Food Technology (Nutrigenomics)

Scheme & Syllabus

for

M. Tech.

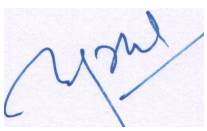
I. K. Gujral Punjab Technical University Jalandhar
Jalandhar-Kapurthala Highway
Kapurthala 144603, Punjab

FIRST SEMESTER

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
PFNB-101	Nutraceuticals& Functional Food	3	1	-	40	60	100	4
PFNB-102	Human Physiology	3	1	-	40	60	100	4
PFNB-103	Molecular Biology	3	1	-	40	60	100	4
PFNB-104	Food Biochemistry	3	1	-	40	60	100	4
PFNB-105	Biomaterial Engineering	3	1	-	40	60	100	4
PFNB-106	Lab –I	-	-	4	40	60	100	2
	Journal Club	-	-	2	Mandatory			2*
	TOTAL	**15**	**5**	**6**	**240**	**360**	**600**	**22+2***

SECOND SEMESTER

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
PFNB-201	Nutrigenomics	3	1	-	40	60	100	4
PFNB-202	Pharmacology Pathophysiology	3	1	-	40	60	100	4
PFNB-203	Advances in Phytochemical Analytical Techniques	3	1	-	40	60	100	4
PFNB-204	Design & Development of Functional Food & Nutraceutical	3	1	-	40	60	100	4
PFNB-205	Regulatory Affairs	3	1	-	40	60	100	4
PFNB-206	Lab –II	-	-	4	40	60	100	2
	Journal Club	-	-	2	Mandatory			2*
	TOTAL	**15**	**5**	**6**	**240**	**360**	**600**	**22+2***



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Head, DFST

THIRD SEMESTER

Course Code	Course Title	Load Allocation			Marks Distribution		Total Marks	Credits
		L	T	P	Internal	External		
PFNB-301	Research Methodology	3	1	-	40	60	100	4
PFNB-302	Elective –I	3	1	-	40	60	100	4
PFNB-303	Elective –II	3	1	-	40	60	100	4
PFNB-304	Seminar	-	-	2	40	60	100	2
PFNB-305	Dissertation (Part-I)	-	-	8	Satisfactory/ Un-Satisfactory			8
	TOTAL	**9**	**3**	**10**	**160**	**240**	**400**	**22**

FOURTH SEMESTER

Course Code	Course Title	Load Allocation			Marks Distribution	Credits
		L	T	P		
PFNB-401	Dissertation (Part –II)	-	-	22	Satisfactory/ Un-Satisfactory	**22****

*** Not to be shown in DMC**
****Non credit (only satisfactory or Un-satisfactory grade to be shown in DMC)**

Terminology: L means Lecture, T means Tutorial, P means Practical, MST means Mid Semester Test, DMC means Detailed Marks Certificate
Credit System: 01 Credit for 01 Lecture / Tutorial / Seminar / Dissertation hour per week.
01 Credit for 02 Practical hour per week

Elective-I

Sr No.	Subject
1.	Modelling & Simulation
2.	Energy Management in Processing Industry
3.	Unit Operations
4.	Genetic Engineering

Elective-II

Sr No.	Subject
1.	Processing of Plant Bioactive
2.	Processing of Animal Bioactive
3.	Preservation and Packaging Technology
4.	Nutraceutical Discovery Process

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PFNB-101 NUTRACEUTICAL AND FUNCTIONAL FOOD

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To teach basic understanding of the concepts of nutraceutical and functional food, and their use for managing chronic diseases*

MODULE 1 **(10 hrs)**

NUTRACEUTICAL

Historical perspective; definition, nature, nutraceutical compounds and their classification based on chemical/biochemical nature with suitable and relevant descriptions; scope and future prospects. Applied aspects of the nutraceutical science, relation of nutraceutical science with other sciences: medicine, human physiology, genetics, food technology, chemistry and nutrition.

Functional food

Overview; definition, classification; functional food, functional food science, food technology and its impact on functional food development; markers for development of functional foods; key issues in Indian functional food industry and nutraceutical. Relation of functional foods and nutraceutical (FFN) to foods and drugs.

MODULE 2 **(16 hrs)**

ANTIOXIDANTS

Concept of free radicals and antioxidants; antioxidants role as nutraceuticals and functional foods.

FOOD AS REMEDIES

Nutraceuticals bridging the gap between food and drug; nutraceuticals for specific situations such as cancer, heart disease, diabetes, stress, osteoarthritis, hypertension; nutraceutical remedies for common disorders like arthritis, bronchitis, circulatory problems, hypoglycemia, liver disorders, osteoporosis, psoriasis and ulcers, etc.

MODULE 3 **(14 hrs)**

FOOD SOURCES

Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants. Coffee, tea and other beverages as functional foods/drinks and their protective effects.

PROPERTIES AND FUNCTIONS OF VARIOUS NUTRACEUTICALS/FUNCTIONAL FOOD INGREDIENTS

Protein, complex carbohydrates like dietary fibers as functional food ingredients; probiotic, prebiotics and symbiotic foods, and their functional role. Sources and role of isoprenoids, isoflavones, flavonoids, carotenoids, tocotrienols, chlorophyll, polyunsaturated fatty acids, lecithin, choline, terpenoids. Glucosamine, lycopene, proanthocyanidins.

MODULE 4 **(14 hrs)**

ANTI-NUTRITIONAL FACTORS PRESENT IN FOODS

Types of inhibitors present in various foods and their inactivation. Assessment of nutritional status and recommended daily allowances. Effects of processing, storage and interactions of various environmental factors on the potentials of such foods.

Marketing and regulatory issues for functional foods and nutraceuticals. Recent development and advances in the areas of nutraceutical and functional foods.

References Books

- Giuseppe Mazza*; Functional Foods: Biochemical and Processing Aspects, Volume 1; CRC Press*
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition; CRC Press*
- Massimo Maffei; *Dietary Supplements of Plant Origin; CRC Press*
- Fereidoon Sahidi, Deepthi K. Weerasinghe; *Nutraceutical Beverages, Chemistry, Nutrition and Health Effects; American Chemical Society*
- Ronald R. Watson; *Vegetables, Fruits, and Herbs in Health Promotion; CRC Press*
- Fruit and Cereal Bioactives: Sources, Chemistry and Applications; ÖzlemTokusoglu; Clifford Hall III; CRC Press
- Susan Sungsoo Cho, Mark L. Dreher; Marcel; *Dekker Handbook of Dietary Fibre*

PFNB-102 HUMAN PHYSIOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *This is a foundation course which will help students to relate the effects of nutraceuticals/functional foods on human body, and to understand the modulation of underlying physiology by use of nutraceuticals/functional food*

MODULE 1 **(10 hrs)**

SKELETAL MUSCLES: Gross anatomy; physiology of muscle contraction, physiological properties of skeletal muscles and their disorders.

SMOOTH MUSCLES: Morphology, electrical and mechanical activity, molecular basis of contraction, relation of length to tension and plasticity.

DIGESTIVE SYSTEM: Gross anatomy of the gastro-intestinal tract, functions of its different parts including those of liver, pancreas and gall bladder, various gastrointestinal secretions and their role in the absorption and digestion of food.

MODULE 2 **(16 hrs)**

HAEMOPOIETIC SYSTEM: Composition and functions of blood and its elements, their disorders, blood groups and their significance, mechanism of coagulation, disorders of platelets and coagulation.

CARDIOVASCULAR SYSTEM: Morphology, electrical properties of cardiac muscle, pacemaker tissue, basic anatomy of the heart, physiology of heart, blood vessels and circulation, cardiac cycle, heart sounds, cardiac cycle, blood pressure and its regulation.

LYMPH AND LYMPHATIC SYSTEM: Composition, formulation and circulation of lymph; disorders of lymph and lymphatic system. Basic physiology and functions of spleen.

MODULE 3

(14 hrs)

CENTRAL NERVOUS SYSTEM: Brain, spinal Cord, **n**eurohumoral transmission in the central nervous system

AUTONOMIC NERVOUS SYSTEM

ENDOCRINE SYSTEM: Basic anatomy and physiology of pituitary, thyroid, parathyroid, adrenals, pancreas, testes and ovary, their hormones and functions.

MODULE 4 **(8 hrs)**

URINARY SYSTEM: Various parts, structures and functions of the kidney and urinary tract. Physiology of urine formation and acid-base balance.

SENSE ORGANS: Basic anatomy and physiology of the taste buds, nose (smell) and skin (superficial receptors), ear and eye.

Reference Books

- Authors: Kim E. Barrett, Susan M. Barman Scott Boitano, Heddwen Brooks; *Ganong's Review of Medical Physiology, 24th Edition. Publisher: Lange.*
- Authors: Arthur C. Guyton , John E. Hall; *Guyton and Hall Textbook of Physiology, 12th Edition. Publisher: Saunders-Elsevier.*
- Author: AnneWaugh and Allison Grant; *Ross and Wilson Anatomy and Physiology in Health and Illnes, 11th edition. Publisher: Churchill Livingstone.*

PFNB-103 MOLECULAR BIOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *Molecular biology deals with nucleic acids and proteins, and how these molecules interact within the cell to promote proper growth, division and development. This course will emphasize the molecular mechanisms of DNA replication, repair, transcription, protein synthesis, and gene regulation in different organisms. Techniques and experiments used to discern these mechanisms, often referring to the original scientific literature, shall be studied. In addition, an in-depth look at some rapidly evolving fields, including chromatin structure and function, RNA polymerase dynamics, and regulation of gene expression by different types of RNAs shall also be studied.*

MODULE 1 **(12 hrs)**

GENOME ORGANIZATION: Organization of bacterial genome; structure of eukaryotic chromosomes; role of nuclear matrix in chromosome organization and function; matrix binding proteins; heterochromatin and euchromatin; DNA reassociation kinetics (Cot curve analysis); repetitive and unique sequences;s Satellite DNA; DNA melting and buoyant density; nucleosome phasing; DNase I hypersensitive regions; DNA methylation and imprinting.

DNA STRUCTURE; REPLICATION, REPAIR AND RECOMBINATION: Structure of DNA A, B, Z- and triplex DNA; measurement of properties -- spectrophotometric, CD, AFMand Electron microscope analysis of DNA structure; replication initiation, elongation and termination in prokaryotes and eukaryotes; enzymes and accessory proteins; fidelity; replication of single stranded circular DNA; gene stability and DNA repair enzymes; photoreactivation; nucleotide excision repair; mismatch correction; SOS repair; recombination: Homologous and non-homologous; site specific recombination; Chi sequences in prokaryotes; gene targeting; gene disruption; FLP/FRT and Cre/Lox recombination.

Module 2 **(12 hrs)**

PROKARYOTIC AND EUKARYOTIC TRANSCRIPTION: Prokaryotic transcription; transcription unit; Promoters -- constitutive and inducible; operators; regulatory elements; initiation; attenuation; termination-rho-dependent and independent; anti-termination; transcriptional regulation-Positive and negative; Operon concept -- lac, trp, ara, his, and gal operons; transcriptional control in lambda phage; transcript processing; processing of tRNA and rRNA; eukaryotic transcription and regulation; RNA polymerase structure and assembly; RNA polymerase I, II, III; eukaryotic promoters and enhancers; general transcription factors; TATA binding proteins (TBP) and TBP associated factors (TAF); activators and repressors; transcriptional and post-transcriptional gene silencing.

Post transcriptional modifications: Processing of hnRNA, tRNA, rRNA; 5'-Cap formation; 3'-end processing and polyadenylation; Sslicing; RNA editing; nuclear export of mRNA; mRNA stability; catalytic RNA.

MODULE 3 **(12 hrs)**

TRANSLATION AND TRANSPORT: Translation machinery; ribosomes; composition and assembly; universal genetic code; degeneracy of codons; termination codons; isoacceptingtRNA; Wobble hypothesis; mechanism of initiation, elongation and termination; Co- and post-translational modifications; genetic code in mitochondria; transport of proteins and molecular chaperones; protein stability; protein turnover and degradation.

MODULE 4 **(12 hrs)**

MUTATIONS; ONCOGENES AND TUMOR SUPPRESSOR GENES: Nonsense, missense and point mutations; intragenic and intergenic suppression; Frameshift mutations; physical, chemical and biological mutagens; transposition -- transposable genetic elements in prokaryotes and eukaryotes; mechanisms of transposition; role of transposons in mutation; viral and cellular oncogenes; tumor suppressor genes from humans; Structure, function and mechanism of action of pRB and p53 tumor suppressor proteins; activation of oncogenes and dominant negative effect; suppression of tumor suppressor genes; oncogenes as transcriptional activators.

Reference Books

- Jones and Barlett; *Benjamin Lewin, Gene IX, 9th Edition, Publishers, 2007*.
- J.D. Watson, N.H. Hopkins, J.W Roberts, J. A. Seitz and A.M. Weiner; *Molecular Biology of the Gene, 6th Edition Benjamin Cummings Publishing Company Inc, 2007.*
- Alberts et al; *Molecular Biology of the Cell, 4th edition, Garland, 2002.*
- Lodish , *Molecular Cell Biology, 7th edition, Freeman, 2013.*

PFNB 104 FOOD CHEMISTRY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *The objective of this course is to impart the knowledge of bio-chemical fate of food materials, natural products & nutraceuticals to the students at molecular level.*

MODULE 1 **(12 hrs)**

CHIRALITY

Introduction, isomerisation in organic/bioorganic compounds, Fischer projections and conventions, D-L configuration, R-S systems, stereoisomersim, threo- and erythro- nomenclature and syn-anti systems, meso- compounds, diastereoisomerism, optical activity, optical isomers, epimerisations in sugars, prostereoisomerism and prochirality, stereoselective and stereospecific synthesis.

WATER

Weak interactions in Aqueous Systems, ionization of water, weak acids, and weak bases, buffering against pH changes in biological systems, water as a reactant, The fitness of the aqueous environment for living organisms.

PRINCIPLE OF BIOENERGETICS

Bioenergetics and thermodynamics, phosphoryl group transfers and ATP, biological oxidation-reduction reactions, biological membranes and transport.

MODULE 2 **(12 hrs)**

CARBOHYDRATES

MONOSACCHARIDES: - Structure and nomenclature, configuration, conformation, physical properties, optical rotation, mutarotation, chemical reactions, caramelization , reactions with amino compounds (*Maillard* Reaction), initial phase of the maillard reaction, redox reactions, *Strecker* Reaction:

Disaccharide– structure, different types, sucrose biosynthesis

Oligosaccharides: - structure and nomenclature, properties and reactions

Polysaccharides:- different types, agar, enzymatic degradation of polysaccharides , amylases, glucan-1,4-α-D-glucosidase (glucoamylase), pectinolytic, thickening agents, metabolism of carbohydrates, glycolysis, gluconeogenesis, pentose phosphate pathway, citric acid cycle.

MODULE 3 **(12 hrs)**

AMINO ACIDS AND PROTEINS:

amino acids, Occurrence: structure, classification, physical & chemical properties, peptides, polypeptide, proteins & their properties, sequence of amino acids, structure of protein denaturation, major source of protein

Metabolism of protein, digestion, absorption & functions, end products of protein metabolism inter–medially metabolism of amino acids & the urea cycle, metabolic Fates of amino groups, nitrogen excretion and the urea cycle, pathways of amino acid degradation, protein targeting and degradation.

MODULE 4 **(12 hrs)**

OILS AND FATS:

Introduction, occurrence, composition, classification of glycosides, structure, physical and chemical properties, rancidity and flavor, reversion processing of oil bearing materials, refining of oils and fats, splitting & esterification hydrogenation, shortenings and low fat spreads.

Lipid metabolism: digestion, absorption and functions. Oxidation of fatty acids, biosynthesis of fatty acids and fats. Food emulsions, digestion, mobilization, transport of fats, oxidation of fatty acids, ketone bodies,

Biosynthesis of fatty acids and eicosanoids, biosynthesis of triacylglycerols, biosynthesis of membrane phospholipids, biosynthesis of cholesterol, steroids, isoprenoids.

Reference Books:

- P.S. Kalsi, *Stereochemistry; New Age international;* ***2000.***
- H.-D. Belitz, Werner Grosch, Peter Schieberle; *Food Chemistry, Springer,* ***2010***.
- David L. Nelson and Michael M. Cox; *Lehninger Principal of Biochemistry, , Sixth Edition*
- Robert K. Murray, David A. Bender, Kathleen M. Botham, Peter J. Kennelly, Victor W. Roadwell, P. Anthony Weil; *Harper's Illustrated Biochemistry,*
- Jeremy M. Berg, John L. Tymoczko, Lubert Stryer; *Biochemistry,.*

PFNB-105 BIOMATERIAL ENGINEERING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To acquaint students with biomaterial engineering and processes involved for new food product design.*

MODULE 1 **(10 hrs)**

Introduction and review of engineering properties of food material. Physico-chemical characteristics: Shape, sphericity, size, volume, density, porosity, surface area, coefficient of friction, angle of repose and their role in the designing of the equipments. Aero and hydrodynamic characteristics: concept and use of drag coefficient, terminal velocity in food products processing and handling.

MODULE 2 **(13 hrs)**

Thermal properties: Specific heat, thermal conductivity, thermal diffusivity.
Electrical properties: Electrical resistance, conductance, dielectric constant.
Optical properties: Reflectivity, transmitivity, absorbtivity of incident rays.
Role of thermal, electrical and optical properties in the products/process designing, processing and/or handling.

MODULE 3 **(13 hrs)**

Rheological properties: Overview, basic concepts of rheology relevant to food texture, elastic vs. textural characteristics of foods, viscoelastic behaviour of food material, viscometry approaches. Time temperature dependency of linear viscoelastic behaviour of agricultural products.
Textural properties: Classification, objective methods of texture evaluation, engineering approach and techniques for evaluation of food texture.

MODULE 4 **(12 hrs)**

Visco-elastic rheological models, mathematical modelling for rheology and texture of food materials. Sensory evaluation and correlation with objective indices, microstructure and its relation to texture from their mechanical models and its examination, flow behavior of granular and powdered food materials.

Reference Books

- Malcolm C. Bourne; An Elsevier Science Imprint; *Food Texture and Viscosity; Concept and Measurement;*
- James F. Steffe; *Rheological Methods in Food Process Engineering; Freeman Press.*
- Rao and Razvi; *Engineering Properties of Foods*
- Mohsenin; *Physical Properties of Plant and Animal Material;.*

PFNB-106 LABORATORY- I

Internal Marks	External Marks	Total Marks	Credits
40	60	100	2

L	T	P
-	-	4

LIST OF EXPERIMENTS

1. Preparation of standard solution.
2. Carboydrates: qualitative tests, estimation of reducing/non-reducing sugars, total sugars, starch and polarimetry of sugars.
3. Lipid extraction and its evaluation. Solvent extraction method, PV, saponification, iodine value, acid value, free fatty acid.
4. Protein estimation.
5. Mineral Estimation.
6. Crude fiber estimation.
7. Determination of moisture content by
   a. loss on drying (using oven and vacuum oven).
   b. Moisture meter.
   c. Distillation.

7. Estimation of total phenolic content of biomaterial.
8. Estimation of total flavonoids content of biomaterial.
9. Estimation of total antioxidant activity of biomaterial.
10. Estimation of FRAP (Ferric reducing antioxidant activity) assay or reducing power.
11. Estimation of hydrogen peroxide (H_2O_2) scavenging activity.
12. Estimation of Free radical scavenging activity on DPPH· (α , α-diphenyl -β - picrylhydrazyl).
13. Organoleptic evaluation of food materials.
14. Objective evaluation of food materials: water activity, viscosity, texture analysis, color.

Reference Books

- Brain S. Furniss, A.J.Hannaford; *Vogel's Text Book of Practical Organic Chemistry,*
- John Wiley & sons; *P.W.G. Smith. A.R.Tatchell, 5th Edition, Inc. New York, 1989.*
- Skoog and West; *Instrumental Methods of Analysis*,.
- C.K. Kokate, VallabhPrakashan; *Practical Pharmacognosy:, New Delhi.*
- K.R., NiraliPrakashan, *Practical Pharmacognosy: Khandewal, Pune.*

PFNB 201 NUTRIGENOMICS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Prerequisite: *Knowledge in Basic Molecular Biology & related techniques and Applied Biochemistry*

Objective and Expected Outcome: *To familiarize students with the basic concepts in NUTRITIONAL GENOMICS and to develop an understanding of GENOMICS AND GENE REGULATION WITH RESPECT TO DIET and to obtain an appreciation for the role and importance of nutrition in prevention of POLYGENIC DISEASES. Students will gain knowledge to apply NUTRAGENOMICS and to design nutritional strategies for prevention of chronic diseases such as cardiovascular disease, obesity, type-2 diabetes and cancer. To reach these objectives students will need to search literature and learn how to use genomic databases, read relevant original research papers, actively participate in preparing specific lecture topics, and discuss concepts and ideas with in the class. In addition, students will work in groups and/or individually on several class/home assignments and write a research grant application*

MODULE 1 **(12 hrs)**

INTRODUCTION TO GENE-DIET INTERACTIONS

Nutrigenomics: Scope and Importance to Human Health and Industry

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

MODULE 2 **(12 hrs)**

MODIFYING DISEASE RISK THROUGH NUTRIGENOMICS:

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

MODULE 3 **(12 hrs)**

TECHNOLOGIES IN NUTRIGENOMICS

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

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

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

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

MODULE 4 **(12 hrs)**

BRINGING NUTRIGENOMICS TO INDUSTRY, HEALTH PROFESSIONALS, AND THE PUBLIC:

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

Reference Books:

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

http://www.ga-online.org/files/Antalya2011/WS2-Daniel.pdf
http://www.authorstream.com/Presentation/winingneeraj01-1272374-nutritional-genomics/

PFNB-202 PATHOPHYSIOLOGY OF COMMON DISEASES & GENERAL PHARMACOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *This course is designed with the aim to confer student's knowledge about the underlying pathological changes in disease states and the molecular basis of nutraceutical action in such diseased states.*

MODULE 1 **(12 hrs)**

NUTRACEUTICALS: the link between nutrition and medicine
Concepts of health and disease: disease causing agents and prevention of disease
ONCOLOGY: cancer cell biology and angiogenesis, apoptosis. Nutraceuticals in chemoprevention
Pathophysiology of Inflammatory diseases: rheumatoid arthritis, osteo-arthritis, gout, asthma
Bone Health
PATHOPHYSIOLOGY OF CARDIAC DISORDERS: hypertension, angina, congestive heart failure, atherosclerosis and myocardial infarction

MODULE 2 **(12 hrs)**

Pathophysiology liver cirrhosis, pancreatitis
Pathophysiology of CNS disorders: depression, mania, epilepsy, Alzheimer's disease and Parkinson's disease
OBESITY: Biology of obesity, evaluation and management of obesity, eating disorders
Gastrointestinal disorders: dysphagia, nausea, vomiting, constipation, ulcerative colitis, inflammatory bowel disease
Pathophysiology of common diseases: diabetes, malaria, AIDS

MODULE 3 **(14 hrs)**

INTRODUCTION TO PHARMACOLOGY: Mechanisms of drug action, introduction to receptors, neurotransmitters, drug transporter, basic mechanisms of membrane transport, membrane transporters, ion channels, second messengers, downstream signaling pathways.

MODULE 4 **(10 hrs)**

Drug response, adverse drug reactions, drug interactions and pharmacogenetics. Drug resistance and tolerance, orphan drugs, essential drug concept, dose response curve, competitive and non- competitive drug antagonism, agonists, antagonist, partial agonist, reverse agonist**.** Principles of basic and clinical pharmacokinetics

Reference Books:

- By Vinay Kumar, Abul K. Abbas, Nelson Fausto and Jon Aster; *Robbins & Cotran Pathologic Basis of Disease. 8th Edition.. Publisher: Elsevier.*
- By Jo Ann Zerwekh, AZ Jo Carol Claborn, Tom Gaglione; *Mosby's Pathophysiology Memory Note Cards: Visual, Mnemonic, and Memory Aids for Nurses, 2nd Edition. Publisher: Elsevier.*
- By Richard Mitchell, Vinay Kumar, Abul K. Abbas, Nelson Fausto and Jon Aste; *Pocket Companion to Robins & Cortan Pathological Basis of Disease. 8th Edition.. Publisher: Elsevier.*
- Authors: Kathryn L. McCance & Sue E. Huether; *Pathophysiology: The Biologic Basis for Disease in Adults and Children. Publisher: Elsevier.*
- By Porth, Carol; *Essentials of Pathophysiology; Concepts of Altered Health States.. Publisher Lippincott Williams & Wilkins.*
- By Sue E Huether, Kathryn RN; *Understanding Pathophysiology. 5th Edition. Publisher: Elsevier.*
- By Humphrey P. Rang, Maureen M. Dale, James M. Ritter, Rod J. Flower, Graeme Henderson; *Rang & Dale's Pharmacology, 7th Edition. Publisher: Elsevier.*
- . By K D Tripathi; *Essentials of Medical Pharmacology. 6th edition Publisher Jaypee.*

PFNB-203 ADVANCES IN PHYTOCHEMICAL ANALYTICAL TECHNIQUES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To develop capabilities for performing analysis of phytochemical constituents and subsequent evaluation in nutraceuticals and natural products.*

MODULE 1 **(10 hrs)**

INTRODUCTION; Production Processes for Herbals and Botanicals: Introduction, Cultivation, Collection from the Wild, Pre-preparation Technique (Cleaning, Drying, Packaging of Dried Plants, grinding, peeling etc.); Selection of Plant and Plant Parts for Phytochemical Analysis

METHODS OF EXTRACTION: Introduction, Organic Solvent Extraction, Extraction with Supercritical Gases, Steam Distillation, Extraction of Essential Oil, Soxhlet Extractor, Accelerated Solvent Extractor, Purification and Concentration of Miscella, Schemes of procedure for extracting Plant Tissues, Other Minor Extraction Methods, Advances in extraction techniques (Ultrasound extraction, microwave extraction etc).

QUALITATIVE PHYTOCHEMICAL SCREENING: Detection of: Alkaloids, carbohydrates and Glycosides, saponins, proteins and Amino Acids, Phytosterols, Fixed Oils and Fats, Phenolic Compounds and Tannins, Gum and Mucilages, Volatile Oil.

MODULE 2 **(14 hrs)**

METHODS FOR SEPARATION OF PHYTOCHEMICALS: Introduction, Chromatography, Paper Chromatography, Thin layer Chromatography, Column Chromatography (Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data).

QUALITATIVE AND QUANTITATIVE ESTIMATION OF PHYTOCHEMICAL: Introduction, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography, High Performance Thin layer Chromatography, Optimum Performance Laminar Chromatography (OPLC) (Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data).

MODULE 3 **(16 hrs)**

METHODS OF IDENTIFICATION: Introduction; Physical Characteristics;

Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data – Spectroscopy; Ultra Violet Spectroscopy; Infrared Absorption Spectroscopy; Near-Infrared Absorption Spectroscopy; Mass Spectroscopy; Nuclear Magnetic Resonance Spectroscopy; CHN Analysis; x-Ray Crystallography .

MODULE 4 **(8 hrs)**

CATEGORIES OF PHYTOCHEMICALS OVERVIEW OF DIFFERENT PHYTOCHEMICALS: Introduction, Terpenoids, Steroids, Phenolic Compounds, Alkaloids, Glycosides, Carbohydrates, Lipids and Related Compounds, Plant Pigments, Vitamins, Amino Acids, Proteins, Nucleic Acids.

