce sources of pollution, and corresponding laboratory sessions.

**AI 4223 Waste and By-product Utilization 3 (2-3-5) Credits**

Prerequisite: BS 2011 Introduction to Microbiology

Principles and practical issues for using waste and by-products from industry to find optimum method to produce products from those waste materials, and corresponding laboratory sessions.