TOXIC RESIDUE DETERMINATION: Pesticide residue, Arsenic and Heavy Metals

Reference Books:

- By Prof N Raman; *Phytochemical Techniques, , New India Publishing Agency.*
- By Veronika R. Meyer, *Practical High- Performance Liquid Chromatography; John Wiley & sons.*
- By W. Jeffery Hurst; *Methods of Analysis for Funtional Foods & Nutraceuticals, CRC Press.*

PFNB – 204 FUNCTIONAL FOOD & NUTRACEUTICAL: DESIGN & DEVELOPMENT

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To develop capability for devising research problem in the area of interest.*

MODULE 1 **(10 hrs)**

Introduction – design & development, Project- Meaning, Characteristics, levels, classification, aspects – Preliminary & Feasibility and approach, Project cycle, Project Analysis. Product Design & development – Concept, Factor affecting development of a new product, People involved in Product Design and development, Product Life cycle

MODULE 2 **(14 hrs)**

The Process of product development- product strategy, Idea/Concept Generation, feasibility/Optimization, product design and process development, pre-launch, product commercialization, product launch and evaluation. Role of consumers research & market research in product development, Requirements for development of food products vs. functional food/nutritional products, Steps to bring Functional foods on the market. The knowledge base for product development technology - knowledge and the food system, knowledge management, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing.

MODULE 3 **(12 hrs)**

Structural Design Principles for improved Food Performance & Processing technology approaches to produce encapsulation and delivery systems – Emulsion, spray drying, freeze drying, co-extrusion, microencapsulation and Nano-laminated Biopolymer Structures in Foods; The shelf life of foods. Reverse pharmacology for developing functional foods/herbal supplements. New trends for food product design & case studies.

MODULE 4 **(12 hrs)**

Natural Products Drug Discovery: Introduction, the current pharmaceutical Scenario, why Natural products are intrinsically useful for drug discovery, possible reasons for the current downsizing of natural product drug discovery, Strategies in natural product drug discovery; Ayurveda in modern medicine-development and modification of bioactivity. Case study of Cancer Drug Discovery and Development

Reference Books:

- Clarke & Wright W. 1999; *Managing New Product and Process Development; Free Press.*
- Earle and Earle 2001; *Creating New Foods, Chadwick House Group.*
- Earle R & Anderson A. *2001; Food Product Development Earle R, Woodhead Publications.*
- Fuller *2004; New Food Product Development - from Concept to Market Place,. CRC.*
- Nissim Garti and D. Julian McClements; *Encapsulation technologies and delivery systems for food ingredients and nutraceuticals; Woodhead Publishing Ltd.*
- D.Julian McClements and Eric A. Decker, *Designing functional foods; Woodhead Publishing Ltd.*
- Jim Smith and Edward*, Functional Food Product Development; Blackwell Publishing Ltd*

PFNB – 205 QUALITY & SAFETY STANDARDS & REGULATION AFFAIRS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To develop the capability for ensuring regulatory obligations in the area of interest nationally as well as internationally*

MODULE 1 **(12 hrs)**

Introduction quality control & quality assurance; Statistical approaches in quality control and quality assurance; Production planning and Control

WTO, GATT, GATS, Codex Allimentarius Commission, Requirement of good manufacturing practices (GMP), good hygienic process (GHP), Cleaning and disinfection Principles.

MODULE 2 **(10 hrs)**

Hazard Analysis Critical Control Point (HACCP) and its implication ISO – 22000:2005, Food safety and standards act – 2006, British Retail consortium, Safe quality food.

AGMARK- 1937, FPO 1955, PFA –1954, BIS –1952, consumer protection act –1986, Vanaspati control order –1978, export quality control and inspection act- 1963, Green Label certification, Organic food certifications, Certifications for GMFs.

MODULE 3 **(12 hrs)**

ISO–9000 series (2008), Concept of total quality control (TQM), ISO- 19011, GLP, ISO-17025.

Functional foods associated health claims for consumer: Introduction, EU legislation, U.S. regulation, Japan, Asia, Australia, New Zealand and other countries regulations on nutrition, health and related claims made on functional foods & their support, regulatory Issues/challenges for herbal medicinal plants. Harmonisation of regulations, DSHEA.

MODULE 4 **(14 hrs)**

Materia-medica. Ayurvedic Pharmacopoeia of India (API), United States Pharmacopoeia (USP), European Pharmacopoeia (EP), European evaluation agency (EMEA), Drug and cosmetic Act. ICMR,, ESCOP, ICH, FDA, WHO, GCLP.

Industrial legislation and laws, acts and disputes. Industrial disputes act –1947, Intellectual Property: concept and fundamental- Patent Laws, copy right, trade mark and IPR governing discovery and development of drugs from natural sources, IPP, WIPO (World Intellectual Property Organization), TRIPS, Trade Related Investment Measures (TRIMS), Biopiracy of Medicinal plants;

Reference Books:

- By Mike Dillon & Chris Griffith; *Auditing in the Food Industry; CRC Press*
- By Norman G. Marriott ; *Essentials of Food Sanitation*
- By Michael M. Cramer; *Food Plant Sanitation (Design, Maintance & Good Manufacturing Practices), CRC Press*
- By Inteaz Alli; *Food Quality Assurance Principles & Practices, CRC Press*
- By Sandy Weinberg; *Good Laboratory Practice Regulations Drugs & Pharmacentical Sciences, CRC Press*
- By Sidney H. Willing, Marcel Dekkerine; *Good Manufacturing Practices for Pharmacentical (A Plan for Total Quality control from Manufacturer to Consumer).*

- By Mcrle D. Pierron & Donald A. Corlett, Van Nostrand Reinhold;.*HACCP (Principle and Applications)*
- By H.L M. Lelieveld, M.A. Mastert & J. Holah; *Handbook of Hygiene Control in the Food Industry CRC Press*
- By Ian Smith and Anthony Furness; *Improving Traceability in Food Processing & Distributions, CRC Press*
- By Graham D Dgg; *A Practical Guide to Quality Management in Clinical Trial Research,., CRC Press*
- By Merton R. Hubbard, Kluwer Academic; *Statistical Quality Control for the food Industry, Plaenum Publishers*
- The CRC Master Keyword Guide for Food : 21 CFR Regulations of Food & Drug Administration, CRC Press
- By Wilbur A. Gould; *Total Quality management for the Food Industries, CTI Publications*
- By Jurg P. Seiler; *Good Laboratory Practice the why & the How, Springer.*

International Standard

ISO 2000: 2005 ; ISO 9001 : 2008 ; Codex Alimentrarius – 17th procedural Manual & all other respective standards Act & Regulation

Websites

www.icmr.nic.in. ; www.whoindia.org. ; www.fda.gov. ; www.wto.org.

PFNB – 301 RESEARCH METHODOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *Basic understanding of research concepts and its methodologies. After completion of this course, student will be enabled to select and define appropriate research problem, prepare project proposal and to write research report and thesis.*

MODULE 1 **(8 hrs)**

INTRODUCTION: Definition, general and specific characteristics of research, classification, types and objective of research, research process, criteria of good research, basic concept of experiments and research, significance of research. Planning and designing a research study: choosing a research topic, literature review, research problem formulation, articulating hypothesis, selection of variables, research participants.

MODULE 2 **(14 hrs)**

Meaning, nature and types of data: primary and secondary; observational; experimental. Data Collection: types of sampling design. Principles of research design and methodology, general types of research designs and approaches. Experimental designs, quasi-experimental designs, non-experimental or qualitative designs, designing a questionnaire, method of survey, epidemiological studies. General approaches for controlling artifact and bias: validity, sources of artifact, bias and their control (randomization and blinding).

DATA ANALYSIS: statistics-concept and types, descriptive and inferential, parametric and non-parametric, stochastic and deterministic. Tools of descriptive statistics and their application. Central tendency, dispersion, measures of association, correlation and regression

MODULE 3 **(18 hrs)**

Concept of probability, probability distribution, normal distribution, poisson distribution. Hypothesis testing and level of significance. Paired and unpaired t-test, Chi-square, F-test, ANOVA: one way and two way, Tukey's HSD, interpreting data and drawing inferences. Multiple correlation and regression, index number.

Non-parametric tests: sign test; Mc Nemer test, Mann-Whitnery test, Kruskal-Wallis test, Spearman's rank correlation, principal component analysis.

MODULE 4 **(8hrs)**

Ethical considerations in research; disseminating research result & distilling principles of research design and methodology: sharing the result of research studies, presentation of result. Research report: need of research report, overall structure of research report, tips on writing specific sections. Types of publication.Writing review and research papers: overall structure of review and research report, general guidelines

Reference Books

- Luciene TM Blessing and Amaresh Chakrabarti; *DRM, a design research methodology.. Springer.*
- Yogesh Kumar Singh; *Fundamental of Research Methodology and Statistics. New Age International (P) Limited, Publishers.*
- Geoffrey Marczyk, David DeMatteo, David Festinger;.*Essential of Research Design and Methodology. John Wiley & Sons*
- Kothari, C.R; *Research Methodology: Methods and Techniques.. New Age International Publishers, New Delhi.*
- Arya. P.P. and Pal; *Research Methodology in Management: Theory and case Studies. Y. Deep and Deep Publishers Pvt. Ltd., New Delhi*

PFNB – 302.1 MODELLING & SIMULATION

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *This course covers modelling and simulation principles with applications of modelling and simulation concepts in different biological process.*

MODULE 1 **(8 hrs)**

Modelling and simulation: fundamentals of modeling and simulation; definition of basic terms like system, entity attribute, activity, state of system, system environment; categories of system, stochastic activities; different steps for modeling and simulation. Types of models, advantages and disadvantages of modelling and simulation. Application areas of modeling & simulation.

MODULE 2 **(12 hrs)**

Role of numerical analysis in modelling and simulation: overview. Optimization**:** introduction, optimization theory, optimization methods, graphical and numerical methods of optimization. Unconstrained optimization, constrained optimization, programming optimization, experimental optimization. Full factorial design; fractional factorial designs.

MODULE 3 **(16 hrs)**

Response surface methodology (RSM), Monte Carlo Method or random simulation.

Curve fitting and regression analysis: concept and types. Different methods of curve fitting: linear, log linear, semi log linear and quadratic and their applications. Method of derivation and interpretation of results. Bivariate regression and correlation analysis. Multiple and partial regression and correlation analysis.

Synthetic biology redux—computer simulation and artificial life. Modelling and simulation for system (circulatory system), disease (cancer), cell, system biology (protein interaction).

MODULE 4 **(12 hrs)**

Optimization of some engineering operations: thermal processing, dehydration & drying, freezing process; extrusion process; filtration processes; membrane separation process; distillation and extraction processes.

Reference Books

- Douglas C. Montgomery*; Design and Analysis of Experiments Response surface methodology.. Wiley*
- R. H. Myers; *Response Surface Methodology. Wiley.*
- A. I. Khuri & J. A. Cornell; *Response surfaces design and analysis. Wiley*
- Luca Formaggia; Alfio Quarteroni & Alessandro Veneziani; *Cardiovascular Mathematics. Springer*.
- Luigi Preziosi; *Cancer Modelling And Simulation. Chapman & Hall/CRC*.
- Evelyn Fox Keller; *Making Sense Of Life (Explaining Biological Development with Models, Metaphors, and Machines).. Harvard University Press.*
- Alexander R. A. Anderson; Mark A. J. Chaplain & Katarzyna A. Rejniak; *Single-Cell based Models In Biology And Medicine.. Birkhäuser Verlag AG*

PFNB – 302.2 ENERGY MANAGEMENT IN PROCESSING INDUSTRY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To enable the students to maximize energy efficacy and energy audit and use of energy in different processing industry.*

MODULE 1 **(6 hrs)**

Fundamentals of heat transfer, fluid mechanics, and thermodynamics in pharmaceutical and food processing industry. Fundamentals of Energy Auditing: Introduction, Procedures for Energy Audit, Measurements, Instrumentation, and Data Collection.

MODULE 2 **(12 hrs)**

Energy project management in pharmaceutical and food processing facilities: introduction, energy analysis, sustainability in the industry, economic analysis, financial analysis, energy management project planning, implementation, and evaluation.

MODULE 3 **(14 hrs)**

Energy consumption and saving opportunities in existing processing facilities. Energy efficiency and conservation in the industry. Energy conservation in unit operations.
Conversion of food processing wastes into energy: Food processing wastes and utilizations, anaerobic digestion of food processing wastes, fermentation of food processing wastes into transportation alcohols.

MODULE 4 **(16 hrs)**

Energy conservation technologies applied to processing facilities. Introduction: steam generation and consumption system, compressed air system, power and electrical systems, heat exchangers, waste-heat recovery and thermal energy storage in processing facilities. Novel thermodynamic cycles applied to the processing industry for improved energy efficiency. Energy efficiency and conservation in emerging processing systems.

References Books

- . Lijun Wang; *Energy Efficiency and Management in Food Processing FacilitiesCRC Press.*

PFNB – 302.3 UNIT OPERATIONS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *The main objective of the course is to examine methodologies, both applied and fundamental, to analyze and scale up different health product manufacturing processes*.

MODULE 1 **(8 hrs)**

Unit operations: introduction, unit systems, state of system. Classification; transport phenomena: definition, mechanisms. Process control: automatic control and computer based systems. Cleaning, sorting, grading & peeling. Size reduction: introduction, factor affecting, theory, equipments and applications

MODULE 2 **(12 hrs)**

Mixing, separation and concentration. Fermentation; irradiation, high hydrostatic pressure, light or ultrasound: introduction, factor affecting, theory, equipments and applications.

MODULE 3 **(14 hrs)**

Heat processing operations: blanching, pasteurisation, heat sterilisation, evaporation and distillation, extrusion. Heat processing using hot air (dehydration, baking and roasting). Heat processing using hot oils (frying); crystallization.

MODULE 4 **(14 hrs)**

Dielectric, ohmic and infrared heating. Heat removal processing operation: chilling, freezing, freeze drying and freez concentration. Post-processing operations: coating or enrobing, filling and sealing of containers, materials handling, storage and distribution.

Reference Books

- Albert Ibarz, Gustavo V. Barbosa-Cánovas; *Unit Operations in Food Engineering. CRC Press.*
- R. Paul Singh, Dennis R. Heldman; *Introduction to Food Engineering. Elsevier Inc.*
- Dennis R. Heldman, Daryl B. Lund; *Handbook of Food Engineering. CRC Press.*
- Anthony J. Hickey, David Ganderton; *Pharmaceutical Process Engineering.. Informa Healthcare*
- Fellows, P. J.; *Food processing technology. CRC Press*

PFNB – 302.4 GENETIC ENGINEERING

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *The objective of the course is to explain the concepts underlying the molecular cloning and describe its application in the upcoming filed of Nutraceuticals.*

MODULE 1 **(12 hrs)**

PRINCIPLES OF GENE CLONING: Gene Cloning; principle; its significance; vehicles (plasmids and bacteriophages); DNA Isolation and its purification; Manipulation of Purified DNA; Introduction of DNA into living Cells

MODULE 2 **(12 hrs)**

VECTORS: Basic Biology; Principle of generation of the vectors and its applications (plasmid, phage vectors, cosmid, phasmid and other advanced vectors); Transformation; Transfection; Applications of Vector Mediated Gene Transfer.

MODULE 3 **(12 hrs)**

Cloning Strategies, Amplification, Principles and Techniques involved in Sequencing and Mutagenesis, Gene Transfer to Plants, Recent Advances in Transgenic Technology in context to Nutrition enhancement

MODULE 4 **(12 hrs)**

GENE CLONING IN RESEARCH AND NUTRACEUTICAL BIOTECHNOLOGY: Principle involved in gene cloning of agriculture (Rice Wheat, Brinjal and Cotton); Production of Proteins from Cloned Genes; Regulatory Affairs involved in Gene Cloning

Reference Books

- by SB Primrose; *Principles of Gene Manipulations RM Twyman and RW Old 7th Edition*
- Gene Cloning: *An Introduction by TA Brown 3rd edition*

PFNB – 303.1 PROCESSING OF PLANT BIOACTIVES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To understand the main classes of bioactive phytoconstituents their identification and their health effects.*

MODULE 1 **(12 hrs)**

Phytoconstituents role and distribution. Biotechnology of plant-derived dietary supplements, plant toxins. Beverages (tea, coffee, cocoa, wine, beer): Introduction, pre-processing techniques, different bioactive components and related processed functional products.

MODULE 2 **(12 hrs)**

Cereal (wheat, oat, rice, maize) structure and composition, pre-processing techniques, different bioactive components. Dietary recommendations and cereal based processed functional products.
Legumes composition, pre-processing techniques, different bioactive components & their Health Benefits and legumes based processed functional products.

MODULE 3 **(12 hrs)**

Fruits (grapes, citrus fruits and others fruits) composition, pre-processing techniques, different bioactive components. Fruits based processed functional products.
Vegetables (cruciferous, onion, garlic & other vegetables) composition, pre-processing techniques, different bioactive components and vegetables based processed functional products.

MODULE 4 **(12 hrs)**

Modified fats and oils: introduction, specialty oils, specialty processed and formulated fats, engineered lipids-modification of triacylglyceride structure.
Herbs, spices & medicinal plants, pre-processing techniques, bioactive components, processed functional products.

Reference Books

- Giuseppe Mazza; *Functional Foods: Biochemical and Processing Aspects, Volume 1. CRC Press*.
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition. CRC Press.*
- Massimo Maffei; *Dietary Supplements of Plant Origin. CRC Press.*
- Fereidoon Sahidi, Deepthi K. Weerasinghe; *Nutraceutical beverages Chemistry, Nutrition and health Effects. American Chemical Society.*
- Ronald R. Watson; *Vegetables, fruits, and herbs in health promotion. CRC Press.*
- Özlem Tokusoglu; *Fruit and Cereal Bioactives: Sources, Chemistry, and Applications. Clifford Hall III. CRC Press.*
- Leland J. Cseke; Ara Kirakosyan Peter B. Kaufman; Sara L. Warber James A. Duke; Harry L. Brielmann; *Natural Products from Plants. CRC Press*

PFNB – 303.2 PROCESSING OF ANIMAL BIOACTIVES

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To understand the main classes of animal derived bioactive compounds their identification and health effects*.

MODULE 1 **(10 hrs)**

Bioactive metabolites from animal sources and their extraction and utilization.

MODULE 2 **(14 hrs)**

Bioactive components in milk and milk products: overview; bioactive components in milk (bovine, goat, sheep, buffalo, camel and mare). Bioactive Components in manufactured dairy products (caseins, caseinates, cheese, yogurt, kefir and koumiss & whey). Probiotics and prebiotics as bioactive components in dairy products.

MODULE 3 **(12 hrs)**

Bioactivity of Marine Organisms: classification of marine organisms; Biosynthesis of Bioactive Metabolites of Marine Organisms, medicinal foods: current status and prospects.
Bioactive Metabolites of marine algae, fungi, bacteria and animals. Marine Toxins; interaction between marine organism bioactives and health.

MODULE 4 **(12 hrs)**

Meat and meat products: bioactive contents from various meat. Egg: nutrient rich eggs.
Insects bioactives: terpenoids, fatty acid and other polyacetate derivatives, polyketides, alkaloids and amines, nucleoside derivatives and miscellaneous compounds.

Reference Books

- D.S. Bhakuni; D.S. Rawat; *Bioactive Marine Natural Products.. Springer.*
- Colin Barrow; Fereidoon Shahidi; *Marine Nutraceuticals and Functional Foods. CRC Press.*
- Marine Medicinal Foods: Implications and Applications - Animals and Microbes
- Se-Kwon Kim; *(Advances in Food Nutrition and research: volume 65).. Elsevier*
- Giuseppe Mazza*; Functional Foods: Biochemical and Processing Aspects, Volume 1.. CRC Press.*
- Robert E.C. Wildman; *Handbook of Nutraceuticals and Functional Foods, Second Edition. CRC Press.*
- Lew Mander and Hung-Wen (Ben) Liu; *Comprehensive Natural Products II (Chemistry and Biology). Elsevier.*
- Young W. Park; *Bioactive Components in Milk and Milk Products. Wiley-Blackwell*.

PFNB – 303.3 PRESERVATION AND PACKAGING TECHNOLOGY

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *To introduce students to the practice of food preservation and packaging.*

MODULE 1 **(8 hrs)**

Food preservation: introduction, type of food, major processes of food deterioration, what, why, how, how long, what to preserve; phase transition and other structural changes in foods; water activity and food preservation.

MODULE 2 **(10 hrs)**

Food preservation methods: Introduction, principle of heat treatment (thermal processing, drying), natural antimicrobials, antioxidants, pH, combined methods for food preservation. Chemical hurdle technology. Surface treatments and edible coatings in food preservation; encapsulation and controlled release in food preservation.

MODULE 3 **(16 hrs)**

Packaging: introduction, types of packaging, general aspects of drug packaging, differences between pharmaceutical and food packaging, function of packaging.
Pharmaceutical packaging materials: introduction (glass, pastic, metal container etc.). Container and closure. Completing all types of filled, pharmaceutical containers; labels and labelling

MODULE 4 **(14 hrs)**

Active and intelligent packaging: introduction, types, advantages and disadvantages. Integrating intelligent packaging, storage and distribution.
Packaging-flavour interaction, consumers and novel packaging; safety and legislative aspects of packaging, issues facing modern drug packaging.

Reference Books

- Raija Ahvenainen; *Novel Food Packaging Techniques. Woodhead Publishing.*
- Gordon L. Robertson; *Food Packaging: Principles and Practice. CRC Press.*
- Hanlon, Kelsey & Forcinio; *Handbook of Package Engineering. Technomic Publishing Company.*
- Paine and Paine; *A Handbook of Food Packaging. Springer.*
- Edward J. Bauer; *Pharmaceutical Packaging Handbook. Informa Healthcare.*
- G. W. Gould; *New Methods of Food Preservation(Non Thermal Processing of Foods). Marcel Dekker, Incorporated.*
- R. Paul Singh, Dennis R. Heldman; *Introduction to Food Engineering. Elsevier Inc.*
- Fellows, P. J.; *Food processing technology. CRC Press.*

PFNB303.4-NUTRACEUTICAL DISCOVERY PROCESS

Internal Marks	External Marks	Total Marks	Credits
40	60	100	4

L	T	P
3	1	-

Objective: *The course aims to provide students with the understanding of the process of novel nutraceutical discovery beginning from identification to introduction into the clinical practice.*

MODULE 1 **(14 hrs)**

Irrational and rational approaches in nutraceutical discovery and evaluation; historical, phytochemical, pharmacological and new approaches. Combinatorial chemistry, high throughput screening, ultra high throughput screening and high content screening, pharmacogenomics and proteomics.
Regulatory Considerations for Dietary Supplements.

MODULE 2 **(14 hrs)**

Pre-clinical evaluation of nutraceuticals: Pharmacological profile tests, safety tests and toxicology tests. Acute, sub-acute and chronic studies (in-vivo and in-vitro studies) and special studies including carcinogenicity, mutagenicity and teratogenicity

MODULE 3 **(10 hrs)**

Clinical evaluation of nutraceuticals ; Principles of controlled clinical trials. Phase 0, Phase I, Phase II, Phase III and Phase IV trials.

MODULE 4 **(10 hrs)**

Pharmacokinetic characterization of nutraceuticals: Biopharmaceutics; bioavailability and bioequivalence. Drug Metabolism and drug Interactions

Reference Books:

- Bennett PN and Brown MJ. *Clinical Pharmacology. Churchill Livingstone, Edinburgh. Latest Edition*
- Walker R and Edwards C. *Clinical Pharmacy and Therapeutics. Churchill Livingstone, London. Latest Edition.*
- Laurence DR. *Clinical Pharmacology. Churchill Livingstone, London. Latest Edition.*
- Vogel HG and Vogel WH. Drug Discovery and Evaluation*. Springer-Verlag, Berlin. Latest Edition*.
- Edwards LD, Fletcher AJ, Fox AW, Stonier PD. *Principles and Practice of Pharmaceutical Medicine, Wiley, England*
- Pathak Y. *Handbook of Nutraceuticals; Ingredient, Formulations, and Applications. CRC Press, Taylor & Francis Group, London.*
- Atkinson AJ, Abernethy DR, Daniels CE, Dedrick RL, Markey SP. Principles of Clinical pharmacology. Academic Press, Elsevier, USA. Second Edition.

Choice Based Credit Based System

Scheme & Syllabus of

Master of Technology- Food Technology/

(M. Tech of Food Technology)

Batch 2019 onwards

By

Board of Study (Food Science & Engineering)

Department of Food Science & Technology Main Campus

IK Gujral Punjab Technical University

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

It is a Post Graduate (PG) Programme of 2 years duration (4 semesters)

Eligibility for Admission: B. Tech./ B.E. (Food Engineering/ Food Technology/ Food B. Tech./ B.E. (Food Engineering/ Food Technology/ Food Engineering & Technology/ Food Process Engineering/ Food Process Technology/ Dairy Technology/ Dairy Engineering/ Food Biotechnology/ Agri. Process Engineering/ Agri. Engineering/Biotechnology)**or B.Sc. (Hons) in Food Technology, BSc (Hons) Agriculture (with elective/honours in Food Technology/Food Process Engineering)** or any equivalent degree with **at least 50% (45% in case of candidate belonging to reserved category) marks in aggregate**

OR

M.Sc. (Food Science/ Food Technology/ Food Science and Technology/ Food Processing and Technology/ Biotechnology/**Agriculture**) or any equivalent degree with **at least 50% (45% in case of candidate belonging to reserved category) marks in aggregate.**

Courses & Examination Scheme:

Program Core (PC)	Program Elective (PE)	Open Elective (OE)	Research Project	Total Credits
24	24	04	26	**78**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Semester First

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-511-19	Advances in Food Engineering	PC	4	0	0	40	60	100	4
UC-MTFT-512-19	Food Safety and Quality Assurance (Theory)	PC	4	0	0	40	60	100	4
UC-MTFT-513a-19 or 514a-19	Program Elective I (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-515a-19or 516a-19	Program Elective II(Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-517-19	Food Safety and Quality Assurance(Lab-I)	PC	0	0	4	30	20	50	2
MTA-xxx	Audit course I		2	0	0	Satisfactory/ Un-Satisfactory#			Non-credit
MTRM101-18	Research methodology and IPR	PC	2	0	0	20	30	50	2
UC-MTFT-513b-19 or 514b	Program Elective I (Lab)	PE	0	0	4	30	20	50	2
UC-MTFT-515b-19 or 516b	Program Elective I I(Lab)	PE	0	0	4	30	20	50	2
	Total		**20**	**0**	**12**	**280**	**320**	**600**	**24**

***Select any audit course from the audit course list.**

the concerned teacher will evaluate the students internally (only) as per marks distributions pattern followed for the other subjects/courses.

Program elective I*

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-513a-19	Technology of Milk and Milk Products (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-513b-19	Milk and Milk Products(Lab-II)	PE	0	0	4	30	20	50	2
UC-MTFT-514a-19	Food Additives and Contaminants (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-514b-19	Food Additives and Contaminants (Lab-III)	PE	0	0	4	30	20	50	2

Note: * Select any one subject from Elective-I. The elective subject for theory & practical will be same.

Dr. Rajneesh Sachdev
Head, DFST

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Program elective II**

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-515a-19	Advances in Post-harvest Technology of Fruits and Vegetable (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-515b-19	Advances in Post-harvest Technology of Fruits and Vegetable(Lab-IV)	PE	0	0	4	30	20	50	2
UC-MTFT-516a-19	Advances in Cereal Science and Technology(Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-516b-19	Cereal Science & Technology (Lab-V)	PE	0	0	4	30	20	50	2

Note: ** Select any one subject from Elective-II. The elective subject for theory & practical will be same.

Dr. Rajneesh Sachdev
Head, DFST

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Semester Second

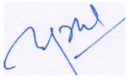
Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-521-19	Advanced Food Processing Technology (Theory)	PC	4	0	0	40	60	100	4
UC-MTFT-522-19	Advances in Food Analysis(Theory)	PC	4	0	0	40	60	100	4
UC-MTFT-527-19	Advances in Food Analysis(Lab VI)	PC	0	0	4	30	20	50	2
UC-MTFT-523a-19 or 524a-19	Program Elective-III (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-523b-19 or 524b-19	Program Elective-III (Lab.)	PE	0	0	4	30	20	50	2
UC-MTFT-525b-19 or *526b*-19	Program Elective-IV (Lab.)	PE	0	0	4	30	20	50	2
MTAXX-18	Audit course II	PC	2	0	0	Satisfactory/ Un-Satisfactory#			Non-credit
UC-MTFT-528-19	Mini project with seminar	PC	0	0	2	30	20	50	2
	Total		**14**	**0**	**14**	**250**	**300**	**550**	**22**

the concerned teacher will evaluate the students internally (only) as per marks distributions pattern followed for the other subjects/courses.

Program Elective-III ***

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-523a-19	Novel Food Packaging(Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-523b-19	(Novel Food Packaging (Lab-VII)	PE	0	0	4	30	20	50	2
UC-MTFT-524a-19	Nutraceuticals and Functional Foods (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-524b-19	Nutraceuticals and Functional Food (LabVIII)	PE	0	0	4	30	20	50	2

Note: ***Select any one subject from Elective-III. The elective subject for theory & practical will be same.



Dr. Rajneesh Sachdev
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IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Program Elective-IV ****

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-525a-19	Technology of Frozen Foods (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-525b-19	Frozen Food Technology (Lab-IX)	PE	0	0	4	30	20	50	2
UC-MTFT-526a-19	Advances in Meat, Fish, Poultry and Egg processing (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-526b-19	Advances in Meat, Fish, Poultry and Egg processing (Lab –X)	PE	4	0	0	40	60	100	4

Note: ***** Select any one subject from Elective-IV. The elective subject for theory & practical will be same.

Dr. Rajneesh Sachdev
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IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Semester Third

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-611-19 or 612-19	Program Elective-V	PE	4	0	0	40	60	100	4
UC-MTFT-613-19	Open elective#	OE	4	0	0	40	60	100	4
UC-MTFT-614-19	Dissertation -I/ Industrial Project	RP	0	0	20	60	40	100	10
	Total		**8**	**0**	**20**	**140**	**160**	**300**	**18**

Program Elective-V***

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-611-19	Food Rheology and Texture (Theory)	PE	4	0	0	40	60	100	4
UC-MTFT-612-19	Bio Process Engineering (Theory)	PE	4	0	0	40	60	100	4

Note: ****** Select any one subject from Elective-V.

 # open elective: The student is required to register for one "Open Elective" paper (in Semester III) of his/her choice from any department other than the parent department

Open Elective –

1. Business Analytics
2. Industrial Safety
3. Operations Research
4. Cost Management of Engineering Projects
5. Composite Materials
6. Waste to Energy

Semester Fourth

Corse Code	Course Title	Type	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
UC-MTFT-621-19	Dissertation-II	RP	0	0	32	60	40	100	16
	Total		**0**	**0**	**32**				**16**

Audit course 1 & 2

1. English for Research Paper Writing
2. Disaster Management
3. Sanskrit for Technical Knowledge
4. Value Education
5. Constitution of India
6. Pedagogy Studies
7. Stress Management by Yoga
8. Personality Development through Life Enlightenment Skills.

Dr. Rajneesh Sachdev
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IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Important Notes: -

1. The credit requirement for the M. Tech (Food Technology) degree is 85 credits inclusive of the 10 elective course credits.
2. The department will offer the following open elective courses for the students of other Engineering departments:
   i. Food Safety and Quality Assurance
   ii. Advances in Food Analysis
3. Theory courses will be of 04 hours and practical will be of 04 hours duration per week. For all lecture courses, one credit per lecture/week/semester will generally be adopted. One laboratory hour per week per semester will be assigned half credit.
4. No elective course will be run unless the number of students registered for the elective course is five or more.
5. Each theory paper examination will be of 3 hours duration and practical examination will be of 4 hours duration.
6. A student is required to undertake a Research Project of 16 credits on a topic approved by the supervisor and the Departmental Research Committee (DRC). The student is required to prepare his/her research project synopsis and should make a presentation to the DRC before the commencement of the final examination of third semester.
7. The research project shall be evaluated by the external examiner at the end of the Semester IV.
8. The student is required to register for one "Open Elective" paper (in Semester III) of his/her choice from any department other than the parent department.
9. A Supervisor will be allotted by the Chairperson for every student in the beginning of third semester.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Program outcomes

1. Ability to apply principles of food engineering in industry.
2. Understand, identify and analyze a problem related to food industry and ability to find an appropriate solution for the same.
3. Design, implement and evaluate a research based project to meet demands of the society.
4. Use appropriate techniques, skills, and modern tools in the food industry and in academic profession.
5. Understanding of professional, ethical, legal, security and social issues and responsibilities for entrepreneurship skills.
6. Ability to function effectively as an individual and in a group.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

SEMESTER

FIRST

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-511-19: ADVANCES IN FOOD ENGINEERING

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To illustrate various aspects of food engineering.
2. To develop understanding about fluid flow and its applications.
3. To understand mechanism of heat transfer in food processing
4. To explain method of freezing process.

Course outcome: On successful completion of the subject, the students will be able to

1. Apply knowledge of food engineering to design new process.
2. Understand pump selection and velocity of flowing fluids.
3. Able to calculate through different dimensions.
4. Able to calculate freezing time.

Course Content:

UNIT-I

Engineering properties of foods, their significance in equipment design. Constraints and need of innovation. Challenges for food engineering. Tools and concepts in process design microbial survivor curves, general method for process calculation. Sterilization of continuous flowing fluid.

UNIT-II

Fluid flow handling systems for Newtonian liquids, force balance on a fluid element flowing in a pipe, derivation of Bernoulli equation. Measurement of viscosity, capillary tube viscometer. Flow characteristics of non Newtonian fluids. Properties of non-Newtonian fluids. Velocity profile of a power law. Pumps-characteristics, types and selection.

UNIT-III

Thermal properties of foods. Steady state and unsteady state heat transfer: Conduction in multilayered systems. Estimation of convective heat-transfer coefficient. Forced and free convection. Estimation of overall heat-transfer coefficient. NTU method for designing heat changers. Design of a plate heat exchanger, Design of a tubular heat exchanger.

UNIT-IV

Pressure-sure-enthalpy charts. Frozen-food properties. Freezing point curves, phase diagrams, methods of freeze concentration, design problems. Freezing o foods, freeze concentration and drying , freezing time: plank's equation and Pham's method, theory of ultra-filtration and reverse osmosis, selection and types of membranes and properties, Properties of steam. Steam traps Methods of estimating steam consumption.

Recommended Readings:

1. Rao, M. A., Rizvi, S. S. H. and Datta A.K. (2005). *Engineering Properties of Foods*: CRC Press.
2. Heldman, D. R. (2007). *Food Process Engineering*:AVI Publications.
3. Toledo, R. T. (1997). *Fundamentals of Food Process Engineering* (2 ed.): CBS Publications, New Delhi.

4. Rizvi, S. S. H. and Mittal, G. S. (1992). *Experimental Methods in Food Engineering*: Van Nostrand Reinhold.
5. Chanes J.W., Gustavo (2002) Engineering and Food for the 21st Century CRC Press.
6. Theodoros V.C., Food Engineering Handbook (2011) CRC Press

Mapping of course "Advances in Food Engineering – MTFT-511-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	3	3	3	2	2	1
	CO 2	3	3	3	3	1	1
	CO 3	3	3	3	3	1	1
	CO 4	3	3	3	2	2	1

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-512-19: FOOD SAFETY AND QUALITY ASSURANCE

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To illustrate the importance of food safety, food quality, food laws and regulations in Food industry.
2. To describe the food quality management systems.
3. To explain the nationals and international food laws and regulations.
4. To exemplify different food adulterants.

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

1. Understand various areas of Food Safety & Quality Assurance.
2. Grasp knowledge of the quality assessments of food products.
3. Comprehend food quality managements systems.
4. Apprehend the Indian and International food laws.
5. Implementation of food safety & quality assurance in one's own domain.

Course Content:

UNIT-I

Definition, objective, scope and functions of food safety and quality assurance, Quality enhancement models, Statistical Quality Control for food industry, Quality control tools, Quality control charts, Causes of failure of Food Safety Programs, Introduction of Food Quality Management Systems, Production planning and Control.

UNIT-II

WTO, FAO, WHO, Codex Allimentarius Commission, GMP, GHP, Cleaning and disinfection Principles. Implementation of quality control programmes, HACCP, ISO – 22000 series, Introduction of FSSAI, Introduction to USFDA & BRC,

UNIT-III

ISO–9000 series, Total quality control, GLP, ISO-17025. Intellectual Property: concept and fundamental- Patent Laws, copy right, trade mark and IPR. Introduction to BIS, AGMARK , Organic food, Functions of EIC in export of food product.

UNIT-IV

Sensory evaluation: Introduction, panel screening, selection methods, interaction and thresholdsFood adulteration: Types of adulterants, Common adulterants for foods like milk and milk products, honey, wheat flours, edible oils, cereals, condiments (whole and ground) pulses, coffee, tea, confectionery, baking powder, non-alcoholic beverages, vinegar, besan and curry powder

Recommended Readings:

1. Lawless, H. T. and Heymann, H. (2013). *Sensory Evaluation of Food: Principles and Practices*: Springer, New Delhi.
2. Shapton, D. A. and Shapton, N. F. (1993). *Principles and Practice for the Safe Processing of Foods*: Heinemann, Oxford.
3. Schmidt, R. H. and Rodrick, G. E. (2003). *Food Safety Handbook*: John Wiley, New Jersey.
4. Rees, N. and Watson, D. (2000). *International Standards for Food Safety*: Aspen, America.
5. Anjaneyulu, Y. and Marayya, R. (2009). *Quality Assurance and Quality Management in Pharmaceutical Industry*: Pharma, Hyderbad.
6. Ho, S. K. M. (1999). *Operations and Quality Management*: ITP, London.

Mapping of course "Food Safety and Quality Assurance- MTFT-512-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**3**	**2**	**3**	**3**	**2**
	CO 2	**2**	**2**	**1**	**3**	**2**	**2**
	CO 3	**2**	**2**	**2**	**3**	**2**	**2**
	CO 4	**1**	**2**	**2**	**2**	**2**	**2**
	CO 5	**1**	**3**	**1**	**3**	**1**	**2**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-517-19: Lab-II (FOOD SAFETY AND QUALITY ASSURANCE)

Total Marks: 50	L	T	P
	0	0	4

Objectives:

1. To exemplify applications of food safety and quality assurance.
2. To describe the quality assessment of food products.
3. To demonstrate the sensory evaluation techniques.
4. To elucidate the adulterants in food products.

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

1. Understand the practical application of food safety and quality assurance in raw and processed foods.
2. Apprehend the quality assessment of food products using various instruments.
3. Perceive the sensory evaluation techniques.
4. Comprehend the detection methods of the adulterants in food products.
5. Grasp the implementation of HACCP.

Course Content:

Techniques of sampling and quality assessment of fruits, vegetable, cereals, dairy products, meat, poultry, milk and other processed products, Measurement of the water activity (aw) of raw and cooked food using A_W meter, Assessing the texture of raw and cooked food using penetrometer, Extraction of pigments from various fruits and vegetables and influence of heating time and pH, Performance of the sensitivity tests for four basic tests (Sweet, salty, sour and bitter), Identification and ranking of food product attributes using Sensory evaluation scales (Hedonic rating, Ranking difference, Triangle test), Sensory evaluation of milk and detection of flavor defects in milk, Qualitative tests for fats and oils, spices and condiments, Inspection of quality as per National and International standards for various foodstuffs- pulses, spices, etc., Detection of adulteration in food products viz. honey, other sweetening agents, spices (whole and powder), pulses, oils, cereals, sweets, tea, coffee, Implementation of HACCP, ISO: 22000.

Mapping of course "Lab-II (Food Safety and Quality Assurance) - MTFT-517-19"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**3**	**3**	**2**	**3**	**2**	**2**
	CO 2	**1**	**2**	**1**	**3**	**2**	**1**
	CO 3	**2**	**1**	**1**	**3**	**2**	**2**
	CO 4	**1**	**2**	**2**	**3**	**2**	**2**
	CO 5	**2**	**3**	**2**	**2**	**3**	**2**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

RESEARCH METHODOLOGY AND IPR

Teaching Scheme : Lectures: 1hrs/week

Course Outcomes:

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

1. Understand research problem formulation.
2. Analyze research related information
3. Follow research ethics
4. Understand that today's world is controlled by Computer, Information Technology, but tomorrow world will be ruled by ideas, concept, and creativity.
5. Understanding that when IPR would take such important place in growth individuals & nation, it is needless to emphasis the need of information about
6. Model Curriculum of Engineering & Technology PG Courses [Volume-I][16]
7. Intellectual Property Right to be promoted among students in general & engineering in particular.
8. Understand that IPR protection provides an incentive to inventors for further research work and investment in R & D, which leads to creation of new and better products, and in turn brings about, economic growth and social benefits.

Course contents

Unit I

Meaning of research problem, Sources of research problem, Criteria Characteristics of a good research problem, Errors in selecting a research problem, Scope and objectives of research problem.Approaches of investigation of solutions for research problem, data collection, analysis, interpretation, Necessary instrumentations

Unit II

Effective literature studies approaches, analysis Plagiarism, Research ethics,

Unit III

Effective technical writing, how to write report, Paper Developing a Research Proposal, Format of research proposal, a presentation and assessment by a review committee

Unit IV

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

Unit V

: Patent Rights: Scope of Patent Rights. Licensing and transfer of technology.Patent information and databases. Geographical Indications.

Unit VI

New Developments in IPR: Administration of Patent System. New developments in IPR; IPR of Biological Systems, Computer Software etc. Traditional knowledge Case Studies, IPR and IITs.

References:

1 Stuart Melville and Wayne Goddard, "Research methodology: an introduction for science & engineering students'"

2 Wayne Goddard and Stuart Melville, "Research Methodology: An Introduction"

3 Ranjit Kumar, 2nd Edition, "Research Methodology: A Step by Step Guide for beginners"

4 Halbert, "Resisting Intellectual Property", Taylor & Francis Ltd,2007.

5 Mayall, "Industrial Design", McGraw Hill, 1992.

6 Niebel, "Product Design", McGraw Hill, 1974.

7 Asimov, "Introduction to Design", Prentice Hall, 1962.

ELECTIVE-I

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-513a-19: TECHNOLOGY OF MILK AND MILK PRODUCTS

Total Marks: 100	L	T	P
	4	0	0

Objective:

1. To illustrate the technologies of processing of milk and milk products.
2. To describe the different physico-thermal properties and their applications.
3. To elucidate the thermal processing of milk and quality changes therein.
4. To explain thehygiene and sanitation practices in milk plant.

Course Outcome: After the completion of the course, the students will be able to:

1. Understand the processes related to storage, processing and distribution of milk and milk Products.
2. Perceive the different properties of milk and milk products.
3. Apprehend the thermal processing of milk.
4. Grasp the technology of fat rich dairy products.
5. Comprehend the technology of condensed milk, dried milk, cheese, yoghurt and indigenous products will be understood.
6. Have knowledge regarding hygiene and sanitation practices in the milk and milk products industry.

Course Content:

UNIT-I

Technology of Market Milk:Dairy Industry in India: present status and scope; Milk: definition, composition and nutritive value; grading of milk; factors affecting composition of milk; physico-chemical properties of milk; FSSAI standards and legislations for market milk. Liquid milk processing: filtration/clarification; bactofugation; standardization; homogenization; pasteurization (LTLT, HTST); sterilization; UHT processing; aseptic packaging; storage and distribution. Technology of special milks: Technology of sterilized/ flavored milk, acidophilus milk, bulgarian milk, kumis, kefir; reconstituted & recombined milk, toned, double toned milk.

UNIT-II

Technology of fat rich dairy products: Cream: definition and legal standards, consumer cream products, standardization & production of cream, processing of cream (neutralization & pasteurization), butter: definition, butter-making process, overrun, yield, theories of churning, quality of butter, fat losses in cream & butter, defects in cream & butter. Ice-cream: definition, classification and composition of ice-cream, technological aspects of ice cream preparation, packaging, hardening, storage and shipping of ice cream.

UNIT-III

Technology of condensed and dried milk: Definition and legal standards for evaporated and condensed milks, methods of manufacture and physico-chemical properties of evaporated and condensed milk, concept of heat stability & its control, defects in condensed and evaporated milks, Quality of raw milk for dried milks, definition and legal standards for dried milks, milk drying system (film, roller, drum, spray, foam spray drying), method of manufacture of dried milks (WMP & SMP), defects in dried milk,Technology of yoghurt and cheese: Yoghurt - Definition and technology of yoghurt manufacturing, technology of different varieties of cheese manufacturing (cheddar &mozarella), changes during ripening of cheese, yield of cheese; manufacture of processed cheese, defects in cheese, accelerated ripening of cheese.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UNIT-IV

Technology of indigenous dairy products: Introduction to traditional dairy products, khoa, channa, paneer, dahi, shrikhand, ghee, khoa and channa based sweets, miscellaneous traditional dairy foods, Dairy industry by-products and sanitation: By-products: introduction, definition, composition, Importance and food applications,whey protein concentrates& isolates,Dairy plant sanitation: hygiene in dairy industry, different types of cleansing/sanitizing agents and their applications, cleaning systems in dairy industry.

Recommended Readings:

1. Winton, A. L. and Winton, K. B. (2000). *Milk and Milk Products*: Agrobios, India.
2. Kutty, C. I. and Khamer, S. (2004). *Milk Production and Processing*: Daya, Delhi.
3. Fox, P. F. and McSweeney, P. L. H. (1998). *Dairy Chemistry and Biochemistry*: Kluwer Academic, New York.
4. Kurmann, J. A., Rasic, J. L. and Kroger, M. (1992). *Encyclopedia of Fermented Fresh Milk Products: An International Inventory of Fermented Milk, Cream, Buttermilk, Whey and Related Products*: CBS Publications, New Delhi.
5. Davis, J. G. (1994). *Milk Testing: The Laboratory Control of Milk*: Agro Botanical, Bikaner.

Mapping of course "Technology of Milk and Milk Products- MTFT-513a-19"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**2**	**2**	**3**	**2**	**3**
	CO 2	**2**	**2**	**2**	**3**	**3**	**2**
	CO 3	**2**	**2**	**1**	**3**	**1**	**3**
	CO 4	**3**	**2**	**2**	**3**	**2**	**3**
	CO 5	**3**	**2**	**2**	**3**	**1**	**3**
	CO 6	**1**	**2**	**2**	**3**	**2**	**3**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT–513b-19: Lab-VII (MILK AND MILK PRODUCTS QUALITY)

Total Marks: 50

L	T	P
0	0	4

Objective:

1. To exemplify the quality of milk and milk products.
2. To depict the detection of adulterants in milk.
3. To demonstrate the manufacturing various dairy products.
4. To illustrate the quality of dairy products.

Course Outcome: After the completion of the course, the students will be able to:

1. Understand different methods of milk quality analysis.
2. Grasp the detection methods of adulterants in milk.
3. Apprehend the manufacturing of different dairy products.
4. Perceive the quality analysis of dairy products.

Course Content:

Analysis of milk: total solids, fat, SNF, protein, lactose, acidity, ash, total bacterial count, analysis of adulteration of milk (sugar, carbohydrate, urea, neutralizer, water), turbidity test for sterilized milk, preparation of sterilized flavoured milk, Cream preparation, preparation of butter from sour cream, salt analysis in butter, overrun in butter, yield of butter, preparation of ghee from cream/ butter, FFA value of ghee, preparation of ice-cream, overrun of ice cream (by weight/by volume), preparation of cheddar/gouda/mozzarella cheese, moisture of milk powder, bulk/true density of milk powder, solubility of milk powder, preparation of prebiotic yoghurt/ dahi, compositional analysis of traditional dairy products, manufacturing of sodium caseinate/calcium caseinate.

Mapping of course "Lab-VII (Milk and Milk Products Quality)- MTFT–513b-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**3**	**2**	**3**
	CO 2	**2**	**2**	**2**	**3**	**2**	**2**
	CO 3	**1**	**2**	**1**	**3**	**2**	**2**
	CO 4	**2**	**2**	**2**	**3**	**2**	**2**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-514a-19: FOOD ADDITIVES AND CONTAMINANTS

Total Marks: 100	L	T	P
	4	0	0

Objective:

1. To describe various food additives and contaminants.
2. To illustrate the functionality of food additives.
3. To exemplify the limits of permissible additives in processed foods.

Course Outcome: After the completion of the course, the students will be able to:

1. Understand the role of food additives in manufacturing of food products.
2. Have the knowledge regarding permissible additives and their limits in the processed food
3. Perceive the contaminants from various sources.
4. Comprehend the effects of contaminants on human health.

Course Content:

UNIT-I

Additives in food processing and preservation: Classification, need, properties, functions and safety, quality evaluation of additives, Food labeling, Laws and regulations for food additives**.**

UNIT-II

Chemistry, uses and functions: Chemical preservative, bio-preservatives, fortification, antioxidants, emulsifiers, humectants, stabilizers, chelating agents, pH control agents and acidulants, texturizing agents, plasticizers, flavor enhancers, enzymes, coloring agents, sweeteners, flavoring agents.

UNIT-III

Food contaminants: biological, chemical, physical and environmental contaminants, Inorganic and organometallic food contaminants, Sources and their impact on human health.

UNIT-IV

Food contaminants from industrial wastes: Heavy metals, polychlorinated polyphenyls, dioxins, Toxicants formed during food processing polycyclic aromatic hydrocarbons, nitrosamines, veterinary drug residues and melamine contaminations, Pesticide residues in food

Recommended Readings:

1. Branen, A. L., Davidson, P. M. and Salminen, S. (2002). *Food Additives*: Marcel Dekker, New York.
2. Wood, R., Foster, L., Damant, A. and Pauline, K. (2004). *Analytical Methods for Food Additives*: Boca Raton, New York.
3. Watson, D. H. (2014). *Food Chemical Safety*: Additives: WP, New Delhi.
4. Steinhart, E., Doyle, M. E. and Cochrane, B. A. (1995). *Food Microbiology and Toxicology*: Marcel Dekker, New York.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Mapping of course "Food Additives and Contaminants- MTFT-514a-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	2	2	1	2	1	2
	CO 2	1	2	1	2	2	2
	CO 3	1	1	1	2	2	2
	CO 4	1	2	1	2	1	3

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-514b-19: Lab-VI (FOOD ADDITIVES AND CONTAMINANTS)

Total Marks: 50	L	T	P
	0	0	4

Objective:

1. To demonstrate the various methods to detect and estimate the food additives.
2. To describe the estimation and identification of contaminants.
3. To exemplify the processing and working of the testing laboratories.

Course Outcome: After the completion of the course, the students will be able to:

1. Grasp the knowledge about thechemical detection and estimation methods of food additives in market food products.
2. Comprehend instrumental techniques of food additives and food contaminants analysis.
3. Differentiate between the natural and synthetic food colors.
4. Understand the processing and working of the testing laboratories.

Course Content:

Detection of non-permitted food additives in market food samples, sweets, ice-creams and beverages products, estimation of antioxidants, Estimation of residual sulphur dioxide in beverages, Estimation of benzoic acid in tomato sauce and fruit beverage, Analysis of edible common salt for moisture content and total chlorides, Determination of caffeine and saccharine by HPLC, Identification of natural colors, Isolation and estimation of synthetic food colors, Estimation of contaminants, chemical residues and aflatoxins, pesticides and heavy metals contaminants in foods, Estimation of pesticide residues in food/water, Visits to the testing laboratories of the food industry, educational institutions and testing centers.

Mapping of course "Lab-VI (Food Additives and Contaminants)- MTFT-523b-18" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**2**	**1**	**3**	**2**	**2**
	CO 2	**2**	**2**	**2**	**3**	**2**	**2**
	CO 3	**1**	**1**	**1**	**2**	**3**	**2**
	CO 4	**1**	**2**	**2**	**2**	**3**	**2**

ELECTIVE-II

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-515a-19: ADVANCES IN POST-HARVEST TECHNOLOGY OF FRUITS AND VEGETABLES

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To illustrate the relationship of Indian economy with respect to the fresh and processed fruits and vegetables and their spoilages.
2. To acquaint with the post-harvest handling technologies of fruits and vegetables to reduce post-harvest losses and their value addition.

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

1. Attain an overview on post-harvest losses and its impact on the Indian economy.
2. Understand about fruit and vegetable physiology, metabolic processes and various nutritional changes in fruits and vegetables along with post-harvest handling techniques.
3. Gain knowledge on different pre-processing operations involved before processing of fruits and vegetables.
4. Develop an understanding on various post-harvest disorders and diseases of fruits, minimising the losses by suitable packaging and minimal processing operations.
5. To development of attitude for new food product based on fruits & vegetables technology.

Course Content:

UNIT-I

Fruit and vegetable production, classification, structure and composition; Importance and scope of post-harvest management of fruits and vegetables in Indian economy, Pre-harvest factors affecting post-harvest quality, post-harvest losses,Maturity indices and standards for selected fruits and vegetables, instrumental methods of maturity determination, standards and specifications for fresh fruits and vegetable, Assessment of Fruit Quality, advances in non-destructive quality measurement of fruits and vegetables.

UNIT-II

Advanced harvesting tools and their design aspects, advances in Post-Harvest Handling operations; Cleaning, washing of fruits and vegetables, types of cleaners, screens, types of screens, rotary screens, vibrating screens, machinery for cleaning of fruits and vegetables (air cleaners, washers), cleaning efficiency, care and maintenance; Sorting and grading: Sorting, grading, methods of grading,Size grading, color grading, specific gravity grading, screening, equipment for grading of fruits and vegetables, grading efficiency, care and maintenance, Separation: Magnetic separator, de stoners, electrostatic separators, pneumatic separators.

UNIT-III

Post-harvest physiological and biochemical changes in fruits and vegetables; ripening of climacteric and non-climacteric fruits; changes duringripening; Role of ethylene in fruit ripening, ripening chambers, Field heat of fruits and vegetables and primary processing operations Post harvest treatments, advances in pre-cooling, equipment Commodity pretreatments-chemicals, types of coating, pre-packaging, irradiation, blanching, peeling and other pre-processing operations;

transportation and storage operations, Mechanism and Advances in CA and MA, hypobaric storage, cold storage design, Zero energy cool chamber

UNIT-IV

Post-harvest disorders chilling injury and diseases,Biological, Physical and Chemical Control of postharvest Diseases, advances in drying and packaging of fruits and vegetables, cushioning materials used in packaging of fresh fruits, Minimal processing.

Recommended readings:

1. Haard, N.F. and Salunkhe, D.K. (1975). *Postharvest Biology and Handling of Fruits and Vegetable:* AVI, Westport.
2. Kader, A. A. (1992). *Post-harvest Technology of Horticultural Crops*, (2ed.): University of California, Division of Agriculture and National Resources, California.
3. Salunkhe, D.K. and Kadam, S.S. (2005). *Handbook of Fruit Science and technology, Production, Composition, Storage, and Processing*: Marcel Dekker, USA.
4. Thompson, A.K. 1995. *Post-Harvest Technology of Fruits and Vegetables*: Blackwell publication.
5. Wills-Ron B.H. and Golding,J.B. (2015). *Advances in Postharvest Fruit and Vegetable Technology*: Taylor and Francis, CRC Press.
6. Siddiqui, M. W., (2015).*Post-Harvest Biology and Technology of Horticultural Crops: Principles and Practices for Quality Maintenance*:Apple Academic Press Inc.
7. Alzamora, S.M., Tapia, M. S. and Lopez- Malo, A., (2005), Minimally Processed Fruits and Vegetables: Fundamental Aspects and Applications: Springer.
8. Arthey, D. and Ashwat P.R. (2005).*Fruit Processing: Nutrition, Products, and Quality Management*, (2 ed.): Springer.

Mapping of course "Post-Harvest Technology of Fruits and Vegetables – MTFT-515a-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	2	3	2	3	2	2
	CO 2	1	2	3	3	2	1
	CO 3	1	1	2	3	2	2
	CO 4	1	2	2	2	2	1

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-515b-19: Lab-III (POST-HARVEST TECHNOLOGY OF FRUITS & VEGETABLES)

Total Marks: 50

L	T	P
0	0	4

Objectives:

1. Practical exposure of students in the area of post-harvest technology of fruits and vegetables.
2. To acquaint the students regarding effects of pre-processing treatments on shelf-life of fruit.
3. To understand the techniques of processing & preservation of fruits and vegetables.

Course Outcomes: On completion of the course the students are expected to:

1. Identify the specific processing technologies used for vegetable, fruits and products derived from these materials.
2. Understand the application of scientific principles in the processing technologies, product specification and regulations.
3. Study the changes in the composition of the raw material with respect to the type of processing technology used.
4. Determine the effects of pre-cooling and types of storage on quality and shelf-life of fruits and vegetables.

Course Content:

Studies on morphological features of some selected fruits and vegetables, maturity indices and quality evaluation of fresh fruits, physico-chemical analysis of fresh fruits, Effects of pre-cooling and types of storage on quality of fruits and vegetables, studies on use of chemicals for ripening and Studies of regulations of ripening of banana, mango, papaya etc., Effects of pre-processing treatments on shelf-life of fruit, edible coating, preparation of fruit juice concentrate, powders and their quality evaluation, estimation of browning and various pigments in pulp and products, estimation of chemical additives in processed fruit products, dehydration of fruits and measurements of dehydration and rehydration ratio, Studies on minimal processing of fruits.

Mapping of course "Lab-III (Post-Harvest Technology of Fruits & Vegetable) – MTFT-515b-18" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	2	3	2	3	1	2
	CO 2	2	3	2	3	2	1
	CO 3	1	1	2	2	1	1
	CO 4	3	1	2	2	1	1

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-516a-19: ADVANCES IN CEREAL SCIENCE AND TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

1. To illustrate the recent developments in the cereals science and technology.
2. To explain modern processing techniques of cereals in food industries.
3. To impart knowledge regarding various processed product lines in food industries.

Course Outcome: On successful completion of the subject, the students will be able to:

1. Comprehend the recent advancement in the major cereal grains quality and processing aspects.
2. Understand the mechanism underlying the interaction of various flour components and their role in end use quality.
3. Grasp the basic and advanced milling methods for wheat, rice, maize.
4. Know about by-product utilization of various grains.

Course Content:

UNIT-I

Present status and future prospects of cereal grains in India, food grain production and consumption trends. Coarse grain processing. Wheat kernel structure, wheat grading, roller flour milling, influence of wheat type and grain quality on flour yield, grain hardness and its relevance to end product quality, advances in wheat cleaning, conditioning and milling, wheat flour component interactions (protein-starch, protein-lipid and starch-lipid) and their influence on end product quality, advances in isolation, biochemical characterization, micro-structural and functionality of wheat gluten proteins.

UNIT-II

Advances in role of wheat proteins in dough and gluten visco-elasticity, micro-structure of dough, conversion of dough foam structure to bread sponge structure during bread baking, concept of gas retention in wheat dough during fermentation and baking, advances in bread making processes, effect of wheat components and ingredients on the growth of yeast during fermentation operation, bread staling and its prevention, production of variety biscuits, breads and pasta products.

UNIT-III

Paddy varieties, their composition and quality characteristics, advances in methods of paddy parboiling, advantages and limitation of parboiling, paddy dehusking processes, Rice ageing, accelerated ageing, modern rice milling, factors affecting head rice yields and losses at different stages of milling, rice mill machinery, Rice based products and their quality. Methods of rice bran oil extraction and refining.

UNIT-IV

Dry and wet milling of maize, modern methods of maize processing, gluten and starch separation, maize starch conversion into value added products, acid hydrolysis, enzyme hydrolysis, processing for dextrose, malto-dextrin and other products, Barley varieties, composition and quality characteristics, malting process and industrial applications of barley malt and malt products.

Recommended Readings:

1. Kulp K. & Ponte J. G. (2014).*Handbook of Cereal Science & Technology,2nd edition*: CRC press.
2. Wrigley C.W. & Batey I. L. (2010).*Cereal grains, assessing and managing quality,* CRC press.
3. Dendy D. A. V. & Dobsasoczyk B. J. (2001).*Cereal and Cereal Products, Chemistry and Technology*: An ASPEN publication.
4. Owens G. (2000).*Cereal Processing Technology*: CRC Press.
5. Faridi H. &Faubin J. M. (1997).*Dough Rheology & Baked product Texture*: CBS Publishers.

Mapping of course "Advances in Cereal Science and Technology- MTFT-516a-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**3**	**2**	**2**	**3**	**1**	**1**
	CO 2	**2**	**2**	**2**	**3**	**1**	**1**
	CO 3	**2**	**2**	**2**	**3**	**1**	**1**
	CO 4	**2**	**2**	**2**	**2**	**2**	**2**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-516b-19: Lab-IV (CEREAL SCIENCE AND TECHNOLOGY)

Total Marks: 50

L	T	P
0	0	4

Objective:

1. To learn the techniques to assess the quality of cereal grains and processed food products.
2. To illustrate the dough rheological properties.

Course Outcome: On successful completion of the subject, the students will be able to:

1. Understand the recent methods of quality assessment of raw materials.
2. Knowledge about rheological characterization of dough through advanced rheological instruments.
3. Aware of role of ingredients and processing parameters on processed products.
4. Understand methods to evaluate the processed food quality.

Course Content:

Grading of wheat varieties, milling quality of hard and soft wheat varieties, effect of conditioning on the flour extraction rates, effect of grains parameters on the flour yield and quality, quality assessment of wheat gluten, damaged starch and bread flour quality, effect of damaged starch of flour on biscuit quality, factors affecting water absorption of wheat flour, effect of ingredients and processing parameters of yeast growth, assessment of dough rheology using dough Lab and mixolab, bread, biscuits, noodles making potential of different wheat flours, quality assessment of bakery products.

Mapping of course "Lab-IV (Cereal Science and Technology)- MTFT-516b-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**3**	**1**	**2**
	CO 2	**2**	**3**	**1**	**3**	**2**	**1**
	CO 3	**1**	**2**	**2**	**3**	**2**	**2**
	CO 4	**2**	**2**	**2**	**2**	**2**	**1**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

SEMESTER SECOND

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT–521-19: ADVANCED FOOD PROCESS TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To acquire knowledge of emerging / alternative technologies applied to food processing.
2. To enable a student to know the relative advantages / disadvantages over existing technologies.
3. To understand the economics and commercialization of newer technologies.
4. To study about microbial safety of foods by emerging methods.

Course Outcome: On completion of the subject, the students will be able to:

1. Develop an appreciation about need of different emerging techniques used in food processing and preservation.
2. Apply their knowledge on high pressure processing, pulsed electric processing, irradiation and hurdle technology in various food industries.
3. Understand the concepts related to membrane technology, supercritical fluid extraction and quality assessment of food using ultrasonic techniques.
4. Get an overview on principles, mechanism and application of nanotechnology in food.

Course Content:

UNIT-I

Membrane Technology**:** Introduction to pressure activated membrane processes, RO/UF/NF applications and technology, Food Irradiation: radiation sources, absorbed dose, regulations, advantage and limitations of food irradiation - nutritional and microbiological changes in irradiated foods.

UNIT-II

Supercritical Fluid Extraction: Property of near critical fluids (NCF), solubility and efficiency of NCF extraction, equipment and experimental techniques used in NCF extraction and industrial application, Microwave Energy in Foods: working principle of magnetron, microwave blanching, sterilization and finish drying, Ohmic and Ultrasound Processing of Foods: Principle of ultrasound – fundamentals – ultrasound as a processing and preservation method–Effect on properties of foods, Properties and generation of ultrasonic, ultrasonic imaging, application of ultrasonic as an analytical tool and processing techniques, Basics of ohmic heating, electrical conductivity- generic configurations-treatment of products.

UNIT-III

High Pressure Processing of Foods: Principles and concept – applications to food systems effect on quality, textural, Nutritional and microbiological quality – factors affecting the quality, applications in food processing, Pulsed Electric field Processing of Food(PEF): Principles Mechanism of action-PEF treatment systems, main processing parameters – PEF Technology – equipments – mechanism of microbial and enzyme inactivation- safety aspects– processing of liquid foods using PEF –process models – comparison of high pressure processing and PEF –Enzymatic inactivation by PEF, examples – microbiological and chemical safety of PEF foods, Oscillating magnetic field.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UNIT-IV

Hurdle Technology: Concept, chemical and biochemical hurdles- organic acids–plant derived antimicrobials, Antimicrobial enzymes, bacteriocin, applications of hurdle technology, Advanced Techniques in Food Processing: Application of technologies of high intensity light, Nanotechnology: Principles and mechanism Radio-frequency heating and drying applications; Hybrid drying technologies- combined microwave vacuum drying, combining microwave vacuum drying with other processes.

Recommended Readings:

1. Sun, Da-Wen (2005). *Emerging Technologies for Food Processing*: Academic Press.
2. Barbosa- Canovas, G. V., Tapia, M. S. and Cano, M. P. (2004). *Novel Food Processing Technologies*: CRC Press.
3. Leistner L. and Gould G. (2002). *Hurdle Technologies –Combination Treatments for Food Stability, Safety and Quality*: Kluwer Academics /Plenum Publishers, New York.

Mapping of course "Advanced Food Process Technology- MTFT–521-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**3**	**2**	**1**	**3**	**2**	**2**
	CO 2	**3**	**2**	**2**	**3**	**1**	**1**
	CO 3	**3**	**2**	**2**	**3**	**1**	**1**
	CO 4	**2**	**2**	**2**	**2**	**1**	**1**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-522-19: ADVANCES IN FOOD ANALYSIS

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To develop an understanding about the advanced analytical and instrumental techniques.
2. To illustrate the principle and mechanism of analytical instruments.
3. To describe bio-chemical analysis of food components.

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

1. Have a thorough knowledge about the applications various analytical and instrumental techniques.
2. Understand the mechanisms and principle behind various analytical techniques.
3. Acquaintwith the spectroscopic and microscopic techniques
4. Grasp technical exposure in chromatographic techniques
5. Comprehend the field of electrophoresis and PCR-based analysis of DNA

Course Content:

UNIT-I

Spectroscopy: UV-Visible spectroscopy, Atomic absorption spectroscopy, Flame photometry, Fluorescence spectroscopy, Emission spectroscopy, Mass-spectroscopy, Fourier Transform Infra-Red.

UNIT-II

Methods of separation and analysis of biochemical compounds and macromolecules:Principles and applications of Gas Chromatography, High Performance Liquid Chromatography, Thin layer chromatography.

UNIT-III

Microscopic techniques: Light microscopy, Scanning electron microscopy, Transmission electron microscopy, particle size analysis, Thermal techniques in food analysis: Differential scanning calorimetry and Thermo gravimetric analysis.

UNIT-IV

Electrophoresis: Different kinds of electrophoresis, western blotting, gel documentation, DNA analysis: DNA purification, PCR-based analysis, DNA fingerprinting.

Recommended Readings:

1. Pare, J. R. J. and Bélanger, J. M. R. (2015). *Instrumental Methods of Food Analysis*: Elsevier
2. Pomeranz, Y. and Meloan, C. E. (1996). *Food Analysis: Theory and Practice* (3 ed.): CBS Publications, New Delhi.
3. Winton, A. L. (2001). *Techniques of Food Analysis:* Agrobios, Jodhpur.
4. Sharma, B. K. (1994). *Instrumental Methods of Chemical Analysis*: Krishna, Meerut.
5. Skoog, D. A., Holler, F. J. and Nieman, T. A. (1998). *Principles of Instrumental Analysis* (5 ed.): Harcourt, Singapore.
6. Gopalan, R., Subramanian, P. S. and Rangarajan, K. (2008). *Elements of Analytical Chemistry*: Sultan Chand & Sons.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Mapping of course "Advances in Food Analysis- MTFT-522-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	2	2	2	3	1	1
	CO 2	2	2	2	3	1	1
	CO 3	2	2	2	3	1	1
	CO 4	2	2	2	3	1	1
	CO 5	2	2	2	3	1	1

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-527-19: Lab-VI (ADVANCES IN FOOD ANALYSIS)

Total Marks: 50

L	T	P
0	0	4

Objectives:

1. To demonstrate the applications of current analytical and instrumental techniques.
2. To describe the advanced analytical methods.
3. To illustrate principle and mechanism of analytical instruments.

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

1. Grasp basic preparation of solutions and buffers.
2. Perceive advanced analytical methods.
3. Understand the functioning and principle of various analytical instruments
4. Interpret the spectrophotometric and chromatographic techniques.
5. Comprehend microstructural and DNA isolation techniques.

Course Content:

Preparation of solutions and buffers, Determination of titratable acidity in foods using a potentiometric titration, Diastatic activity of honey, UV-Visible Spectro-photometric analysis of a carotenoid, determination of hydroxymethylfurfural in honey, Atomic absorption spectroscopic analysis of heavy metals in foods, Secondary structure analysis of starch and proteins using Fourier Transform Infra-Red (FTIR), Gas chromatography (GC) quantification of alcohol content in beverages using the internal standard method, High performance liquid chromatography (HPLC) quantification of sugars in foods and beverages, Separation and identification of food constituents using HPLC, thin layer chromatography (TLC) of food colors, Microstructural and partical size analysis of starch, Determination of thermal properties of food samples, Extraction of different types of proteins and identification using electrophoresis, DNA isolation and fingerprinting of plant tissues.

Mapping of course "Lab-I (Advances in Food Analysis)- MTFT-527-19"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**2**	**1**	**1**
	CO 2	**2**	**2**	**3**	**3**	**2**	**2**
	CO 3	**3**	**2**	**3**	**3**	**2**	**2**
	CO 4	**3**	**2**	**2**	**3**	**1**	**1**
	CO 5	**3**	**2**	**2**	**3**	**1**	**1**

ELECTIVE-III

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-523a-19: NOVEL FOOD PACKAGING

Total Marks: 100	L	T	P
	4	0	0

Objective:

1. The purpose of this course is to explain the various recent techniques of food packaging, applications, principles and requirements of these techniques.
2. Identify the purpose, principle and advance knowledge related to the various packaging technology systems.
3. Awareness of students about the recycling of packaging materials, biodegradable packaging materials and safety and legislative aspects.

Course Outcome: On successful completion of the subject, the students will be able to:

1. Comprehend advance knowledge on the properties and production of various packaging materials and effect of various indicators used in supply chain management to indicate the food quality
2. Understand various types of scavengers and emitters for improving the food shelf life.
3. Learn about consumer response about new packaging systems and safety and legislative requirements
4. Acquaint about food-package interaction between package-flavour, gas storage systems for food storage, recycling and use of green plastics for reducing the pollution and their effect on food quality.

Course Content:

UNIT-I

Active and intelligent packaging techniques, oxygen, ethylene and other scavengers: Oxygen scavenging technology, selection of right type of oxygen scavengers, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging, antimicrobial packaging system, effectiveness of antimicrobial packaging.

UNIT-II

Advantages of non-migratory bioactive polymers, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, defining and classifying time temperature indicators (TTIs), requirements for TTIs, development of TTIs, maximizing the effectiveness of TTIs to monitor shelf-life during distribution, use of freshness indicator in packaging: Compounds indicating the quality of packaged food products, pathogen indicators, moisture regulation: Silica gel, clay, molecular sieve, humectants, irreversible adsorption.

UNIT-III

Developments in modified atmosphere packaging (MAP): Novel MAP applications for fresh-prepared produce, novel MAP gases, testing novel MAP applications, Applying high O_2 MAP. Combining MAP with other preservation techniques, packaging-flavor interactions: Factors affecting flavor absorption, role of the food matrix, role of differing packaging materials.

UNIT-IV

Modern packaging systems: Green plastics for food packaging, problem of plastic packaging waste, range of biopolymers, developing novel biodegradable materials, Integrating intelligent packaging**:**

role of packaging in the supply chain, creating integrated packaging, storage and distribution: alarm systems and time temperature indicators, traceability: radio frequency identification, recycling packaging materials: recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, using recycled plastics in packaging, methods for testing consumer responses to new packaging concepts.

Recommended Readings:

1. Jung, H. H. (2014). *Innovations in Food Packaging*: Oxford, London.
2. Ahvenainen. R. (2003). *Novel Food Packaging Techniques*: CRC Publications.
3. Robertson, G. L. (2010). *Food Packaging and Shelf Life*: CRC Publications, New York.
4. Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2 ed.): CRC Publications, Boca Raton.

Mapping of course "Novel Food Technology- MTFT-523a-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**2**	**2**	**3**	**1**	**1**
	CO 2	**2**	**2**	**2**	**3**	**1**	**1**
	CO 3	**1**	**2**	**2**	**2**	**1**	**2**
	CO 4	**1**	**2**	**1**	**2**	**2**	**1**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-523b-19: Lab-V (NOVEL FOOD PACKAGING)

Total Marks: 50

L	T	P
0	0	4

Objective:

1. To provide practical knowledge of various recent techniques
2. To illustrate fundamental understanding of food packaging techniques used in industries.

Course Outcome: On successful completion of the subject, the students will be able to:

1. Understand different types of food packaging materials.
2. Aware of symbols used in food industries.
3. Understand the role and effectiveness of various packaging systems.
4. Shelf life evaluation of packaged foods.

Course Content:

Testing of properties of different packaging materials (paper, plastic, glass and metal), study of symbols and labels used on food packages, vacuum packaging, form-fill- seal packaging, determination of changes in packaged foods, packaging of foods under different conditions, preparation and application of edible coatings, comparative evaluation of different packages for fragile foods, estimation of shelf life of food under different packaging materials.

Mapping of course "Lab-V (Food Packaging)- MTFT-523b-19" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**3**	**1**	**2**
	CO 2	**1**	**1**	**1**	**2**	**2**	**2**
	CO 3	**1**	**2**	**2**	**2**	**2**	**2**
	CO 4	**2**	**1**	**2**	**2**	**2**	**1**

UC-MTFT-524a-19: NUTRACEUTICALS AND FUNCTIONAL FOODS

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To impart the concept of nutraceuticals and functional ingredients in foods, and to determine their role in health and disease prevention.
2. To learn about various phytochemicals-their sources, functions and usefulness.
3. To understand basics of Extraction methods of Phyto-chemicals and development of functional foods.
4. To study the usefulness and effects of Probiotics & Prebiotics in gastrointestinal health.

Course outcomes: On completion of the subject, the students will be able to:

1. Acquire knowledge on various bio molecules showing health benefits.
2. Understand various physiological and biochemical aspects of life threatening and chronic diseases.
3. Apply their knowledge regarding extraction, isolation, characterization and application of nutraceuticals in food industries.
4. Identify various aspects about safety, quality and toxicology of food products including, nutraceutical and functional foods.

Course Content:

UNIT-I

Nutraceuticals and functional foods: definition, types and scope, need, food applications and their health benefits, Nutraceutical compounds and their classification, Nutraceuticals for specific situations such as cancer, heart disease, stress, osteoarthritis, hypertension etc.

UNIT-II

Photochemical and their usefulness: Antioxidants and Flavonoids, Omega-3 Fatty Acids, Carotenoids, Dietary fibres, Phytoestrogens,Glucosinolates,Organosulphur Compounds etc. their effectiveness in specific disease conditions; other functional ingredients in foods such as peptides, fatty acids, Cereal products as functional foods – oats, wheat bran, rice bran etc, Functional vegetable products, oil seeds, sea foods and sea weeds, antimicrobial compounds, Coffee, tea and other beverages as functional foods/drinks and their protective effect, Effects of processing, storage and interactions of various environmental factors on the potentials of such foods, health benefits.

UNIT-III

Extraction of Phyto-chemicals and development of functional foods: Extraction methods for maximum recovery, Stability studies, Developing functional foods, Use of bioactive compound in appropriate form with protective substances and activators, Effect of environmental conditions in food matrix on activity of bioactive compound, Effects of processing conditions and storage, Development of biomarkersto indicate efficacy of functional ingredients, delivery of immune-modulators/vaccines in functional foods.

UNIT-IV

Prebiotics and Probiotics: Usefulness of Probiotics & Prebiotics in gastrointestinal health and other benefits, Examples of useful microbes and their benefits, Prebiotic ingredients in foods, types of prebiotics and their effects on gut microbes, Probiotic foods and their functional role, Marketing and regulatory issues for functional foods and nutraceuticals.

Recommended readings:

1. Mine, Y and Fereidoon, S. (2006). *Nutraceutical Proteins and Peptides in Health and Disease*: TF, Bocaraton.
2. Bagchi, D. (2008). *Nutraceutical and Functional Food Regulations in United States and Around the World*: Elsevier, London.
3. Shi, J. (2007). *Functional Food Ingredients and Nutraceuticals*:Processing Technologies: CRC Press, London.
4. Guo, M. (2009). *Functional Food*: Principles and Technology: WP, New Delhi.

Mapping of course "Nutraceuticals and Functional Foods- MTFT-524a-19"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**3**	**2**	**1**
	CO 2	**1**	**2**	**2**	**3**	**2**	**1**
	CO 3	**1**	**2**	**2**	**3**	**1**	**1**
	CO 4	**1**	**3**	**2**	**2**	**1**	**2**

UC-MTFT-524b-19: Lab-VI (NUTRACEUTICALS AND FUNCTIONAL FOODS)

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Total Marks: 50

L	T	P
0	0	4

Objectives:

1. To gain knowledge about the nutraceutical constituents present in various food products.
2. To understand the techniques of analysis plant based nutraceuticals.
3. To prepare and evaluate probiotic foods.
4. To acquire knowledge on estimation and identification of nutraceutical and functional food compounds by various advanced analytical techniques.

Course Outcome: On completion of the subject, the students will be able to:

1. Acquire knowledge on various nutraceutical components and their health benefits.
2. Understand various extraction and estimation methods of nutraceuticals.
3. Apply their knowledge regarding extraction, isolation, characterization and application of nutraceuticals in food industries.
4. Study and demonstrate various aspects regarding safety, quality and toxicology of food products including, nutraceutical and functional foods.

Course Content:

Extraction and estimation of nutraceuticals, isoflavones, capsaicinoids, organosulfur cereals and monosaturated fatty acids and lecithins, Isolation and determination of lycopene in tomato and tomato products,Extraction and estimation of plant phenolic substances by colorimetric and spectrophotometric techniques, Preparation and evaluations of probiotic foods, Extraction, estimation and identification of nutraceutical and functional food compounds by GLC and HPLC, Study and demonstration of the antimicrobial effects of plant tannins, alkaloids and sulfur compounds, Market survey of existing functional foods, study of labels of existing health foods.

Mapping of course "Lab-VI (Nutraceuticals and Functional Foods)- MTFT-524b-18" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**3**	**2**	**2**
	CO 2	**2**	**2**	**2**	**3**	**1**	**2**
	CO 3	**3**	**2**	**3**	**3**	**2**	**1**
	CO 4	**2**	**2**	**2**	**2**	**2**	**2**

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

ELECTIVE-IV

UC-MTFT-525a-19: TECHNOLOGY OF FROZEN FOODS

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Total Marks: 100	L	T	P
	4	0	0

Objectives:

1. To understand important aspects of freezing such as thermo physical properties, glass transition temperature, microbiology of frozen food, freezing loads and freezing time calculations.
2. To acquire in depth knowledge on cold chain facility for the frozen foods and innovations in the freezing processes.
3. To study on quality and safety of frozen foods and learn about various techniques to measure and control the quality of frozen foods.
4. To understand suitability of different packaging materials for frozen foods.

Course Outcome: On completion of the subject, the students will be able to:

1. Acquire knowledge on different properties and microbiology of frozen foods.
2. Understand calculations of freezing load, freezing time, glass transition temperature phenomenon in frozen foods and its manipulation.
3. Know about different freezing methods, equipment and transportation of frozen foods.
4. Gain knowledge on quality and safety of different frozen foods.

Course Content:

UNIT-I

Food freezing :importance and potentialities, nutritive values of frozen foods, Microbiology of frozen foods , Freezing methods and equipment, sharp freezers the Quick freezing systems –Freezing cabinets and walk in freezers, Frozen food locker plants, Glass transitions in frozen foods and biomaterials, Thermo-physical properties of frozen foods, Freezing loads and Freezing time calculation, Innovations in freezing process.

UNIT-II

Cold Chain: Cold store design and maintenance, Packaging and machineries, Transportation, Retail display equipments and management, Household refrigerators and freezers, Monitoring and control of the cold chain, Cold storage and thawing of foods – Adaptability of vegetables to freezing, preparation and freezing of meat, poultry and fish, freezing of Dairy products, precooked frozen foods, storage of frozen food.

UNIT-III

Quality and Safety of Frozen Foods: Importance of quality control and standards in the frozen food industries, Quality and safety of frozen meat and meat products, frozen fish, Shellfish, and related products, frozen vegetables, frozen fruits, frozen dairy products, frozen ready meals, frozen bakery products, frozen eggs and egg products, Sensory analysis of frozen foods, Monitoring and Measuring Techniques for Quality and Safety, Chemical Measurements, Food borne illnesses and detection of pathogenic microorganisms, Shelf-life prediction of frozen foods.

UNIT-IV

Packaging of Frozen Foods**:** Introduction to frozen food packaging, Plastic packaging of frozen foods, Paper and card packaging of frozen foods, Packaging of frozen foods with other materials, Packaging machinery.

Recommended readings:

1. Sun, Da-Wen (2012). *Handbook of Frozen Food Processing and Packaging*: Taylor & Francis, United State of America.
2. Kennedy, C. J. (2000). *Managing Frozen Foods*: CRC Press, New York.
3. Potter, S. (2006). *Food Science*: Sage, New Delhi.

Mapping of course "Technology of Frozen Foods- MTFT-525a-18" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**1**	**2**	**2**	**2**	**1**	**2**
	CO 2	**1**	**2**	**2**	**3**	**1**	**2**
	CO 3	**2**	**2**	**2**	**3**	**1**	**1**
	CO 4	**1**	**1**	**2**	**3**	**2**	**2**

UC-MTFT-525b-19: Lab-VI (FROZEN FOOD TECHNOLOGY)

Total Marks: 50

L	T	P
0	0	4

Objectives:

1. To determine effective cooling and freezing time.
2. To evaluatefrozen food quality and their shelf life.
3. To standardize methods for preparation of frozen vegetables.
4. To understand suitability of different packaging materials for packing of frozen foods.

Course Outcome: On completion of the subject, the students will be able to apply their knowledge on:

1. Cold storage of perishable products and their quality evaluation.
2. Calculating freezing load and freezing time for different foods.
3. Determination of mineral impurities in frozen food.
4. Packaging of frozen food and their shelf life evaluation.

Course Content:

Determination of effective freezing time, cooling and half cooling time, Quality evaluation of frozen foods, mechanism and driving force for freezer burn, adequacy of thawing, Demonstration of components of a refrigerator, Standardization of procedure for preparation of frozen peas and corn, Frozen food packaging and shelf –life evaluation, Tests of adequacy of blanching of raw material before freezing, Mineral impurities in frozen vegetables, Color grading of fresh and frozen fruit juices, Packaging of frozen food.

Mapping of course "Lab-VI (Frozen Food Technology)- MTFT-525b-19"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**2**	**2**	**3**	**2**	**1**
	CO 2	**3**	**2**	**2**	**3**	**1**	**2**
	CO 3	**2**	**2**	**2**	**2**	**1**	**2**
	CO 4	**2**	**2**	**2**	**3**	**2**	**2**

UC-MTFT-526a-19: ADVANCED MEAT, FISH, POULTRY AND EGG TECHNOLOGY

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Total Marks: 100	L	T	P
	4	0	0

Objective:

1. To understand the importance of livestock, egg and poultry industry.
2. To describestructure, composition and nutritional quality of animal products.
3. To comprehend the various post-mortem changes related to muscle and various other tissues.
4. To illustrate the processing technology of meat, poultry, fish and eggs.
5. To explain value addition and packaging of meat, fish and poultry products.

Course Outcome: After the completion of the course, the students will be able to:

1. Understand the technology for raw material characteristics, handling, processing, and preservation.
2. Grasp by-product utilization of meat, poultry, fish and egg products.
3. Apprehend the hygiene, sanitation and mechanized practices of meat, fish, poultry and egg industry.
4. Comprehend the food standards in relation to these food commodities.
5. Perceive the knowledge regarding transportation and storage practices.
6. Prepare various value added products.

Course Content:

UNIT-I

Production, Processing and consumption trends, Prospects of meat industry, Meat spoilage, Endogenous and exogenous infections, Hygiene and sanitation, Meat composition from different sources, Post-mortem muscle chemistry and composition, Intramuscular fat, Rigor mortis, The conversion of muscle into meat: Animals' stunning methods, ante-mortem and post-mortem examination, Design of handling facilities: Slaughtering and dressing, Consequences of circulatory failure, Proteolytic and other chemical changes, Operational factors affecting meat quality, Effects of processing on meat tenderization, Chilling, freezing and preservation, prepared meat products, intermediate moisture and dried meat products, The eating quality of meat: color, flavors and retention, water holding capacity, juiciness, texture and taste, meat eating and health, Inedible by-products.

UNIT-II

Quality characteristics of poultry products, Lay-out and design of poultry processing plants, Plant sanitation, Poultry meat processing operations and equipment for de-feathering, bleeding, scalding etc., Poultry meat products, Refrigerated storage of poultry meat, by-products

UNIT-III

Egg structure, structural abnormalities, functions of egg in food system, egg products, whole egg powder, egg yolk products, by-products, their packaging and storage, eating quality of eggs, Inspection and grading, preservation and safe handling.

UNIT-IV

Commercially important marine products from India, Product export and its sustenance, Processing operations, Basic biochemistry, Preservation of postharvest fish freshness, Transportation in refrigerated vehicles, Deodorization of transport systems, Design of refrigerated and insulated trucks, Grading and preservation of shell fish, pickling and preparation of fish protein concentrate, fish oil and other by-products

Recommended Readings:

1. Lawrie, R. A. (1998). *Lawrie's Meat Science* (6 ed.): Woodhead Publications, Cambridge.
2. Alan, H. V. and Jane, P. S. (1995). *Meat and Meat Products: Technology, Chemistry and Microbiology*: Champan& Hill, London.
3. Carmen, R. O. and George, J. M. (1997). *Poultry Meat and Egg Production*: CBS Publications, New Delhi.
4. Winton, A. L. and Barberwinton, K. (1999). *Fish and Fish Products*: Agrobios, Bikaner.
5. Winton, A. L. and Winton, K. B. (1993). *The Structure and Composition of Animal Product*: Agro Botanical, Bikaner.

Mapping of course "Advanced Meat, Fish, Poultry and Egg Technology- MTFT-617-18"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**
Course Outcome (CO)	**CO 1**	**2**	**2**	**2**	**3**	**1**	**2**
	CO 2	**2**	**1**	**2**	**3**	**1**	**2**
	CO 3	**3**	**2**	**2**	**2**	**2**	**2**
	CO 4	**2**	**2**	**2**	**2**	**3**	**2**
	CO 5	**2**	**2**	**2**	**2**	**1**	**2**
	CO 6	**2**	**2**	**1**	**3**	**2**	**2**

SEMESTER THIRD

UC-MTFT-614-19: Dissertation-I

L	T	P
0	0	8

The student is required to prepare his/her research project synopsis and should make a presentation to the DRC before the commencement of the final examination of third semester.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

ELECTIVE-V

UC-MTFT-611-19: FOOD RHEOLOGY AND TEXTURE

Total Marks: 100

L	T	P
4	0	0

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Objective:

1. To understand the concepts of food rheology and food texture
2. To depict rheological properties of foods and measuring methods.

Course Outcome: After the completion of the course, the students will be able to:

1. Comprehend various rheological and textural properties of solid and liquid foods.
2. Apprehend different models and tests related to food rheology.
3. Grasp knowledge regarding various instruments used in determination of food rheology.

Course Content:

UNIT-I

Food rheology concept, scope of food rheology, texture of foods – type of stress, types of strain, types of viscosity, modulus (young, shear, bulk), poisson's ratio, definition and importance of texture, texture-related concepts.

UNIT-II

Determination of rheological properties and measuring methods: destructive and non-destructive measurements, creep recovery and stress relaxation, dynamic mechanical tests, Modeling food texture: introduction, factor affecting texture, models to predict texture.

UNIT-III

Rheological properties of fluid food: viscosity, factors affecting viscosity, flow of material- Newton's law of viscosity, viscous fluids (Newtonian fluids, non-Newtonian fluids), plastic fluids (Bingham plastic, non-Bingham plastic fluids), fluid behavior in steady- shear flow: time dependent and time independent material function, viscosity measurement- capillary flow viscometers, orifice type viscometers, falling ball viscometers, rotational viscometers- concentric cylinder (coaxial rotational) viscometers, cone and plate viscometers, parallel plate viscometers, single-spindle viscometers (brookfield viscometer).

UNIT-IV

Rheological properties of solid food: deformation of material, viscoelastic behavior, Failure and glass transition in solid foods: failure in solid foods, glass transition of solids foods (measurement, factors affecting, importance), Texture of foods: compression, snapping-bending, cutting shear, puncture, penetration, texture profile analysis, dough testing instruments- farinograph and mixograph, extensograph and alveograph, amylograph.

Recommended readings:

1. Rao, M. A., Rizvi, S. S. H. and Datta A. K. 2005. *Engineering Properties of Foods*: CRC Press.
2. Heldman, D. R. (2007). *Food Process Engineering*:AVI Publications.
3. Faridi, H. and Faubion, J. M. (1997). *Dough Rheology and Baked Products*: CBS Publications, New Delhi.
4. Rao, M. A. (2007). *Rheology of Fluid and Semisolid Foods: Principles and Applications* (2 ed.): Springer, USA.

Mapping of course "Food Rheology and Texture- MTFT-611-18" outcomes and Program outcomes:

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	3	1	2	3	1	2
	CO 2	3	1	2	2	1	2
	CO 3	2	2	1	2	1	2

UC-MTFT-612-19: BIOPROCESS ENGINEERING

Total Marks: 100

L	T	P
4	0	0

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Objective:

1. To acquaint the students with recent concepts of Bioprocess Engineering.
2. To illustrate the functioning of various devices involved in formation and recovery of bio-processed products.

Course Outcome: After the completion of the course, the students will be able to:

1. Aware of the status of bio-processing in food industry.
2. Comprehend the fermentation technology involving design and processing.
3. Perceive knowledge regarding instrumentation involved in production of bio-processed products.
4. Apprehend about the recovery of bio-processed products.

Course Content:

UNIT-I

Introduction to bioprocessing, historical developments, bioenergetics, enzyme kinetics- Micaelismenton model, effect of temperature on reaction rate, microbial growth kinetics- batch culture, continuous culture, fed batch culture and application of fed batch culture, Sterilization and sanitation: thermal death kinetics, medium sterilization (batch and continuous design), sterilization of fermenter, feed and wastes; filter sterilization of media, air and exhaust air; theory of depth filters, isolation, preservation (storage on reduced temp, storage under liquid nitrogen, storage on agar slopes, storage in dehydrated form) and improvement of industrially important micro-organisms.

UNIT-II

Fermenter design- basic functions of fermenters, types of fermenter, construction material, pipes and tubes, valves and steam traps, agitator and impeller, stirrer and bearing (seals and drives), sparger, baffles, achievement and maintenance of aseptic conditions (sterilization of air, exhaust gas and fermenter), sampling port, controlling devices.

UNIT-III

Product recovery- foam separation, precipitation, filtration (batch, continuous, cross flow filtration), filter aids, filteration equipment, filteration theory, centrifugation, centrifuge equipment, centrifugation theory, liquid- liquid extraction– solvent recovery, two phase aqueous extraction, supercritical fluid extraction, chromatography, (adsorption chromatography, gel permeation, ion exchange chromatography, HPLC, RPC, continuous chromatography), membrane processes (ultrafilteraiton, reverse osmosis, liquid membranes), drying, crystallization, whole broth processing.

UNIT-IV

Bioprocess instrumentation- Offline analytical methods, physical, chemical and biosensors, online sensors.

Recommended readings:

1. Doran, P. M. (1995). *Bioprocess Engineering Principles*: Academic press, New Delhi.
2. Shuler, M. L. (2002). *Bioprocess Engineering Basic Concepts* (2 ed.): PHI, New Delhi.
3. Sablani, S. S., Rahman, M. S., Datta, A. K. and Mujumdar, A. S. (2007). *Handbook of Food and Bioprocess Modeling Techniques*: CRC Publications, New York.

Mapping of course "Bioprocess Engineering- MTFT-612-18" outcomes and Program outcomes:

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)							
	Program Outcome (PO)						
		PO1	PO2	PO3	PO4	PO5	PO6
Course Outcome (CO)	CO 1	2	2	2	2	2	1
	CO 2	2	2	1	3	1	2
	CO 3	2	2	2	2	1	2
	CO 4	1	2	2	3	1	2

OPEN ELECTIVES

Business Analytics

Course objective

1. Understand the role of business analytics within an organization.
2. Analyze data using statistical and data mining techniques and understand relationships between the underlying business processes of an organization.
3. To gain an understanding of how managers use business analytics to formulate and solve business problems and to support managerial decision making.
4. To become familiar with processes needed to develop, report, and analyze business data.
5. Use decision-making tools/Operations research techniques.
6. Mange business process using analytical and management tools.
7. Analyze and solve problems from different industries such as manufacturing, service, retail, software, banking and finance, sports, pharmaceutical, aerospace etc.

UNIT I

Business analytics: Overview of Business analytics, Scope of Business analytics, Business Analytics Process, Relationship of Business Analytics Process and organisation, competitive advantages of Business Analytics. Statistical Tools: Statistical Notation, Descriptive Statistical methods, Review of probability distribution and data modelling, sampling and estimation methods overview.

UNIT II

Trendiness and Regression Analysis: Modelling Relationships and Trends in Data, simple Linear Regression. Important Resources, Business Analytics Personnel, Data and models for Business analytics, problem solving, Visualizing and Exploring Data, Business Analytics Technology.

UNIT III

Organization Structures of Business analytics, Team management, Management Issues, Designing Information Policy, Outsourcing, Ensuring Data Quality, Measuring contribution of Business analytics, Managing Changes. Descriptive Analytics, predictive analytics, predicative Modelling, Predictive analytics analysis, Data Mining, Data Mining Methodologies, Prescriptive analytics and its step in the business analytics Process,
Prescriptive Modelling, nonlinear Optimization.

UNIT IV

Forecasting Techniques: Qualitative and Judgmental Forecasting, Statistical Forecasting Models, Forecasting Models for Stationary Time Series, Forecasting Models for Time Series with a Linear Trend, Forecasting Time Series with Seasonality, Regression Forecasting with Casual Variables, Selecting Appropriate Forecasting Models. Monte Carlo Simulation and Risk Analysis: Monte Carle Simulation Using Analytic Solver Platform, New-Product Development Model, Newsvendor Model, Overbooking Model, Cash Budget Model.

UNIT V

Decision Analysis: Formulating Decision Problems, Decision Strategies with the without Outcome Probabilities, Decision Trees, The Value of Information, Utility and Decision Making.

UNIT VI

Recent Trends in : Embedded and collaborative business intelligence, Visual data recovery, Data Storytelling and Data journalism.

COURSE OUTCOMES

1. Students will demonstrate knowledge of data analytics.
2. Students will demonstrate the ability of think critically in making decisions based on data and deep analytics.
3. Students will demonstrate the ability to use technical skills in predicative and prescriptive modeling to support business decision-making.

4. Students will demonstrate the ability to translate data into clear, actionable insights.

Reference:

1. Business analytics Principles, Concepts, and Applications by Marc J. Schniederjans, Dara G. Schniederjans, Christopher M. Starkey, Pearson FT Press.
2. Business Analytics by James Evans, persons Education.

OPEN ELECTIVES

Industrial Safety

UNIT I

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

UNIT II

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

UNIT III

Wear and Corrosion and their prevention: Wear- types, causes, effects, wear reduction methods, lubricants-types and applications, Lubrication methods, general sketch, working andapplications, i. Screw down grease cup, ii. Pressure grease gun, iii. Splash lubrication, iv. Gravity lubrication, v. Wick feed lubrication vi. Side feed lubrication, vii. Ring lubrication, Definition, Model Curriculum of Engineering & Technology PG Courses [Volume-I] principle and factors affecting the corrosion. Types of corrosion, corrosion prevention methods.

UNIT IV

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

UNIT V

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

Reference:

1. Maintenance Engineering Handbook, Higgins & Morrow, Da Information Services.
2. Maintenance Engineering, H. P. Garg, S. Chand and Company.
3. Pump-hydraulic Compressors, Audels, Mcgrew Hill Publication.
4. Foundation Engineering Handbook, Winterkorn, Hans, Chapman & Hall London.

OPEN ELECTIVES

Operations Research

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Teaching Scheme : Lectures: 3 hrs/week

Course Outcomes: At the end of the course, the student should be able to
1. Students should able to apply the dynamic programming to solve problems of discreet and continuous variables.
2. Students should able to apply the concept of non-linear programming
3. Students should able to carry out sensitivity analysis
4. Student should able to model the real world problem and simulate it.

Course Contents:

UNIT I

Optimization Techniques, Model Formulation, models, General L.R Formulation, Simplex Techniques, Sensitivity Analysis, Inventory Control Models

UNIT II

Formulation of a LPP - Graphical solution revised simplex method - duality theory - dual simplex method - sensitivity analysis - parametric programming

UNIT III

Nonlinear programming problem - Kuhn-Tucker conditions min cost flow problem - max flow problem - CPM/PERT
]

UNIT IV

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

UNIT V

Competitive Models,Single and Multi-channel Problems, Sequencing Models, Dynamic Programming, Flow in Networks, Elementary Graph Theory, Game Theory Simulation

References:

1. H.A. Taha, Operations Research, An Introduction, PHI, 2008
2. H.M. Wagner, Principles of Operations Research, PHI, Delhi, 1982.
3. J.C. Pant, Introduction to Optimisation: Operations Research, Jain Brothers, Delhi, 2008
4. Hitler Libermann Operations Research: McGraw Hill Pub. 2009
5. Pannerselvam, Operations Research: Prentice Hall of India 2010
6. Harvey M Wagner, Principles of Operations Research: Prentice Hall of India 2010

Open Elective

Cost Management of Engineering Projects

Teaching scheme :Lecture: - 3 h/week

Introduction and Overview of the Strategic Cost Management Process

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

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

Cost Behavior and Profit Planning Marginal Costing; Distinction between Marginal Costing and Absorption Costing; Break-even Analysis, Cost-Volume-Profit Analysis. Various decision-making problems. Standard Costing and Variance Analysis. Pricing strategies: Pareto Analysis. Target costing. Life Cycle Costing. Costing of service sector. Just-in-time approach, Material Requirement Planning, Enterprise Resource Planning, Total Quality Management and Theory of constraints. Activity-Based Cost Management, Bench Marking; Balanced Score Card and Value-Chain Analysis. Budgetary Control; Flexible Budgets; Performance budgets; Zero-based budgets. Measurement of Divisional profitability pricing decisions including transfer pricing.

Quantitative techniques for cost management, Linear Programming, PERT/CPM, Transportation problems, Assignment problems, Simulation, Learning Curve Theory.

References:

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

Open Elective

Composite Materials

Teaching scheme : Lecture: - 3 h/week

UNIT–I

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

UNIT – II

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

UNIT – III

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

UNIT–IV

Manufacturing of Polymer Matrix Composites: Preparation of Moulding compounds and prepregs – hand layup method – Autoclave method – Filament winding method – Compression moulding – Reaction injection moulding. Properties and applications.

UNIT – V

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

TEXT BOOKS:

1. Material Science and Technology – Vol 13 – Composites by R.W.Cahn – VCH, West Germany.
2. Materials Science and Engineering, An introduction. WD Callister, Jr., Adapted by R. Balasubramaniam, John Wiley & Sons, NY, Indian edition, 2007.

References:

1. Hand Book of Composite Materials-ed-Lubin.
2. Composite Materials – K.K.Chawla.
3. Composite Materials Science and Applications – Deborah D.L. Chung.
4. Composite Materials Design and Applications – Danial Gay, Suong V. Hoa, and Stephen W. Tasi.

Open Elective

Waste to Energy

Teaching scheme : Lecture: - 3 h/week

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

Unit-I

Introduction to Energy from Waste: Classification of waste as fuel – Agro based, Forest residue, Industrial waste - MSW – Conversion devices – Incinerators, gasifiers, digestors

Unit-II

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

Unit-III

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

Unit-IV

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

Unit-V

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

References:

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

SEMESTER FOURTH

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IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

UC-MTFT-621-19: Dissertation-II

L	T	P
0	0	36

A student is required to undertake a Research Project of 16 credits on a topic approved by the supervisor and the Departmental Research Committee (DRC). The research project shall be evaluated by the external examiner at the end of the Semester IV.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: ENGLISH FOR RESEARCH PAPER WRITING

Course objectives:
Students will be able to:
1. Understand that how to improve your writing skills and level of readability
2. Learn about what to write in each section
3. Understand the skills needed when writing a Title
Ensure the good quality of paper at very first-time submission

Course content

UNIT I

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

UNIT II

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

UNIT III

Review of the Literature, Methods, Results, Discussion, Conclusions, The Final Check.

UNIT IV

key skills are needed when writing a Title, key skills are needed when writing an Abstract, key skills are needed when writing an Introduction, skills needed when writing a Review of the Literature,

UNIT V

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

UNIT VI

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

Suggested Studies:

1. Goldbort R (2006) Writing for Science, Yale University Press (available on Google Books)

2. Day R (2006) How to Write and Publish a Scientific Paper, Cambridge University Press

3. Highman N (1998), Handbook of Writing for the Mathematical Sciences, SIAM. Highman'sbook.
4. Adrian Wallwork, English for Writing Research Papers, Springer New York Dordrecht Heidelberg London, 2011

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: DISASTER MANAGEMENT

Course Objectives: -Students will be able to:

1. learn to demonstrate a critical understanding of key concepts in disaster risk reduction and humanitarian response.
2. critically evaluate disaster risk reduction and humanitarian response policy and practice from multiple perspectives.
3. develop an understanding of standards of humanitarian response and practical relevance in specific types of disasters and conflict situations.
4. critically understand the strengths and weaknesses of disaster management approaches, planning and programming in different countries, particularly their home country or the countries they work in

Course content

UNIT I

Introduction Disaster: Definition, Factors And Significance; Difference Between Hazard And Disaster; Natural And Manmade Disasters: Difference, Nature, Type And Magnitude.

UNIT II

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

UNIT III

Disaster Prone Areas In India Study Of Seismic Zones; Areas Prone To Floods And Droughts, Landslides And Avalanches; Areas Prone To Cyclonic And Coastal Hazards With Special Reference To Tsunami; Post-Disaster Diseases And Epidemics

UNIT IV

Disaster Preparedness And Management Preparedness: Monitoring Of Phenomena Triggering A Disaster Or Hazard; Evaluation Of Risk: Application Of Remote Sensing, Data From Meteorological And Other Agencies, Media Reports: Governmental And Community Preparedness.

UNIT V

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

UNIT VI

Disaster Mitigation Meaning, Concept And Strategies Of Disaster Mitigation, Emerging Trends In Mitigation. Structural Mitigation And Non-Structural Mitigation, Programs Of Disaster Mitigation In India.

SUGGESTED READINGS:

1. R. Nishith, Singh AK, "Disaster Management in India: Perspectives, issues and strategies "'New Royal book Company. Model Curriculum of Engineering & Technology PG Courses [Volume-I] 42]
2. Sahni, PardeepEt.Al. (Eds.)," Disaster Mitigation Experiences And Reflections", Prentice Hall Of India, New Delhi.
3. Goel S. L., Disaster Administration And Management Text And Case Studies",Deep &Deep Publication Pvt. Ltd., New Delhi.

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: SANSKRIT FOR TECHNICAL KNOWLEDGE

Course Objectives

1. To get a working knowledge in illustrious Sanskrit, the scientific language in the world
2. Learning of Sanskrit to improve brain functioning
3. Learning of Sanskrit to develop the logic in mathematics, science & other subjects . enhancing the memory power
5. The engineering scholars equipped with Sanskrit will be able to explore the huge knowledge from ancient literature

Course content

UNIT I

Alphabets in Sanskrit, Past/Present/Future Tense, Simple Sentences

UNIT II

Order ,Introduction of roots, Technical information about Sanskrit Literature

UNIT III

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

Suggested reading

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

Course Output

Students will be able to

1. Understanding basic Sanskrit language
2. Ancient Sanskrit literature about science & technology can be understood
3. Being a logical language will help to develop logic in students

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: VALUE EDUCATION

Course Objectives

Students will be able to

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

Course content :

UNIT I

Values and self-development –Social values and individual attitudes. Work ethics, Indian vision of humanism. Moral and non- moral valuation. Standards and principles. Value judgements

UNIT II

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

UNIT III

Personality and Behavior Development - Soul and Scientific attitude. Positive Thinking. Integrity and discipline. Punctuality, Love and Kindness. Avoid fault Thinking. Free from anger, Dignity of labour. Universal brotherhood and religious tolerance. True friendship. Happiness Vs suffering, love for truth. Aware of self-destructive habits. Association and Cooperation. Doing best for saving nature

UNIT IV

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

Suggested reading

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

Course outcomes

Students will be able to

1. Knowledge of self-development
2. Learn the importance of Human values
3. Developing the overall personality

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: CONSTITUTION OF INDIA

Course Objectives:

Students will be able to:

1. Understand the premises informing the twin themes of liberty and freedom from a civil rights perspective.
2. To address the growth of Indian opinion regarding modern Indian intellectuals' constitutional role and entitlement to civil and economic rights as well as the emergence of nationhood in the early years of Indian nationalism.
3. To address the role of socialism in India after the commencement of the Bolshevik Revolution in 1917 and its impact on the initial drafting of the Indian Constitution.

Course content:

Unit I

History of Making of the Indian Constitution: History Drafting Committee, (Composition & Working)

UNIT II

Philosophy of the Indian Constitution: Preamble **,**Salient Features

UNIT III

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

UNIT IV

Organs of Governance: Parliament **,**Composition **,**Qualifications and Disqualifications Powers and Functions**,** Executive **,** President **,** Governor**,** Council of Ministers **,**Judiciary, Appointment and Transfer of Judges, Qualifications **,**Powers and Functions

UNIT V

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

UNIT VI

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

Suggested reading

1. The Constitution of India, 1950 (Bare Act), Government Publication.
2. Dr. S. N. Busi, Dr. B. R. Ambedkar framing of Indian Constitution, 1st Edition, 2015.
3. M. P. Jain, Indian Constitution Law, 7th Edn., Lexis Nexis, 2014.
4. D.D. Basu, Introduction to the Constitution of India, Lexis Nexis, 2015.

Course Outcomes:

Students will be able to:

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M. Tech of Food Technology (Batch 2019 onward)

1. Discuss the growth of the demand for civil rights in India for the bulk of Indians before the arrival of Gandhi in Indian politics.
2.conceptualization of social reforms leading to revolution in India.
3. Discuss the circumstances surrounding the foundation of the Congress Socialist Party [CSP] under the leadership of Jawaharlal Nehru and the eventual failure of the proposal of direct elections through adult suffrage in the Indian Constitution.Discuss the passage of the Hindu Code Bill of 1956.

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M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: PEDAGOGY STUDIES

Course Objectives:

Students will be able to:

1. Review existing evidence on the review topic to inform programme design and policy making undertaken by the DfID, other agencies and researchers.
2.. Identify critical evidence gaps to guide the development.

Course content:

UNIT I

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

UNIT II

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

UNIT III

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

UNIT IV

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

UNIT V

Research gaps and future directions Research design **,**Contexts **,** Pedagogy**,** Teacher education **,**Curriculum and assessment Dissemination and research impact.

Suggested reading

1. Ackers J, Hardman F (2001) Classroom interaction in Kenyan primary schools, Compare, 31 (2): 245-261.
2. Agrawal M (2004) Curricular reform in schools: The importance of evaluation, Journal of Curriculum Studies, 36 (3): 361-379.
3. Akyeampong K (2003) Teacher training in Ghana - does it count? Multi-site teacher education
research project (MUSTER) country report 1. London: DFID.
4. Akyeampong K, Lussier K, Pryor J, Westbrook J (2013) Improving teaching and learning of basic maths and reading in Africa: Does teacher preparation count? International Journal Educational Development, 33 (3): 272–282.
5. Alexander RJ (2001) Culture and pedagogy: International comparisons in primary education.
Oxford and Boston: Blackwell.
6. Chavan M (2003) Read India: A mass scale, rapid, 'learning to read' campaign.
7. www.pratham.org/images/resource%20working%20paper%202.pdf.

Course Outcomes

Students will be able to understand:

1. What pedagogical practices are being used by teachers in formal and informal classrooms in developing countries.
2..What is the evidence on the effectiveness of these pedagogical practices, in what conditions, and with what population of learners?
3. How can teacher education (curriculum and practicum) and the school curriculum and guidance materials best support effective pedagogy?

IK Gujral Punjab Technical University
M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: STRESS MANAGEMENT BY YOGA

Course Objectives
1. To achieve overall health of body and mind
2. To overcome stress

Course content:

UNIT I

Definitions of Eight parts of yog. (Ashtanga)

UNIT II

Yam and Niyam. Do`s and Don't's in life. ,Ahinsa, satya, astheya, bramhacharya and aparigraha , Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

UNIT III

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

Suggested reading
1. 'Yogic Asanas for Group Tarining-Part-I" :Janardan Swami Yogabhyasi Mandal, Nagpur
2. "Rajayoga or conquering the Internal Nature" by Swami Vivekananda, AdvaitaAshrama (Publication Department), Kolkata

Course Outcomes:
Students will be able to:
1. Develop healthy mind in a healthy body thus improving social health also
2. Improve efficiency

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M. Tech of Food Technology (Batch 2019 onward)

AUDIT 1 and 2: PERSONALITY DEVELOPMENT THROUGH LIFE ENLIGHTENMENT SKILLS

Course Objectives

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

Course content:

UNIT I

Neetisatakam-Holistic development of personality

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

UNIT II

Approach to day to day work and duties.

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

UNIT III

Statements of basic knowledge.

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

Suggested reading

1. "Srimad Bhagavad Gita" by Swami SwarupanandaAdvaita Ashram (Publication Department), Kolkata
2. Bhartrihari's Three Satakam (Niti-sringar-vairagya) by P.Gopinath, . Rashtriya Sanskrit Sansthanam, New Delhi.

Course Outcomes

Students will be able to

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

Scheme & Syllabus of

Master of Science- Food Technology

(M. Sc. of Food Technology)

Batch 2019 onwards

By

Board of Study (Food Science and Engineering)
(Main Campus)

Department of Food Science and Technology
IK Gujral Punjab Technical University

Vision:

To create competent professionals those, contribute towards the economic development of the nation by going in line with the policy of Government of India in the field of food processing food safety and security.

Mission:

- Development of human resources in the field of food science and technology to serve the cause of nation
- Providing a strong theoretical and practical background across the food science discipline with an emphasis on developing sustainable resources to cater food and nutrition related challenges
- Development of human resources in the area of clinical nutrition and research to contribute effectively in making India healthy
- Create favorable environment for innovation to translate theoretical knowledge into practical applications
- Inculcating professional ethical values, innovative research capabilities and leadership abilities
- Holistic development of the youth through the process of self evaluation and continuous improvement

Program Education Objectives:

1. The interdisciplinary nature of the MSc. Food Science & Technology course prompts intake of students from mixed disciplines creating the need to bring students from varying academic backgrounds to a common platform of understanding through courses structured to meet this need.
2. To make the students competent in developing the foods of the future by utilizing technologies such as food fermentations, applications of enzymes in food processing, food product development, nutraceuticals, nutritional and functional foods.
3. To keep students abreast with the rapid developments reported within technology and biological science that is creating completely new ways of developing various processed food.
4. To impart an understanding of modern food processing and profound knowledge of technology associated with the development of healthy and safe foods.
5. To motivate and enable students of MSc. Food Science & Technology to opt for higher levels of learning viz. doctoral programs by research in this interdisciplinary field with the view of developing highly skilled professionals to work in Industry and academia.

Program Outcomes:

1. An ability to apply the knowledge of science, microbiology and technology
2. An ability to apply the knowledge of underlying chemistry, properties and effects of processing on food components
3. An ability to use the techniques, skills, and modern tools necessary food processing operations
4. Demonstrate knowledge and understanding of technology and management principles, manage projects efficiently in food science and technology and multidisciplinary environments after consideration of economical and financial factors
5. An ability to design and conduct experiments, as well as to analyze and interpret data
6. An ability to apply knowledge for production of safe food and shelf-life extension of food products
7. An ability to identify, formulates, and solve food science and technology problems
8. An ability to extract information pertinent to unfamiliar problems through literature survey and experiments, apply appropriate research methodologies, techniques and tools, design, conduct experiments, analyze and interpret data
9. Contribute individually/in group(s) to the development of scientific/technological knowledge in food science and technology.

Mapping of Program Outcomes with Program Education Objectives:-

PEO / PO	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	2	1	1	2
PO2	3	1	1	1	2
PO3	1	3	1	1	1
PO4	2	2	1	1	2
PO5	1	1	2	1	1
PO6	1	2	1	3	1
PO7	1	3	3	3	1
PO8	1	1	3	3	3
PO9	2	2	2	1	3

It is a Post Graduate (PG) Programme of 2 years duration (4 semesters)

Eligibility for Admission:
Bachelor of Science / Applied Science in any subject/ B. Tech Food Technology / Biotechnology/ Sugar Technology/ Sugar and Alcohol Technology/ Fermentation Technology / Dairy Technology/B.Voc. (Food Science & Technology/Agri Food Technology/Food Processing) /Bachelor in Hotel Management and Catering Technology or any other examination recognized equivalent thereto with at least 50% marks in aggregate

Semester First

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-511- 19	Food Chemistry	4	-	-	30	70	100	4
UC-MSFT-512- 19	Principles of Food Engineering	4	-	-	30	70	100	4
UC-MSFT-513- 19	Food Microbiology	4	-	-	30	70	100	4
UC-MSFT-514- 19	Food Processing & Preservation	4	-	-	30	70	100	4
UC-MSFT-515- 19	Lab - I (Food Microbiology)	-	-	4	35	15	50	2
UC-MSFT-516- 19	Lab - II (Food Preservation & Analysis)	-	-	4	35	15	50	2
UC-MSFT-517- 19	Nutraceuticals & Functional Foods	4	-	-	30	70	100	4
	Total	**20**	**-**	**8**	**220**	**380**	**600**	**24**

Dr. Rajneesh Sachdev
Head, DFST

Semester Second

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-521- 19	Dairy Technology	4	-	-	30	70	100	4
UC-MSFT-522- 19	Technology of Fruits & Vegetables	4	-	-	30	70	100	4
UC-MSFT-523- 19	Packaging Technology	4	-	-	30	70	100	4
UC-MSFT-524- 19	Lab - III (Dairy Technology)	-	-	4	35	15	50	2
UC-MSFT-525- 19	Lab - IV (Technology of Fruits & Vegetables)	-	-	4	35	15	50	2
UC-MSFT-526- 19	Lab - V (Packaging Technology)	-	-	4	35	15	50	2
UC-MSFT-527- 19 or 528- 19	Programme Elective-I	4	-	-	30	70	100	4
UC-MSFT-529- 19 or 530- 19	Programme Elective-I (Lab)	-	-	4	35	15	50	2
	Total	**16**	**-**	**16**	**260**	**340**	**600**	**24**

Programme Elective-I *

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-527- 19	Bioprocess Technology	4	-	-	30	70	100	4
UC-MSFT-528- 19	Technology of Beverages	4	-	-	30	70	100	4
UC-MSFT-529- 19	Lab - VI (Bioprocess Technology)	-	-	4	35	15	50	2
UC-MSFT-530- 19	Lab - VII (Technology of Beverages)	-	-	4	35	15	50	2

Note: * Select any one subject from Elective-I. The elective subject for theory & practical will be same.

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Head, DFST

Semester Third

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-611- 19	Technology of Cereals, Pulses & oilseeds	4	-	-	30	70	100	4
UC-MSFT-612- 19	Food Safety, Standards & Quality Control	4	-	-	30	70	100	4
UC-MSFT-613- 19	Agri Business Management	2	-	-	15	35	50	2
UC-MSFT-614- 19	Lab - VIII (Technology of Cereals, Pulses & oilseeds)	-	-	4	35	15	50	2
UC-MSFT-615- 19 or 616- 19	Programme Elective-II	4	-	-	30	70	100	4
UC-MSFT-617- 19 or 618- 19	Programme Elective-II (Lab)	-	-	4	35	15	50	2
UC-MSFT-619- 19	In-Plant Training	-	-	12		150	150	6
UC-MSFT-630- 19	Seminar	-	-	2	35	15	50	1
	Total	**14**	**-**	**22**	**220**	**430**	**650**	**25**

Programme Elective-II **

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-615-19	Food Additives	4	-	-	30	70	100	4
UC-MSFT-616-19	Nutrition & Health	4	-	-	30	70	100	4
UC-MSFT-617-19	Lab – IX (Food Additives)	-	-	4	35	15	50	2
UC-MSFT-618-19	Lab – X (Nutrition & Health)	-	-	4	35	15	50	2

Note: ** Select any one subject from Elective-II. The elective subject for theory & practical will be same.

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Semester Fourth

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-621- 19	Snack Food Technology	4	-	-	30	70	100	4
UC-MSFT-622- 19 or 623- 19	Programme Elective-III	4	-	-	30	70	100	4
UC-MSFT-624- 19	Dissertation	-	-	24	200	100	300	12***
	Total	**8**	**-**	**24**	**260**	**240**	**500**	**20**

*****Non-credit (only satisfactory or un-satisfactory grade to be shown in DMC)**

Programme Elective-III for Fourth Semester ****

Corse Code	Course Title	Load Allocation			Marks Distribution		Total	Credits
		L	T	P	Internal	External		
UC-MSFT-622- 19	Food Biotechnology	4	-	-	30	70	100	4
UC-MSFT-623- 19	Technology of Meat, Fish and Poultry	4	-	-	30	70	100	4

Note: **** Select any one subject from Elective-III.

Important Notes: -

1. The credit requirement for the M.Sc. degree in Food Technology is 92 credits inclusive of the 16 elective course credits.
2. One laboratory hour per week per semester will be assigned half credit.
3. No elective course will be run unless the number of students registered for the elective course is five or more.
4. Each theory paper and practical examination will be of 3 hours duration.
5. After the second semester, the students will be required to undertake an In-plant training comprising 4-6 weeks in industry/organization/institute and shall submit an In-plant (Industrial) Daily dairy with In-plant-training report for which seminar presentation and viva-voce examination will be held in the beginning of the third semester by a Departmental Research Committee (DRC) including the supervisor/mentor.
6. A student is required to undertake a Research Project of 12 credits on a topic approved by the supervisor and the Departmental Research Committee (DRC). The student is required to prepare his/her research project synopsis and should make a presentation to the DRC before the commencement of the final examination of third semester.
7. The research project shall be evaluated by the external examiner at the end of the Semester IV.
8. A Supervisor will be allotted by the Departmental Research Committee (DRC) for each student in the beginning of first semester.

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SEMESTER

FIRST

UC-MSFT-511- 19: FOOD CHEMISTRY

Total Marks: 100	L	T	P
	4	0	0

Objective:
To acquaint the students about chemistry of various foods.

UNIT-I

Scope, introduction, definition and importance of food chemistry.

Chemistry of carbohydrates: Classification, functions, chemical and physical properties, pentosans, mannans and galactans, pectic substances, gums. Types of fibers and its constituents, Celluloses, hemicelluloses, soluble fibers, insoluble fibers and their important functions. Enzymes and starches-alpha amylase, beta amylase, modified starches, resistant starches, gelatinization of starches and starch blockers.

UNIT-II

Proteins and amino acids: Types, chemical, physical and functional properties, denaturation of protein, gel formation. Proteins from milk, egg and meat. Allergens, toxic constituents and anti-nutritional factors of foods (enzyme inhibitors, trypsin and chymotrypsin inhibitor, amylase inhibitor, flatulence causing oligosaccharids, phytolectins).

UNIT-III

Fats and oils: Classification, functions, physico-chemical properties, oxidation of oils and fats, rancidity. Chemistry of emulsifiers, antioxidants, stabilizers and additives used in food industry. Chemical properties and functions of minerals and vitamins. Chemistry of pigments and flavour compounds.

UNIT-IV

Enzymatic and non-enzymatic browning in Foods, reactions of aldehydes and ketones with amino compounds, caramelization, oxidative changes of polyphenols) and their applications in food products.

Important chemical changes during storage and cooking of foods, with some suitable examples from cereals, pulses and fruits and vegetables.

Recommended Readings:

1. Wang, D. (2012). *Food Chemistry*: Nova Science Publishers.
2. Chopra, H. K. & Panesar, P. S. (2010). *Food chemistry*: Alpha Science International Ltd, Oxford, U.K.
3. Coultate, T. P. (2009). *Food: The Chemistry of Its Components* (5 ed.): American Chemical Society.
4. Newton, D.E. (2009). *Food Chemistry*: Facts On File, Incorporated.
5. Damodaran, S., Parkin, K. L., & Fennema, O. R. (2007). *Fennema's Food Chemistry*: CRC Press, Taylor and Francis group.

Course Outcomes:

1. Students shall be aware of the underlying chemistry, properties and effects of processing on food components.
2. Understanding of food components reactions and their impact on sensory, nutritional, and functional properties of foods.
3. Ability to identify the structure of food constituents and relate the structure to the constituents function and importance in foods with respect to food quality, nutrition, safety, processing, etc.
4. Ability to explain influence of factors such as temperature, pH, ionic characteristic and strength, bonding, etc. on chemical changes in food systems and judge how to adjust these conditions to improve or minimize chemical and biochemical deterioration of food systems.
5. Ability to integrate chemistry and biochemistry principles into real-world food science and nutritional problems.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	1	1	2	2
PO2	3	2	2	2	2
PO3	1	2	2	1	1
PO4	1	2	2	2	2
PO5	1	1	1	1	1
PO6	2	3	3	3	3
PO7	3	3	3	3	3
PO8	1	2	2	2	2
PO9	2	3	3	3	3

UC-MSFT-512- 19: PRINCIPLES OF FOOD ENGINEERING

Total Marks: 100	L	T	P
	4	0	0

Objective:

The course provides principles of engineering mechanics applied to food processing operations.

UNIT-I

Introduction to food engineering. Material and energy balances- Basic principles, total mass and component mass balance. Material balance calculations involved in dilution, concentration and dehydration. Heat balance calculations. Fluid flow theory and application - Fluid statics and fluid dynamics, mass and energy balances in fluid flow. Newtonian and non-newtonian fluids, streamline and turbulent flow. Fluid flow applications- measurement of pressure and velocity. Liquid transport system. Pipelines and pumps for food processing plants-positive displacement pumps, air-lift pumps, propeller pumps, centrifugal pumps and jet pumps.

UNIT-II

Heat transfer in food processing- Thermal properties of foods, modes of heat transfer, conductive heat transfer in a rectangular slab, tubular pipe, and multilayered systems. Natural and forced convection. Estimation of convective heat transfer coefficient in forced and natural convection. Estimation of overall heat transfer coefficient. Heat exchangers- Plate, tubular, scraped surface, and steam infusion. Thermal process calculation- Commercial sterility concept, Microbial inactivation rates at constant temperature. Effect of temperature on thermal inactivation of microorganisms. Calculation of processing time in continuous flow systems.

UNIT-III

Psychrometrics- Properties of dry air, composition of air, specific volume of air, specific heat of dry air, enthalpy of dry air, dry bulb temperature. Properties of water-vapor- Specific volume, specific heat and enthalpy. Properties of air-vapor mixtures- Gibbs-Dalton law, Dew-point temp, humidity ratio, relative humidity, wet bulb temperature. The psychrometric chart- Use of psychrometric chart to evaluate complex air conditioning processes.

UNIT-IV

Material handling- theory and classification of various material handling equipments. Conveyors (gravity and powered conveyors), elevators (bucket and screw-type elevators), trucks (high lift and pallet trucks), cranes and hoists. Sorting and grading– advantages and methods.

Recommended Readings:

1. Singh, R. P., & Heldman, D. R (2014). *Introduction to Food Engineering* (5th ed.): Academic Press, New Delhi.
2. Saravacos, G. D., & Maroulis, Z. B. (2011). *Food Process Engineering Operations*: CRC Press, Boca raton.
3. Toledo, R.T. (2007). *Fundamentals of Food Process Engineering* (3rd ed.): Springer, New York.
4. Gustavo, V. B-C., & Ibarz, A. (2002). *Unit Operations in Food Engineering*: CRC Press.
5. Lozano, J. E (2000). *Trends in Food Engineering.*
6. Rao, D.G (2014). Fundamentals of Food Engineering: PHI Learning, Delhi
7. Heldman, R & Daryl, B (2007). Handbook of Food Engineering (2nd ed.): CRC Press

8. Smith, P.G (2011). Introduction to Food Process Engineering (2nd ed.): Springer, New York
9. Stavros Yanniotis (2008). Solving Problems In Food Engineering; Springer, New York

Course Outcomes:

1. Students shall be able to understand Basics of Mass & Energy Conservation as applied to Food Processing Operations.
2. Students shall be able to understand Basics of Fundamentals of Food Processing Operations.
3. Students shall be able to understand working of equipments in Food Industry related to transport of Fluids, Thermal Processing and Material Handling along with basics as applied to Food Processing Operations.
4. Students shall be able to understand Basics of Psychrometrics & Air Conditioning Processes related to Food Processing Operations.
5. Student shall be able to understand Basics of Mathematical Calculations related to above Engineering Applications as applied to Food Processing Operations.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	2	1	1	1
PO2	1	1	1	1	1
PO3	3	3	3	3	2
PO4	1	1	1	2	1
PO5	3	2	1	2	3
PO6	1	1	1	1	1
PO7	2	3	3	3	1
PO8	1	2	2	2	3
PO9	2	3	2	3	2

UC-MSFT-513- 19: FOOD MICROBIOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

To understand the role and significance of microbes of different categories, microbial inactivation and environmental factors that affect them in foods.

UNIT-I

Introduction to microbiology: Historical developments, Classification – A brief account, basis of classification. Three and five kingdom classification, Procaryotes and Eucaryotes. Microbial growth and nutrition. Introduction to food microbiology: Classification of microbes, Types of micro-organism normally associated with food- mold, yeast, and bacteria. Contamination of foods- vegetables, cereals, pulses, oilseeds, milk and meat during handling and processing.

UNIT-II

Factors affecting microbial growth: Intrinsic and extrinsic factors, Biochemical changes caused by micro-organisms, deterioration of various types of food product. Microbiology of food preservation, heating process, irradiation, low temperature storage, chemical preservatives, high-pressure processing, control of water activity.

UNIT-III

Fermented and microbial foods: Fermented milk and milk products, fermented fruits and vegetables, fermented meat and fish products, fermented beverages (beer, vinegar and wine), single cell protein.

UNIT-IV

Food microbiology and public health: food poisoning and microbial toxins, types of food poisonings. Bacterial agents of food borne illness. Non-bacterial agents of food borne illness- poisonous algae, fungi and food borne viruses. Microbial standards for different foods. HACCP and food safety, hurdle technology and its applications.

Recommended readings:

1. Frazier, W. C. and Weshoff, D. C. (2015). *Food Microbiology*: Tata McGraw Hill Publication, New Delhi.
2. Adam, M. R. & Moss, M. O. (2008). *Food Microbiology:* Royal Society of Chemistry, Cambridge.
3. James, M. J. (2005). *Modern Food Microbiology* (5th ed.): CBS Publishers, New Delhi.
4. Stanier, R.Y. (1996). *General Microbiology* (5th ed.): MacMillan, Hampshire.
5. Creager, J. G., Black, J. G. & Davison, V. E. (1990). *Microbiology: Principles & Applicants.* Prentice Hall, New Jersey.
6. Frazier, W. C. & Westhoff, D. C. (1995). *Food Microbiology (*4th ed.). TMH, New Delhi

Course Outcomes:

1. Understand the principles involving food spoilage and preservation involving microorganisms and explain why microbiological quality control programmes are necessary in food production.
2. Ability to identify the characteristics of important pathogens and spoilage microorganisms in foods.

3. Understand the role and significance of intrinsic and extrinsic factors on growth of microorganisms in foods and differentiate which organisms would be likely to grow in a specific food product.
4. Identify the conditions under which the important pathogens and spoilage microorganisms are commonly inactivated killed or made harmless in foods and identify ways to control microorganisms in foods.

5. Describe the beneficial role of microorganisms in fermented foods and in food processing.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	2	3	3	3
PO2	1	1	1	1	1
PO3	1	1	2	1	2
PO4	3	2	2	1	1
PO5	1	2	1	1	1
PO6	3	3	3	3	3
PO7	2	2	2	2	1
PO8	2	1	2	3	1
PO9	2	2	2	2	2

UC-MSFT-514- 19: FOOD PROCESSING & PRESERVATION

Total Marks: 100	L	T	P
	4	0	0

Objective:

To impart knowledge on the causes of food spoilage and principles of different techniques used in processing and preservation of foods. To identify and select preservation methods appropriate for specific foods and to learn the effects of preservation methods on the quality of food.

UNIT-I

Scope and importance of food processing, Historical developments in food processing. Types of foods and causes of food spoilage. Heat preservation and processing: Heat penetration, heat resistance of microorganisms, thermal death curve, types of heat treatments and effects on foods. Canning of foods, cans and container types, spoilage of canned foods.

UNIT-II

Cold preservation and processing: Distinction between refrigeration and freezing. Refrigeration– introduction, components of refrigeration system and changes in food during refrigerated storage. Effect of low temperature on fresh food. Freezing- technological principles of freezing operations, freezing curves, freezing systems and methods, factors determining freezing rate, changes in food during freezing. Freeze drying– conventional drying vs freeze drying, equipments used and effects of freeze drying on food quality.

UNIT-III

Drying, Dehydration and concentration: Sun drying and solar dehydration, drying curves, drying methods and type of dryers. Food concentration- methods of concentration of fruit juices, liquid food concentrates, changes in food during dehydration and concentration. Water activity- role of water activity in food preservation. Intermediate moisture foods (IMF)- principle, characteristics, advantages and problems of IM foods.

UNIT-IV

Food Irradiation: Use of ionization radiations in food preservation, sources, units, effects, limitations, dose determination, safety and wholesomeness of irradiated foods, food irradiation techniques and recent applications of irradiation in food preservation.

Microwave processing: Properties, mechanism of heating, application of microwave in food processing and its effects on nutrients.

Preservatives: Uses and effects of class I and class II preservatives in foods.

Recommended readings:

1. Sivasankar, B. (2014). *Food processing and preservation:* Hall of India Pvt., New Delhi.
2. Fellows, P. J. (2009). *Food processing Technology: Principles and Practice:* Woodhead Publishing.
3. Brennan, J. G. (2006). *Food Processing Handbook:* Weinheim: Wiley-VCH.
4. Zeuthen, P. & Bogh- Sprensen, L. (2003). Food Preservation Techniques: CRC Press, Boca raton.
5. Vonloesecka, H. W. (1998). *Drying and Dehydration of Foods:* Allied, Bikaner.

Course Outcomes:

1. To impart knowledge on the causes of food spoilage.
2. To learn principles of different techniques used in processing and preservation of foods.
3. To identify and select preservation methods appropriate for specific foods.
4. To learn the effects of preservation methods on the quality of food.
5. To learn different permitted food additive used in food industry.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	1	3	3	3	3
PO4	1	3	3	3	2
PO5	1	2	2	2	2
PO6	2	3	3	3	3
PO7	2	3	3	3	1
PO8	1	2	2	2	2
PO9	3	3	3	3	3

UC-MSFT-515- 19: LAB - I (FOOD MICROBIOLOGY)

Total Marks: 50	L	T	P
	0	0	4

Objective:

To understand the microbial techniques and to develop skills related to microbial quality evaluation of foods using various techniques.

List of experiments:

1) Introduction to microbiological techniques:
    a. Requirements of a microbiology lab,
    b. Safety rules to be followed in the lab,
    c. Cleaning and sterilization techniques,
    d. Preparation of different types of growth media.
2) Bright field microscopy and examination of living micro-organisms,
3) Direct microscopic count of micro-organisms– use of Neubauer counting chamber.
4) Staining techniques:
    a. Simple staining,
    b. Gram staining,
    c. Spore staining and
    d. Negative staining etc.,
5) Culture techniques-
    a. Aseptic technique,
    b. Dilution technique.
6) Isolation of bacteria by
    a. Serial dilution (streak plate),
    b. Pour plating and spreading,
    c. Bacterial population count- standard plate count.
7) Microbiology of food:
    a. Microbiological analysis of food products-
        i. Bacterial count,
        ii. Yeast and mold count,
        iii. Coliform count,
        iv. Standard plate count of milk and direct microscopic count of milk,
        v. Reductase Test (MBRT).
    b. Microbiological testing of water-
        i. Quantitative test,
        ii. Bacteriological quality testing (MPN).

Course Outcomes:

1. Acquire the practical skills for the sampling of foods to carry out microbial analysis.
2. Ability to carry out various sterilization techniques and to identify the most suitable technique for specific food.
3. Ability to isolate and identify common food borne microbial pathogens.
4. Understand microbiological analysis methods for food products and ability to analyze different foods for presence of hazardous microorganisms using food microbiology technology.
5. Ability to interpret microbiological analysis of food products.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	1	1	1	1	1
PO3	2	1	1	3	1
PO4	1	1	1	1	1
PO5	1	3	2	2	3
PO6	3	3	3	3	3
PO7	1	1	2	1	1
PO8	1	1	1	1	1
PO9	2	2	2	2	2

UC-MSFT-516- 19: LAB - II (FOOD PRESERVATION & ANALYSIS)

Total Marks: 50	L	T	P
	0	0	4

Objective:

To understand the effect of various preservation techniques on the quality and safety of food products. To design and evaluate a processing procedure used to preserve a food product.

List of experiments:

1. Sampling techniques and preparation of test samples,
2. Estimation of Water activity of food sample.
3. Physical and Chemical evaluation of thermally processed food (Canned or Bottled),
4. Test for adequacy of Blanching, pasteurization and sterilization.
5. In-bottle pasteurization and sterilization of fruit juices,
6. Standardization of the procedure for thawing of frozen food,
7. Pickling and curing of foods,
8. Determination of sodium chloride in brine,
9. Determination of moisture content in fresh and dried food samples,
10. Effect of pH on microbial stability of food,
11. Dehydration of foods
12. Preparation of fruit juice concentrates and powder,
13. Physicochemical analysis of dehydrated food sample,
14. Use of chemical preservatives in food,
15. Estimation of crude fat in pickle samples.
16. Estimation of amount of preservatives in processed food sample,
17. Determination of total minerals of fruit pulp.
18. Freeze drying of food sample by Lyophilizer.
19. Freezing point determination by freezing point apparatus.

Course Outcomes:

1. To understand the sampling techniques and preparation of test samples.
2. To understand the effect of various preservation techniques on the quality and safety of food products.
3. To design and evaluate a processing procedure used to preserve a food product.
4. To understand the physical and chemical evaluation of thermally processed food.
5. To understand and utilize different food preservation techniques.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	3	3	3	3	3
PO4	3	3	2	2	2
PO5	3	3	3	3	3
PO6	1	3	3	3	3
PO7	2	3	3	3	3
PO8	3	3	3	3	3
PO9	3	3	3	3	3

UC-MSFT-517- 19: NUTRACEUTICAL & FUNCTIONAL FOODS

Total Marks: 100	L	T	P
	4	0	0

Objective:

To teach basic understanding of the concepts of nutraceuticals and functional foods and their use for managing chronic diseases.

UNIT-I

Nutraceutical
Historical perspective, definition, Nature, Nutraceutical compounds and their classification based on chemical and biochemical nature with suitable and relevant descriptions, Scope and Future prospects. Applied aspects of the Nutraceutical Science, Relation of Nutraceutical Science with other Sciences: Medicine, Human physiology, genetics, food technology, chemistry and nutrition.

Functional Food
Overview, Definition, Classification Functional Food, functional Food science, Food technology and its impact on functional food development, Markers for development of functional foods, Key issues in Indian functional food industry & nutraceutical.

Antioxidant
Concept of free radicals and antioxidants, Antioxidants role as nutraceuticals and functional foods.

UNIT-II

Food as remedies
Nutraceuticals bridging the gap between food and drug; Nutraceuticals for specific situations such as cancer, heart disease, Diabetics, stress, osteoarthritis, hypertension.

Food sources
Different food as functional food: Cereal products (oats, wheat bran, rice bran etc.), fruits & vegetables, milk and milk products

UNIT-III

Food sources
Legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plant. Coffee, tea and other beverages as functional foods/drinks and their protective effects

Properties and functions of various Nutraceuticals / Functional Food Ingredients
Protein, Complex carbohydrates like Dietary fibers as functional food ingredients, Probiotic, prebiotics & symbiotic foods and their functional role. Properties and functions of various polyphenols.

UNIT-IV

Anti-nutritional Factors present in Foods:
Types of inhibitors present in various foods and their inactivated. Assessment of nutritional status and Recommended Daily allowances.

Effects of processing, storage and interactions of various environmental factors on the potentials of such foods

Marketing and regulatory issues for functional foods and nutraceuticals. Recent development and advances in the areas of nutraceutical and functional foods.

References Books:

1. Functional Foods: Biochemical and Processing Aspects, Volume 1; Giuseppe Mazza; CRC Press
2. Handbook of Nutraceuticals and Functional Foods, Second Edition; Robert E.C. Wildman; CRC Press
3. Dietary Supplements of Plant Origin; Massimo Maffei; CRC Press
4. Nutraceutical beverages Chemistry, Nutrition and health Effects; Fereidoon Sahidi, Deepthi K. Weerasinghe; American Chemical Society
5. Vegetables, fruits, and herbs in health promotion Ronald R. Watson; CRC Press
6. Fruit and Cereal Bioactives: Sources, Chemistry, and Applications; Özlem Tokusoglu; Clifford Hall III; CRC Press
7. Handbook of Dietary Fibre Susan Sungsoo Cho, Mark L. Dreher; Marcel Dekker

Course Outcomes:

1. To understand the concept of nutraceuticals and functional foods towards managing chronic diseases.
2. To understand the source of various nutraceuticals and functional foods.
3. to understand the role of various nutraceuticals and functional foods towards managing chronic diseases.
4. Describe a healthy diet and food choices, and explain why such choices will help prevent health problems.
5. To learn the marketing and regulatory aspects of nutraceuticals and functional foods.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	2
PO2	3	3	3	3	1
PO3	3	2	3	2	3
PO4	3	2	3	2	3
PO5	2	2	2	2	1
PO6	3	2	3	2	2
PO7	3	3	3	3	2
PO8	2	2	2	2	2
PO9	3	3	3	3	3

SEMESTER

SECOND

UC-MSFT–521- 19: DAIRY TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

To impart knowledge about processing of milk and its products and legislation for the quality control of milk and milk products.

UNIT-I

Dairy industry in India: scope, strengths and opportunities for dairy industry.

Definition, composition and nutritive value of milk, Environmental and biological factors affecting composition of milk. Physicochemical properties of milk. Milk lipids: chemical properties, structure, fat destabilization, functional properties. Milk proteins: types, protein precipitation (casein micellar structure and its aggregation). Milk enzymes, enzymatic and acid coagulation of milk.

UNIT-II

Storage and processing of fluid milk: pasteurization, sterilization, homogenization, UHT processing and aseptic packaging.

Membrane processing of milk: types of membranes, principle of operation, applications of reverse osmosis, ultrafiltration and microfiltration.

Technology of condensed and evaporated milk: composition, nutritive value, process of manufacture, defects - their causes and prevention.

Technology of milk powders (WMP, SMP): composition, nutritive value, process of manufacture, defects - their causes and prevention, Instantization of milk powder.

UNIT-III

Technology of Milk products: Cheese- classification, composition, nutritive value, process of manufacture of cheddar, mozzarella, cottage and processed cheese, defects - their causes and prevention.

Frozen milk products- composition, nutritive value, process of manufacture, defects (their causes and prevention).

Indigenous milk products - dahi, butter, ghee, channa, paneer etc. Utilization of milk industry by-products- importance/need and food applications.

UNIT-IV

Milk and milk products standards and legislations in India, Grading of milk and criterion of grading.

Dairy plant sanitation- hygiene in dairy industry, different types of cleansing and sanitizing agents, their applications, cleaning systems (cleaning in place, central cleaning system, self-contained cleaning system).

Newer concepts in dairy products- cream powder, sterilized cream, butter spread, butter powder, cheese spread, caseinates, co-precipitates, WPC, lactose powder.

Recommended readings:

1. Sukumar, De. (1980). *Outlines of Dairy Technology:* Oxford University Press, Delhi.
2. Byron, H. W., Arnold, H. J. & John, A. A. (1987). *Fundamentals of Dairy Chemistry* (2nd ed.): CBS, Delhi.
3. Atherton, H. V. & Newlander, J. A. (1987). *Chemistry and Testing of Dairy Products* (4th ed.): CBS, New Delhi.
4. Wong, N. P. (1988). Fundamentals of Dairy Chemistry (3rd ed.): VNR, New York.
5. Cheke, V. & Sheepard, A. (1997). Cheese and Buller: Allied, Bikaner.

Course Outcomes:

Students shall acquire knowledge about

1. Composition of milk and milk products.
2. Processing of milk and milk products.
3. Different milk product development.
4. Organization and operations involved in milk processing unit.
5. To understand legislation for the quality control of milk and milk products.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	2
PO2	3	3	3	2	1
PO3	3	3	3	3	3
PO4	3	3	3	2	3
PO5	2	2	2	1	1
PO6	3	3	3	3	2
PO7	3	3	3	2	2
PO8	2	2	3	3	2
PO9	3	3	3	3	3

UC-MSFT-522- 19: TECHNOLOGY OF FRUITS AND VEGETABLES

Total Marks: 100	L	T	P
	4	0	0

Objective:

To develop knowledge regarding biochemistry and physiology of fruits and vegetables and their role in pre- and post-harvest changes in product quality.

UNIT-I

Current status of fruits and vegetables processing, classification and composition of fruits and vegetables and their nutritional significance. Pre-harvest factors influencing post-harvest physiology, post-harvest handling and precooling methods, post-harvest treatments, edible coatings, cold chain, and commercial cooling systems.

UNIT-II

Physical and chemical indices of fruit maturity, crop maturity and ripening. Biochemical changes during maturation, ripening, processing and storage.

Methods of storage: refrigerated, controlled atmosphere and hypobaric storage. Modified atmosphere packaging- role of gases, and influence of MAP on microorganisms, advantages and disadvantages.

Pre-processing operations- washing, blanching, peeling, sorting and grading of raw materials. Minimal processing of fruits and vegetables, quality factors for processing, fruit product order (FPO).

UNIT-III

Technology of production of jam, jellies and marmalades, specifications, role of pectin and theories of gel formation. Preparation of fruit juices, concentrates, fruit juice powders, specifications and packaging. Technology of juice extraction and clarification, tomato products, preserved and candied fruits, dehydrated fruits. Spoilage of processed products. Canning of fruits and vegetables, preparation of syrups and brines, can reforming and can seaming.

UNIT-IV

Stages of new product development, by-products from fruit and vegetable wastes, utilization and disposal of fruit industry wastes. Technology of mushroom: production, processing and its processed products. Technology of cashew and coconut: chemical composition, processing and processed products.

Recommended Readings:

1. Jongen, W. (2002). *Fruit and vegetable processing: Improving Quality:* Woodhead Publishing, Boca raton.
2. Thompson, A. K. (1996). *Post-harvest Technology of Fruit and Vegetables:* Blackwell, Australia.
3. Thompson, A. K. (2003). *Fruits and Vegetables- Harvesting, Handling and Storage:* Blackwell, Oxford.
4. Verma, L. R. & Joshi, V. K. (2000). *Post-harvest Technology of Fruits and Vegetables:* Indus, New Delhi.
5. Srivastava, R. P. & Kumar, S. (2001). *Fruit and Vegetable Preservation– Principles and Practices (3 ed.):* International Book distributing Co., Lucknow (India).

Course Outcomes:

1. The students shall be able to understand Biological, Chemical & Physical Properties of Fruits & Vegetables.
2. The students shall be able to understand Technologies involved in Processing, Preservation & Value- Addition of Fruits & Vegetables.
3. Students shall be able to understand Industrial Processes for Commercial Production of Jams, Jellies, Marmalade, Fruit Juices, Concentutes, Fruit Juice Powder, Dehydrated Fruits, and Canning of Fruits & Vegetables.
4. Students shall be able to understand Basics of New Food Products Development & Ideas Generation for Product Development.
5. Students shall be able to understand Basics of By Product Utilization & Waste Utilization related to Fruits & Vegetables.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	1	1
PO2	2	1	1	1	1
PO3	1	2	2	2	2
PO4	1	3	1	3	1
PO5	1	2	1	1	1
PO6	1	2	3	1	1
PO7	2	1	3	2	3
PO8	1	1	1	1	1
PO9	3	1	1	3	1

UC-MSFT-523- 19: PACKAGING TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

The course aims to develop the student's knowledge in packaging of foods.

UNIT-I

Introduction to food packaging: definition, factors involved in the evolution and selection of a food package, functions of food packaging. Paper and paper based packaging materials: types of paper (Kraft, bleached, greaseproof, glassine), paper products (paper bags, cartons, drums and moulded paper containers), and functional properties of paper. Testing of paper packaging materials. Plastic packaging materials: classification of polymers. Thermoplastic polymers- functional and mechanical properties, processing and conversion of thermoplastic polymers (extrusion, blow moulding, injection moulding, compression moulding, lamination and heat sealing). Testing of plastic packages.

UNIT-II

Metal packaging materials: container making processes (end manufacture, three-piece can manufacture and protective and decorative coatings), functional properties of metal containers and quality control tests of tin plate containers. Glass packaging materials: composition, manufacturing and nomenclature of glass containers. Glass containers- closure functions, closure terminology and construction. Properties of glass containers– mechanical, thermal and optical properties. Testing of glass containers.

UNIT-III

Aseptic packaging of foods: sterilization of packaging material, food contact surfaces and aseptic packaging systems. Active food packaging: definition, scope, physical and chemical principles. Edible films and coatings: use of edible active layers to control water vapour transfer and gas exchange, modification of surface conditions with edible active layers. Oxygen absorbents: classification and types of oxygen absorbents, factors influencing the choice of oxygen absorbents, application of oxygen absorbents for shelf-life extension of food and their advantages and disadvantages.

UNIT-IV

Ethanol vapour: ethanol vapour generator, uses of ethicap for shelf-life extension of food, effect of ethanol vapour on food spoilage/food poisoning bacteria, advantages and disadvantages of ethanol vapour generators. Safety considerations in food packaging: types of food safety problems associated with package, package labelling and food safety.

Packaging requirements of selected foods: cereal and snack food, beverages, milk and dairy products, poultry and eggs, red meat, frozen foods, horticultural products and microwavable foods.

Recommended readings:

1. Rooney, M.L. (1995). *Active Food Packaging*: Blackie Academic & Professional, Glasgow, UK.
2. Coles, R. & Kirwan, M. (2011). *Food and Beverage Packaging Technology* (2nd ed.): Wiley-Blackwell, UK.
3. Eiri Board of Consultants. (2007). *Food Packaging Technology:* Engineers India Research Institute, New Delhi.

4. Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2nd ed.)*:* CRC Press, Boca raton.
5. Piringer, O. P. & Baner, A. L. (2000). *Plastic Packaging Materials for Food:* Wiley-VCH, Weinheim.

Course Outcomes:

Students shall gain knowledge on

1. The different types of materials and media used for packaging foods.
2. Manufacturing processes for different packaging materials.
3. Quality testing techniques for different packaging materials.
4. Hazards and toxicity associated with packaging materials.
5. Laws, regulation and the monitoring agencies involved in food safety.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	3	3	3	2	3
PO4	3	3	3	3	3
PO5	1	3	3	3	3
PO6	3	3	3	3	3
PO7	3	3	3	3	3
PO8	2	3	3	3	3
PO9	3	3	3	3	3

UC-MSFT-524- 19: LAB - III (DAIRY TECHNOLOGY)

Total Marks: 50	L	T	P
	0	0	4

Objective:

Imparting knowledge about the general methods of quality evaluation, testing and processing fresh milk and milk products.

List of experiments:

1. Sampling of milk and milk products,
2. Platform tests of milk:
    a. Organoleptic test,
    b. Sediment test,
    c. COB test,
    d. Alcohol test,
    e. Alcohol-Alizarin test,
    f. Titratable acidity and
    g. pH milk.
3. Determination of specific gravity of milk,
4. Total solids and solid-not-fat using lactometer,
5. Detection of milk adulterant-
    a. Added water,
    b. Starch,
    c. Cane sugar,
    d. Neutralizers and
    e. Preservatives (formalin and hydrogen peroxide),
    f. Synthetic milk (urea test, detergent test, common salt),
6. Alkaline phosphatase test to determine adequacy of pasteurization.
7. Estimation of casein in milk, lactose, chlorides, Reichert-Meissel number and Polensky value,
8. Moisture in butter (Dean and Stark distillation),
9. Colouring matter in butter,
10. Curd and salt in butter,
11. Peroxide value, Iodine value of ghee,
12. Acid value of ghee,
13. Saponification value of ghee,
14. Fat in cream
15. Total solids in cream.
16. Development of some indigenous dairy products-
    a. Standardization and preparation of khoa/ice cream/ rasogulla.

Course Outcomes:

Student shall acquire knowledge about

1. How to do sampling of milk and milk products.
2. Physical, Chemical & Microbial analysis of milk and milk products.
3. Development of different milk products.
4. Characterization of milk products.
5. Quality control of milk & milk products.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	1	3
PO2	1	2	1	1	2
PO3	3	1	1	3	1
PO4	2	1	2	1	1
PO5	1	2	1	2	1
PO6	1	1	2	3	1
PO7	3	2	1	1	2
PO8	2	3	3	2	1
PO9	1	1	3	2	1

UC-MSFT-525- 19: LAB - IV (TECHNOLOGY OF FRUITS AND VEGETABLES)

Total Marks: 50

L	T	P
0	0	4

Objective:

To equip students with skills required for preparation and evaluation of jam, jelly, marmalade, pickles, sauces and preserves.

List of experiments:

1. Determination of maturity indices for fruits.
2. Colour measurement of fruits and vegetables/products by disc colorimetry/tintometer.
3. Preparation of jam, cheese, preserved and candy, jelly and testing of jelly grade.
4. Preparation of fruit juice products, Squash, Nectar/cordial, fruit bar, murabba, tomato puree, paste, sauce.
5. Enzyme extraction and clarification of fruit pulp/juice.
6. Dehydration of fruits,
7. Thermal processing of fruits/fruit products.
8. Adequacy of pasteurization/ sterilization/blanching.
9. Proximate analysis of fruits and their products-
    a. Estimation of TSS,
    b. moisture,
    c. total solids,
    d. titratable acidity,
    e. ascorbic acid,
    f. total and reducing sugars ,
    g. non-enzymatic browning,
    h. pectin,
    i. total polyphenolic compounds,
    j. tannin,
    k. total carotenoids.
10. Determination of enzymatic activity in ripe fruit sample.
11. Estimation of minerals in fruits by spectrophotometery, flame photometery/AAS.

Course Outcomes:

1. Ability to assess the quality of fruit and vegetables.
2. Ability to establish the quality specifications for the processing of fruit and vegetables.
3. Ability to develop various fruit and vegetable products with quality assurance and safety.
4. Understand principles and methods of preservation of fruits and vegetables.
5. To develop proficiency skill in preserving fruits and vegetables into various products.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	2	3	3
PO2	1	3	2	2	2
PO3	1	3	3	3	2
PO4	3	2	1	2	3
PO5	1	3	2	2	2
PO6	1	3	3	3	3
PO7	3	3	1	3	3
PO8	1	2	1	2	2
PO9	2	3	3	3	3

UC-MSFT-526- 19: LAB – V (PACKAGING TECHNOLOGY)

Total Marks: 50

L	T	P
0	0	4

Objective:

The course aims to develop the practical knowledge of testing of package, package material and packaging of foods.

List of experiments:

1. Identification and testing of packaging materials,
2. Determination of wax from wax paper;
3. Testing of lacquered tin plate sheets;
4. Determination of equilibrium moisture content;
5. Determination of water vapour transmission rate of packaging material;
6. Determination of Gas transmission rate of packaging material;
7. Determination of COB value of Paper and CFB
8. Determination of Burst strength of the boxes,
9. Testing the compression strength of the boxes;
10. Scuf Proffness Test,
11. To perform vacuum packaging of food sample and carry out its storage study;
12. Packaging the food material in seal and shrink packaging machine and study its shelf life;
13. Testing the strength of glass containers by thermal shock test;
14. Testing the strength of filled pouches by drop tester,
15. Head Space Gas Analysis Laboratory/ Practical.
16. Preparation sorption isotherm curve and estimation of shelf life various packaged foods.

Course Outcomes:

Students shall gain knowledge

1. To identify different types of materials and media used for packaging foods.
2. Quality testing techniques for different packaging materials.
3. Novel packaging used in food industry.
4. Laws and regulation related to labelling of food product.
5. Application of different packing materials for food industry.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	3	3	3	3	3
PO3	3	3	3	3	3
PO4	3	3	3	3	3
PO5	3	3	2	3	3
PO6	3	3	3	3	3
PO7	3	3	3	3	3
PO8	3	3	2	3	3
PO9	3	3	3	3	3

ELECTIVE-I

UC-MSFT-527- 19: BIOPROCESS TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

Acquaintance with importance of food fermentation and its application in food sector.

UNIT-I

Overview of fermentation: fermentation as an ancient art, modern era of fermentation technology. Biology of industrial micro-organisms- isolation, screening and genetic improvement of industrially important micro-organisms.

UNIT-II

Fermentation systems: batch and continuous systems, fed-batch culture, feedback systems, fermenter design, solid substrate fermentation, Instrumentation and control. Fermentation raw materials- criteria used in media formulation, influence of medium, raw materials for process control.

UNIT-III

Downstream processing: objectives, steps, problems, separation processes. Microbial production of various primary and secondary metabolites- alcohol, amino-acids , organic acids (citric acid and acetic acid), enzymes, antibiotics (penicillin, cephalosphorin). Principles of overproduction of metabolites.

UNIT-IV

Biomass production: microbial production of single cell protein, Baker's yeast. Immobilized enzyme technology- methods of immobilization and applications. Membrane technology- methods and applications in bioprocessing. Waste treatment- introduction, waste treatment systems, microbial inoculants and enzymes for waste treatments.

Recommended readings:

1. Crueger, W. & Crueger, A. (2000). *Biotechnology: A Textbook of Industrial Microbiology* (2nd ed.)*:* Panima, New Delhi.
2. Rehm, H. J., Red, G. (1993). *Biotechnology: A Multi Volume Comprehensive Treatise* (2nd ed.): VCH, New York.
3. Stansbury, P. F., Whitakar, A. and Hall, S. J. (1997). *Principles of Fermentation Technology* (2nd ed.): Pergamen Press, Oxford.
4. Reed, G. (1987). *Prescott & Dunn's Industrial Microbiology* (4th ed.): CBS, New Delhi.
5. Mansi, E. M. T. E. L. & Bryce, C. F. A. (1999). *Fermentation Microbiology and Biotechnology:* Taylor and Francis, London.

Course Outcomes:

At the completion of the program the student will:

1. Appreciate the positive role and benefits of microorganisms and enzymes in food production, processing, and preservation.
2. Understand basic biological and chemical processes of living cells, enzymes, and microbial nutrition in relation to fermentation processes.
3. Understand principles of inoculum /starter culture development for industrial fermentations and fermenter /reactor design, control and operation.

4. Understand both upstream and downstream unit operations and technologies used for substrate preparation and recovery and purification of fermentation products.
5. Discuss and evaluate the operational considerations and relative advantages relating to the choice of techniques used in downstream processing of food products.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	3	1	1	1
PO2	2	3	1	1	1
PO3	1	2	1	2	1
PO4	1	1	1	3	3
PO5	2	1	2	1	1
PO6	3	2	3	1	1
PO7	3	3	1	1	2
PO8	1	2	1	3	2
PO9	2	1	1	1	1

UC-MSFT-528- 19: TECHNOLOGY OF BEVERAGES

Total Marks: 100	L	T	P
	4	0	0

Objective:

To provide an understanding of the science and technology for processing different types of beverages.

UNIT-I

Beverages, importance of beverages in our diet, treatment of water for food industry. Technology of alcoholic and non-alcoholic beverages- wine, cider, brandy, perry, toddy. Fruit juice beverages- methods of production, preservation and packaging, physiological aspects of fruit juice production and methods of fruit juice clarification.

UNIT-II

Technology of soft drinks, mineral water, ingredients, and additives used in production of soft drinks. Manufacturing of carbonated and non-carbonated beverages, technology of carbonation, and application of CO_2 in juice preservation.

UNIT-III

Citrus beverages, whey beverages and utilization of whey in development of fortified drinks, use of low calorie sweeteners in beverages.
Equipments and machineries for juice pressing, methods of bottling, enzymatic clarification and debittering of juices. Fruit juice beverages, squash, cordial, crush, RTS, nectar, syrups, their types and production, blending of juices.

UNIT-IV

Production, processing and chemistry of tea manufacturing, tea products such as soluble tea, tea concentrate, de-caffeinated and flavoured tea. Production, processing, roasting and brewing of coffee, soluble coffee manufacture, standards and specifications of coffee products, de-caffeinated coffee, and coffee brew concentrate and chicory. Cocoa processing and cocoa beverages.

Recommended Readings:

1. Rao, L. J. M. & Ramalakshmi, K. (2011). *Recent trends in soft beverages:* AFST, India.
2. Priest, F. G. & Campbell, I. (1996). *Brewing Microbiology* (2nd ed.): Chapman and Hall, London.
3. Hui, Y. H. (2004). *Handbook of Food and Beverage Fermentation Technology:* Marcel Dekker, New York.
4. Varnam, A. H. & Sutherland, J. P. (1994). *Beverages: Technology, Chemistry and Microbiology:* Chapman, London.
5. Varnam, A. H. & Sutherland, J. P. (2009). *Beverages Technology, Chemistry and Microbiology:* Springer, UK.

Course Outcomes:

1. Ability to understand the science and technology for processing different types of beverages.
2. Ability to explain processing of fruit juice beverages, carbonated beverages, citrus beverages, tea and coffee.
3. Understanding of permitted additives in beverages.
4. Ability to understand the impact of processing on quality of beverage.

5. Knowledge of recent high value added beverages and recent trends in beverage industry.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	2	3	3	2
PO2	3	2	3	3	2
PO3	3	3	1	2	3
PO4	2	2	2	1	3
PO5	1	1	1	1	1
PO6	2	2	3	3	3
PO7	3	3	1	3	3
PO8	1	1	2	1	2
PO9	2	2	2	2	2

UC-MSFT-529- 19: LAB – VI (BIOPROCESS TECHNOLOGY)

Total Marks: 50	L	T	P
	0	0	4

Objective:

To educate students about industrial production of fermented foods and their analytical techniques.

List of experiments:

1. Isolation of yeast from natural sources,
2. Isolation of lactic acid bacteria from different sources,
3. Amylase/lipase/protease production from soil/samples.
4. Production of
    - **a.** Industrial alcohol,
    - **b.** Grape wine (Red wine/ white wine),
    - **c.** lactic acid,
    - **d.** Yoghurt,
    - **e.** Acidophilus milk,
    - **f.** Sauerkraut.
5. Analytical assays in fermentation:
    - **a.** Estimation of ethanol, lactic acid, total acids.
6. Determination of cell mass.
7. Analysis of COD in Distillery/Food industry effluent sample.
8. Estimation of Hardness of water/ Bottled water/Potable water samples.
9. Evaluation of antimicrobial activity/ efficacy of various sanitizers/ Disinfectants and preservatives.

Course Outcomes:

At the completion of the program the student will:

1. Understand the various concepts of fermentation.
2. Isolate and identify microorganisms from fermenting fruits, cereals and milk;produce some drinks and foods e.g. bread, beer, wine and vinegar resulting from alcoholic fermentation.
3. Produce some foods and drinks e.g. yoghurt resulting from acidic fermentation.
4. Experience in functioning within a team.
5. Understand principles underlying Quality Assurance.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	1	1	1	3
PO2	3	1	3	1	2
PO3	1	3	1	2	1
PO4	1	1	1	3	1
PO5	1	1	2	1	1
PO6	1	1	1	1	2
PO7	2	2	3	2	1
PO8	1	1	1	1	1
PO9	1	1	1	3	1

UC-MSFT-530- 19: LAB - VII (TECHNOLOGY OF BEVERAGES)

Total Marks: 50

L	T	P
0	0	4

Objective:

To educate students various laboratory techniques for analysing and measuring the important physicochemical parameters of beverages.

List of experiments:

1. Determination of water quality parameters for beverages,
2. Preservation and packaging of alcoholic and non-alcoholic beverages,
3. Determination of quality parameters for alcoholic and non-alcoholic beverages,
4. Standardization of method for fruit juice extraction and clarification, enzymatic clarification, process optimization of fruit juice beverages,
5. Effect of carbonation on shelf life of fruit beverages,
6. Extraction and dibittering of citrus juice,
7. Evaluation of quality testing parameters of wines,
8. Chemical and sensory quality analysis of soft drink,
9. Preparation of whey based beverages.
10. Decaffeination and sensory evaluation of coffee beverages:
    a. Process optimization and sensory evaluation of cocoa beverages,
11. Determination of brewing quality parameters of tea and coffee.

Course Outcomes:

1. Ability to use laboratory techniques to analyze and measure important physicochemical parameters of beverages.
2. Ability to assess various quality parameters of beverages including sensory evaluation.
3. Ability to understand regulatory requirements regarding quality of water for beverages.
4. Ability to acquire skill for development of high value added tea and coffee beverages.
5. Ability to acquire skill for standardization of methods for developing beverages.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	3	3	3	3
PO2	2	2	2	2	2
PO3	2	1	1	3	3
PO4	1	3	2	3	3
PO5	3	2	1	1	1
PO6	1	3	3	2	3
PO7	3	1	1	3	1
PO8	1	1	2	1	2
PO9	3	3	3	2	3

SEMESTER

THIRD

UC-MSFT-611- 19: TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS

Total Marks: 100	L	T	P
	4	0	0

Objective:

To create knowledge about the processing and quality evaluation of cereal grains.

UNIT-I

Current status and future scenario of world wheat production and uses. Criteria of wheat quality– physical and chemical. Chemical composition of wheat grain and its relation to processing quality. Molecular basis of wheat grain hardness/softness. Wheat milling – general principle, cleaning, conditioning and milling systems. Flour streams, extraction rates and their composition. Criteria of flour quality. Functionality of wheat proteins, carbohydrates and lipids in bakery products. Manufacturing techniques, uses and functionality of vital wheat gluten. Enzymes of wheat and their technological significance.

UNIT-II

Dough rheology and dough testing apparatus such as recording dough mixers. Bread making processes, importance of critical unit operations, development in bread making methods, functions of ingredients/additives such as fat, emulsifiers, oxidants, reducing agents, conditioners. Bread faults and remedies. Technology of biscuit, cake, cookie and cracker manufacture. Functions of ingredients in soft wheat products. Durum wheat- chemistry, quality and technology of pasta products.

UNIT-III

Rice grain structure and chemical composition. Milling of rice- types of rice mill (huller mill, sheller-cum-huller mill, sheller-cum-cone polisher mill, small capacity rice mill). Modern rice milling unit operations – dehusking, paddy separation, polishing and grading. Factors affecting rice yield during milling. Control and assessment of degree of milling. By- products of rice milling and their utilization. Cooking quality of rice. Parboiling of rice- traditional methods and their drawbacks. CFTRI process of parboiling. Properties of parboiled rice. Changes during parboiling. Advantages and disadvantages of parboiling. Rice convenience foods- precooked rice, canned rice, expanded rice, rice based infant food formulas, rice puddings and breads, rice cakes, rice noodles and fermented foods.

UNIT-IV

Chemical, technological and nutritional aspects of sorghum, oats and millets. Coarse grain based processed foods. Wet and dry milling of corn. Corn products and their uses. Malting of barley-steeping, germination and drying. Classification of malt products, nutritive value and food applications of malt. Pluses: composition and importance in Indian diet. Dal milling and processing of pulses. Oilseeds: Conditioning and oil extraction, significance of oil seeds processing in India, expeller pressing and solvent extraction of oil, oil refining, preparation of protein concentrate, isolates and their use in high protein foods.

Recommended readings:

1. Khatkar, B.S. (2010). Baking Science and Technology. Arihant Prakashan Pvt Ltd., New Delhi.
2. Samuel, A.M. (2014). *The Chemistry and Technology of Cereals as Food and Feed:* CBS Publication, New Delhi.
3. Khan, K. & Shewry, P. R. (2009). *Wheat: Chemistry and Technology:* St. Paul, U.S.A.
4. Champagne, E.T. (2004). *Rice: Chemistry and Technology*(3rd ed.): *AACC, USA.*

5. Dendy, D. A. V. & Dobraszczyk, B. J. (2001). *Cereals and Cereal Products: Chemistry and Technology:* Aspen, Maryland.
6. Pomeranz, Y. (1998). *Wheat: Chemistry and Technology (3rd ed.):* AACC, USA.

Course Outcomes:

1. Student will acquire the understanding of the technology for Wheat Milling & Wheat based Food Products.
2. Student will acquire the understanding of the technology for Rice Milling & Rice based other Food Products.
3. Student will acquire the understanding of working of equipments related to Wheat & Rice Milling along with equipments related to Wheat based & Rice based Food Products.
4. Student will be able to understand technology for Milling of Corn & Corn based other Food Products along with equipments.
5. Student will be able to understand technology for Oil Extraction & Oil Seed Processing along with equipments.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	2	3	3
PO2	3	3	2	3	3
PO3	3	3	3	3	3
PO4	3	3	3	3	3
PO5	1	1	1	1	1
PO6	1	1	1	1	1
PO7	3	3	3	3	3
PO8	2	2	2	2	2
PO9	3	3	3	3	3

UC-MSFT–612- 19: FOOD SAFETY, STANDARDS AND QUALITY CONTROL

Total Marks: 100	L	T	P
	4	0	0

Objective:

To create understanding of quality control and assurance, risk assessments, GMPs, and regulations in the food sector.

UNIT-I

Definition, objective, scope and functions of food safety and quality assurance, Quality enhancement models, Statistical Quality Control for food industry, Quality control tools, Quality control charts for food plant sanitation, Food Safety Management Systems, Causes of failure of Food Safety Programs, Introduction of Food Quality Management Systems, Production planning and Control.

UNIT-II

WTO, FAO, WHO, Codex Allimentarius Commission, GMP, GHP, Cleaning and disinfection Principles. Implementation of quality control programmes, HACCP, ISO – 22000 series, Introduction to USFDA & BRC.

UNIT-III

ISO–9000 series, Concept of total quality control (TQM), GLP, ISO-17025. Intellectual Property: concept and fundamental- Patent Laws, copy right, trade mark and IPR. Sampling and labeling requirements for different Food products, Introduction to BIS, AGMARK, Organic food, Functions of EIC in export of food product.

UNIT-IV

Sensory evaluation: Introduction, panel screening, selection methods, interaction and thresholds. Food adulteration: Types of adulterants, Common adulterants for foods like milk and milk products, honey, wheat flours, edible oils, cereals, condiments (whole and ground) pulses, coffee, tea, confectionery, baking powder, non-alcoholic beverages, vinegar, besan and curry powder

Recommended readings:

1. Singh, S. P. (2009). *Food Safety, Quality Assurance and Global Trade: Concerns and Strategies:* International Book Distributing Co. Lucknow.
2. Metha, R. & George, J. (2005). *Food Safety regulation concerns and trade: A Developing Country Perspective.*
3. Pomeranz, Y. & Meloan, R. (1995). *Food Analysis: Theory and Practice:* AVI Publication, New York.
4. Askar, A. & Treptow, H. (1993). *Quality assurance in Tropical Fruit Processing.*
5. Mahindru, S. N. (2000). *Food Safety: A Techno-legal Analysis:* Tata Mc, India.

Course Outcomes:

1. To create understanding of quality control and assurance system in food industry.
2. To understand the risk assessments procedure for food sector.

3. GMPs and GHP regulations in the food sector.
4. To understand the different food safety management used worldwide.
5. To understand the sensory evaluation methodology used in food industry.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	3	3	3
PO2	2	3	2	2	3
PO3	3	3	3	3	3
PO4	3	3	3	3	3
PO5	2	2	2	2	3
PO6	3	3	3	3	3
PO7	2	3	2	2	3
PO8	2	2	2	2	3
PO9	3	3	3	3	3

UC-MSFT- 613- 19: AGRI BUSINESS MANAGEMENT

Total Marks: 50 L T P

2 0 0

Objective:

To impart knowledge related to market types, the procurement, marketing and management of raw and processed agricultural produce meant for human consumption.

UNIT-I

Introduction, definition, history, objectives, importance with respect to Indian economy and globalization. Agricultural and food policy, rural management. Management of agri-business. New product development: introduction, development and value analysis.

UNIT-II

Entrepreneurship Development Programs (EDP): introduction, importance, characteristics and functions of an entrepreneur, SWOT analysis of new industries and products. Government schemes and incentives for promotion of entrepreneurship. Financing and risk management in agri-business.

UNIT-III

Marketing management: role of management in agri-business, attributes and responsibility of manager. Marketing of agricultural produce. Market research for agri-business. Different types of management in agri-business: production, retail and supply chain and inventory management (introduction, need, attributes and function).

UNIT-IV

World trade agreements related with food business, export and prospects of food products in India. Consumer behaviour towards food consumption, consumer surveys by various institutes and agencies.

Recommended readings:

1. Kottler (1994). *Marketing Management:* Prentice Hall of India, New Delhi.
2. Baker, G. A., Grunewald, O. & Gorman, W. D. (2002). *Introduction to food and agribusiness management:* Prentice Hall of India, New Delhi.
3. Khanks, S. S. (1999). *Entrepreneurial Development:* Chand and company, New Delhi.
4. Jakobsen, G. & Torp, J. E. (2001). *Understanding business systems in developing countries.*
5. Ahmad, S. M. (2000). *Management Info Guide*.

Course Outcomes:

1. Ability to understand the basic concepts of marketing of food items.
2. Ability to understand market types, the procurement, marketing and management of raw and processed agricultural produce meant for human consumption.
3. Acquire knowledge of the legal and ethical environment impacting agriculture organizations and effectively evaluate the impact of trade policy.
4. Understand the need for careful management of a business human resources.
5. Understand the impact of planning, decision making and risk taking on an agri-business.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	1	1
PO2	1	1	1	1	1
PO3	2	2	2	2	2
PO4	3	3	3	3	3
PO5	1	1	1	1	1
PO6	1	1	1	1	1
PO7	2	2	2	2	2
PO8	1	1	1	1	1
PO9	1	1	1	1	1

UC-MSFT-614- 19: LAB – VIII (TECHNOLOGY OF CEREALS, PULSES AND OILSEEDS)

Total Marks: 50

L	T	P
0	0	4

Objective:

To familiarize the students with quality tests of wheat flour and yeast with reference to bread processing and to equip them with the necessary skills for bread, biscuits and cookies processing.

List of experiments:

1. Estimation of different physicochemical characteristics of cereals grains.
2. Milling quality evaluation of wheat grains.
3. Functional quality test of wheat flour-
    a. Wet & dry gluten content
    b. SDS sedimentation maltose value
    c. Falling number values of wheat flour
    d. Dough raising capacity of yeast.
4. Rheological tests of wheat flour-
    a. Viscoamylographic characteristics
    b. Farinographic characteristics
    c. Extensographic characteristics
    d. Effect of different oxidizing & reducing agents on the farinographic & extensographic characteristics.
5. Test baking of bread, biscuits and cake.
6. Milling of rice.
7. Effect of parboiling treatment on the milling quality of rice.
8. Effect of degree of polishing on the milling quality of rice.

Course Outcomes:

1. Student shall be well versed with Processing Techniques of Cereals.
2. Student shall be well versed with quality parameters of cereals.
3. Student will be able to understand practical implication of Milling of Wheat & Rice.
4. Student will be able to get acquaintance with machinery being utilized in Milling of Wheat & Rice.
5. Student will be able to understand Lab SOPs for above.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	2	2	2	2	1
PO2	2	2	2	2	1
PO3	3	3	3	3	2
PO4	3	3	3	3	3
PO5	3	2	3	3	3
PO6	2	2	2	2	1
PO7	3	3	3	3	2
PO8	3	2	3	3	3
PO9	3	3	3	3	3

ELECTIVE-II

UC-MSFT-615- 19: FOOD ADDITIVES

Total Marks: 100	L	T	P
	4	0	0

Objective:

To impart knowledge about additives in food processing, types of food additives, chemical nature, their analysis and risk and benefits.

UNIT-I

General classification, types, uses, functions, legal aspects, risks and benefits. Preservatives-antimicrobial agents (types, mode of action and their application). Antioxidants (types and mechanism of oxidation inhibition). Anti-browning agents (types, functions and mode of action).

UNIT-II

Coloring Agents: synthetic food colorants, color chemistry, application and levels of use, natural colorants, sources of natural color (plant, microbial, animal and insects), misbranded colors, color extraction techniques.
Flavoring agents: sweeteners (nutritive and non-nutritive), flavors (natural and synthetic flavors), off-flavor in foods, flavor enhancers, flavor stabilization. flavor encapsulation.

UNIT-III

Emulsifiers: types, selection of emulsifiers, emulsion stability, functions and mechanism of emulsifiers. Stabilizers: types, uses and functions.
Chelating agents and sequestrants: types, uses and mechanism.
Acidulents and pH control agents: types, uses and mode of action.

UNIT-IV

Nutritional additives: types and uses, Spices and condiments- chemical composition, uses and special attributes of important Indian spices, seasoning blends, extraction of spices, general processing of spices.

Recommended readings:

1. Emerton, V. & Choi, E. (2008). *Essential Guide to Food Additives* (3rd ed.): *RSCP, UK.*
2. *Ashurst, P. R. (1995). Food Flavorings* (2nd ed.): Chapman and Hall, Glasgow.
3. Crompton, T. R. (2007). *Additive Migration from Plastics into Foods: A Guide for Analytical Chemistry:* Smithers Rapra, Shawbury.
4. Brannel, A. L., Davidson, P. M. & Salminen, S. (1990). *Food Additives:* Marcel Dekker, New York.
5. Hirasa, K. & Takemasa, M. (1998). *Spice Science and Technology:* Marcel Dekker, New York.

Course Outcomes:

1. Student shall gain a thorough knowledge of Chemical Nature, Analysis, Risk & Benefits of Food Additives.
2. Student shall gain a thorough knowledge of Antimicrobial Agents, Antioxidants & Anti Browing Agents.
3. Student shall gain a thorough knowledge of Synthetic Food Additives (Coloring Agents, Flavoring Agents).

4. Student shall gain a thorough knowledge of Emulsifier, Stabilizer Chelating Agents, Acidulents & pH control agents.
5. Student shall gain a thorough knowledge of Nutritional Additives along with their properties.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	3	2	3	3
PO2	3	2	3	3	2
PO3	1	2	1	1	2
PO4	2	1	2	2	1
PO5	1	1	2	1	1
PO6	3	3	2	3	3
PO7	2	3	3	2	3
PO8	2	3	2	2	3
PO9	2	2	3	2	3

UC-MSFT-616- 19: NUTRITION AND HEALTH

Total Marks: 100	L	T	P
	4	0	0

Objective:

To understand the importance of various nutrients and effects of imbalance in human health.

UNIT-I

Foods and nutrients-basic definitions, functions of food and nutrients, levels of nutritional status, changing concepts of nutrition. Major world health problems- food supply and security, malnutrition, heart diseases, cancer, diabetes etc. Recommended dietary allowances (R.D.A.), ICMR standards, food guide, exchange lists, health promotion guidelines.

UNIT-II

Carbohydrates: classification, dietary importance, special functions of carbohydrates in body tissues, relationship between dietary fiber and various health problems. Fats- health needs of fat, health problems with fat, essential fatty acids, visible and hidden food fat, cholesterol, lipoproteins. Energy balance-food energy measure, energy control in human metabolism, basal metabolic rate (B.M.R.), factors affecting B.M.R., measuring B.M.R., energy requirements and its estimation.

UNIT-III

Proteins: nature and essentiality of amino-acids and proteins, functions of protein, concept of protein balance, factors influencing protein requirements, comparative quality of food proteins, biological value, net protein utilization, protein efficiency ratio, other methods of evaluation of protein quality. Vitamins-definition, general nature and classification, clinical applications, sources, requirements and functions of Vitamin A, D, E, K, C and B complex vitamins. Vitamin toxicity.
Minerals: minerals in human health, functions, clinical applications, food sources and requirements, trace elements and their importance in diet.

UNIT-IV

Psychologic influences on food habits-motivation, perception, food misinformation, food faddist claims, vulnerable groups. Drug food interactions-drug effects on food intake, drug effects on nutrient absorption, vitamin antagonists. Nutrition and weight management- obesity and its causes, body composition, B.M.I., weight for height measures, health implications of obesity, and problems of weight management.

Recommended readings:

1. ICMR. (2011). *Nutrient Requirement & RDA:* ICMR, New Delhi.
2. Elia, M., Ljungqvist, O. & Stratton, R., J. (2013). *Clinical Nutrition.*
3. Hegarty, V. (1992). *Nutrition Food and the Environment:* Eagen Press.
4. Brian, A. F. & Allen, G. (1995). *Food Science, Nutrition & Health:* Edward Arnold, member of Hodder Headline Group London, Sydney, Auckland.
5. Macrae, R., Robinson, R. K. & Sadler, M.J. (1993). Encyclopedia of Food science, Food technology and Nutrition.
6. Williams, S. R. (1990). *Essentials of Nutrition and Diet Therapy:* Times Mirror / Mosby College Publishing.

Course Outcomes:

After completing this course, you should be able to

1. Utilize knowledge from the physical and biological sciences as a basis for understanding the role of food and nutrients in health and disease processes.
2. Describe the digestion and metabolism of the energy nutrients (carbohydrates, lipids, protein) and non-energy nutrients (vitamins/minerals).
3. Distinguish sound nutritional information from unreliable nutritional information.
4. Describe a healthy diet and food choices, and explain why such choices will help prevent health problems.
5. Review Biochemistry of Energy Transfer particularly the lactic acid system and the aerobic systems.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	2	1	1	3
PO2	2	1	1	1	2
PO3	1	1	1	2	2
PO4	2	1	1	1	1
PO5	1	1	1	3	1
PO6	2	1	2	1	1
PO7	1	2	2	2	1
PO8	1	1	3	1	2
PO9	2	2	1	2	1

UC-MSFT-617- 19: LAB - IX (Food Additives)

Total Marks: 50

L	T	P
0	0	4

Objectives:

To acquaint students to the methods of determination of additives in food system.

List of experiments:

1. Determination of benzoic acid in the presence of saccharin in the Ready-to Serve beverages.
2. Estimation of nitrate and nitrite, aspartame, saccharine and caffeine.
3. Identification of natural colours.
4. Estimation of synthetic food colours, oil soluble colours, antioxidants.
5. Detection of brominated vegetable oils in soft drinks, magnesium carbonate in pan masala / gutka.
6. Food applications of emulsifiers, stabilizers, thickeners, favours and flavour enhancers.

Course Outcomes:

1. Ability to do Chemical Analysis of Additives in food items.
2. Ability to estimate Food Additives for extension of shelf life & safety.
3. Ability to hire good perception of quality of food by addition of additives.
4. Ability to identify suitable additives for various food items.
5. Ability to acquire commercial aspects of food additives related to food industry.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	3	2	3	3	1
PO2	3	3	2	3	1
PO3	2	3	3	2	2
PO4	1	2	1	3	3
PO5	2	1	2	1	1
PO6	3	3	1	3	3
PO7	3	3	1	2	2
PO8	2	2	2	1	2
PO9	2	1	2	2	3

UC-MSFT-618- 19: LAB - X (NUTRITION AND HEALTH)

Total Marks: 50

L	T	P
0	0	4

Objectives:

To train students in nutrient analysis and basics of meal planning.

List of experiments:

1. Proximate analysis of foods– Moisture, protein, ether extract, fiber, starch, soluble sugars, ash content.
2. Calorific value of foods using Bomb Calorimeter.
3. Protein analysis by Spectrophotometeric method.
4. Protein quality evaluation (Protein digestibility *in vitro*).
5. Starch digestibility (*in vitro*).
6. Amylase inhibitor activity.
7. Trypsin inhibitor activity.
8. Estimation of polyphenols/tannins, phytic acid, calcium, phosphorus, iron content.
9. Phytase activity determination in pulses.
10. Mineral analysis using Atomic Absorption Spectrophotometer.
11. Assessment of effect of processing method (e g. Frying / Microwave cooking / Germination on nutritive value of foods.
12. Nutritional assessment and dietary adequacy in terms of various nutrients.
13. Planning a diet using “Food Composition Tables” (ICMR).
14. Diet planning using “Food Exchange” method.
15. Standardization of nutritious snacks (Protein rich / Energy rich / Low calorie / Calcium rich / Iron rich / Vitamin rich), nutritious snacks for specific physiological needs (Infant weaning / Pre-schooler / School children/ Old people).

Course Outcomes:

At the completion of the program the student will:

1. Describe methods used to assess nutrition status.
2. Describe the methods used to carry out nutrition research.
3. Understand how nutrition science studies are designed, analyzed and interpreted.
4. Experience in functioning within a team.
5. Students will be able to demonstrate critical thinking skills to analyze data and interpret results in the nutritional sciences.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	1	1
PO2	1	2	1	1	1
PO3	1	3	2	2	1
PO4	1	1	1	3	1
PO5	2	2	3	1	3
PO6	1	1	2	1	2
PO7	2	2	2	1	1
PO8	2	3	1	1	3
PO9	3	1	1	3	1

SEMESTER

FOURTH

UC-MSFT-621- 19: SNACK FOOD TECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

To impart knowledge related to various snack foods and their manufacturing techniques.

UNIT-I

Extrusion: Introduction to extruders and their principles, types of extruders. Extruders in the food industry: History and uses. Single screw extruder: principle of working, factors affecting extrusion process, co-kneaders. Twin screw extruder: Feeding, screw design, screw speed, screw configurations. Pre-conditioning of raw materials used in extrusion process: operations and benefits and de-volatilization. Chemical and nutritional changes in food during extrusion. Addition and subtraction of materials, shaping and forming at the die. Post-extrusion processes- colouring, flavouring and packaging of extruded snack foods.

UNIT-II

Breakfast cereals: Introduction and classification (flaked cereals, oven puffed cereals, gun puffed cereals, shredded products). Breakfast cereal-manufacturing processes (traditional and modern methods), High shear cooking process and steam cookers. Texturized vegetable protein: definition, processing techniques. Direct expanded (DX) and third generation (3G) snacks: types. Concept of junk & fried foods and their impact on human health.

UNIT-III

Technology for grain-based snacks: Whole grains- roasted, toasted, puffed, popped, flaked. Coated grains- salted, spiced and sweetened. Formulation, processing and quality assessment of chips and wafers, papads, instant premixes of traditional Indian snack foods.

UNIT-IV

Technology for fruit and vegetable-based snacks- chips, wafers; Technology for coated nuts- salted, spiced and sweetened chikkies. Equipments for frying, baking, drying, toasting, roasting, flaking, popping, blending, coating and chipping.

Recommended Readings:

1. Booth, R. G. (1997). *Snack Food:* CBS, New Delhi.
2. Raymond, W. L. & Rooney, L. W. (2001). *Snack Foods Processing:* CRC. London.
3. Lusas, E. W. & Rooney, L. W. (2015). *Snack Foods Processing:* CRC. London.
4. Guy, R. (2001). *Extrusion Cooking: Technologies and Applications:* Woodhead, USA.
5. Riaz, M. N. (2000). *Extruders in Food Applications:* Technomic, Lanchester.

Course Outcomes:

1. Students shall be able to understand Basics of Preparing Extruded Snack Foods Items along with working of equipments related to extrusion of Food Products.
2. Students shall be able to understand preparation of Breakfast Snacks in particular cereal based Snacks Food Items.
3. Students shall be able to understand preparation of Grain based Snacks Food Item.
4. Students shall be able to understand preparation of Fruits & Vegetables based Snack Item along with introduction of related equipments.

5. Students shall be able to understand Basics Kitchen Recipe with scaling up to Commercial Level of all above.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	2	1
PO2	1	1	1	1	1
PO3	3	3	3	3	2
PO4	1	1	1	1	1
PO5	1	1	1	1	1
PO6	1	1	1	1	1
PO7	2	2	2	2	1
PO8	1	1	1	1	1
PO9	3	2	2	2	2

UC-MSFT-624-19: Dissertation

L	T	P
0	0	24

A student is required to undertake a Dissertation of 12 credits. The dissertation shall be evaluated at the end of the Semester IV as per notification no. IKGPTU/Reg/NF/157 dated 04/04/2019.

ELECTIVE-III

UC-MSFT-622- 19: FOOD BIOTECHNOLOGY

Total Marks: 100	L	T	P
	4	0	0

Objective:

Imparting knowledge about principles of genetic engineering, use of biotechnology in the production of modified foods, enzymes, vitamins and proteins.

UNIT-I

Introduction to food biotechnology, basic principles of gene cloning, food safety and biotechnology. Impact of Biotechnology on microbial testing of foods. Immunological methods, DNA based methods in food authentication, real time PCR (polymeric chain reaction) based methods.

UNIT-II

Transgenic plants- current status, methods, prospects, risks and regulation. Transgenic Animals- methods and applications, ethical issues.

UNIT-III

Natural control of micro-organisms– bacteriocins of lactic acid bacteria, applications of bacteriocins in food systems. Aflatoxins– production, control and reduction using molecular strategies. Protein engineering in food technology– methods, objectives, limitations and applications of protein engineering (glucoseisomerase, lactobacillus β-galactosidase and peptide antibiotic nisin).

UNIT-IV

Biotechnology and food ingredients – biogums, fats, oils, fatty acids and oilseed crops, fat substitutes, citric, fumaric and malic acids, bioflavours and biocolors. Biosensors- principle, types and applications in food processing.

Recommended readings:

1. Joshi, V. K. & Pandey, A. (1999). *Biotechnology- Food Fermentation Microbiology, Biochemistry and Technology:* EPD, New Delhi.
2. Gutierrez, G. F. & Barbosa-Canovas, G. V. (2003). *Food Science and Food Biotechnology:* CRC Press, Boca raton.
3. Chawla, H. S. (2000). *Introduction to Plant Biotechnology:* Oxford & IBH, New Delhi.
4. Chawla, H. S. (1998). *Biotechnology in Crop Improvement:* International, Lucknow.
5. Saha, B. C. (2003). *Fermentation Biotechnology:* ACS, Washington.

Course Outcomes:

At the completion of the program the student will:

1. Knowledge and understanding of definition and the different uses of food biotechnology. These include the tools used, production of recombinant proteins and additives to use in food technology, transgenic foods, diagnostic system used in food industry, and ethics and safety of food biotechnology.
2. After the course the students are expected to understand new development in the field with analytical thinking of the various aspects of the new technology.
3. Students are expected to ask questions and participate in discussions.
4. Appraise the applications and implications of genomics and genetic modification on foods.

5. Describe the beneficial effects of microorganisms on foods with regards to nutritional and functional properties.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	1	1	1	3
PO2	1	1	1	1	2
PO3	3	1	1	3	1
PO4	2	1	1	1	1
PO5	1	2	1	2	1
PO6	1	1	2	3	1
PO7	3	1	1	1	2
PO8	1	3	2	1	1
PO9	1	1	3	1	1

UC-MSFT–623- 19: TECHNOLOGY OF MEAT, FISH AND POULTRY

Total Marks: 100	L	T	P
	4	0	0

Objective:

This course shall educate students about the significance and necessity of organized animal products sector, humane slaughtering of animals and poultry and value addition of meat, poultry, egg and fish.

UNIT-I

Status and scope of meat industry. Traditional and scientific methods of slaughter of meat animals and birds, humane methods of slaughter. Structure, composition and nutritive value of meat. Conversion of muscle into meat. Factors affecting meat quality. Post-mortem changes in meat, thaw rigor, cold shortening, pre-rigor processing.

UNIT-II

Storage and preservation of meat, fish and poultry: chilling, freezing, curing, smoking, dehydration, freeze drying, irradiation, canning and glazing of fish. Eating quality of meat- color, flavor, tenderness, juiciness, water holding capacity, warmed over flavour in meats. Restructured meat products- sausages and comminuted meat products, ingredients used and their significance. Meat tenderization techniques. Ageing of meat.

UNIT-III

Quality of fresh fish. Processing of fish. Manufacturing of fish paste, fish sauces, fish oil, fish protein concentrate.
Structure, composition and nutritive value of eggs. Storage and preservation of shell eggs. Functional properties of eggs, factors affecting functional properties, mechanism and measurement.

UNIT-IV

Quality of eggs- internal and external quality evaluation, candling, albumen index, haugh unit, shape index, yolk index etc. Grading of eggs. Pasteurization, dehydration, freezing and desugerization of egg. Liquid egg products, egg powder, value added egg products (e.g., meringues, poached etc.). Packaging of egg and egg products.
Utilization of meat, fish and egg industry by-products: importance, food and non-food applications.

Recommended Readings:

1. Varnam, A. H. & Sutherland, J. P. (1995). *Meat and Meat Products: Technology, Chemistry and Microbiology:* Champan & Hill, London.

2. Lawrie, R. A. (1998). *Lawrie's Meat Science* (6th ed.): Woodhead, Cambridge.
3. Kerry, J., Kerry, J. & Ledward, D. (2002). *Meat Processing Improving Quality:* CRC Press, USA.
4. Hui, Y. H. (2010). *Handbook of Poultry Science and Technology*.
5. Fernandes, R. (2009). *Fish and Seafood*.

Course Outcomes:

1. Student shall know about the significance & necessity of organized animal product sector.
2. Students shall acquire the ability of value- addition to Meat, Poultry, Egg & Fish.

3. Student shall be well versed with processing, preservation & quality control of Meat, Egg & Fish in Food Industry.
4. Student shall be well versed with manufacturing practices of egg based, fish based and meat based by products & their processing techniques.
5. Student will be having broad knowledge of status & scope of Meat, Egg, & Poultry industry world wide.

Mapping of Course Outcomes with Program Outcomes:

CO / PO	CO1	CO2	CO3	CO4	CO5
PO1	1	3	3	1	1
PO2	1	1	3	1	1
PO3	3	3	2	2	2
PO4	3	3	1	3	3
PO5	1	1	1	3	1
PO6	1	1	3	2	1
PO7	2	2	1	1	2
PO8	1	1	1	1	1
PO9	2	2	2	3	3

Study Scheme & Syllabus of

Master of Science in Clinical Research

(M.Sc. Clinical Research)

Batch 2020 Onward

By

Board of Study Clinical Research

Main Campus

IK Gujral Punjab Technical University

IK Gujral Punjab Technical University

Vision

To be an institution of excellence in the domain of higher technical education that serves as the fountainhead for nurturing the future leaders of technology and techno-innovation responsible for the techno-economics, social, cultural and environmental prosperity of the people of the State of Punjab, the Nation and the World

Mission

To provide seamless education through the pioneering use of technology, in partnership with industry and society with a view to promote research, discovery and entrepreneurship and to prepare its students to be responsible citizens of the world and the leaders of technology and techno-innovation of the 21st Century by developing in them the desirable knowledge, skill and attitudes base for the world of work and by instilling in them a culture for seamlessness in all facets of life.

Department of Food Science and Technology

Vision

To create competent professionals those contribute towards the economic development of the nation by going in line with the policy of Government of India in the field of food processing, food safety, health and nutrition.

Mission

- Development of human resource in the field of food science and technology to serve the cause of nation
- Development of human resource in the area of clinical nutrition and research to contribute effectively in making India healthy
- Providing a strong theoretical and practical background across the food science discipline with an emphasis on developing sustainable resources to cater food and nutrition related challenges
- Create favourable environment for innovation to translate theoretical knowledge into practical applications
- Inculcating professional ethical values, innovative research capabilities and leadership abilities
- Holistic development of the youth through the process of self evaluation and continuous improvement

MSc. Clinical Research

Programme Educational Objectives

PEO1	To accomplish the demand for well qualified clinical researchers in academia and industry
PEO2	To pursue successful industrial, academic and research careers in specialized fields of clinical research and drug safety
PEO3	Solve problems through application of critical thinking and evidence-based processes
PEO4	To sensitize students about the importance of ethical practices in clinical research and practice
PEO5	Pursue self-learning to remain abreast with latest developments for continuous professional growth

Programme Outcomes

PO1	Ability to participate and contribute effectively as clinical research team member
PO2	Understand the roles and responsibilities of the different stakeholders in clinical research
PO3	Compare and summarize international regulations, clinical requirements and best practices for the clinical research process
PO4	Integrate knowledge from foundational sciences and pharmaceutical sciences for effective planning and implementation of study protocols
PO5	Apply knowledge of disease pathophysiology and current therapy in designing clinical trial protocols and analyzing data
PO6	Evaluate the suitability, accuracy, and reliability of clinical study data by analyzing experimental design, statistical tests, interpreting results, and formulating conclusions
PO7	Ability to review existing evidence in literature
PO8	Describe Good Clinical Practices in different aspects of the clinical studies
PO9	Communicate professionally both orally and in writing within the clinical research environment

Mapping of Program Outcomes with Program Educational Objectives

	PEO1	PEO2	PEO3	PEO4	PEO5
PO1	3	1	1	1	1
PO2	3	2	1	1	1
PO3	1	3	2	3	2
PO4	3	2	3	2	3
PO5	2	3	3	2	3
PO6	3	3	3	1	3
PO7	3	3	3	2	3
PO8	2	2	2	3	2
PO9	2	3	1	1	3

1: Slightly 2: Moderately 3: Substantially

Duration of course	Two Academic Years
Maximum duration for course completion & award of degree	4 Years
Eligibility	Graduation with minimum 50% marks in Life Sciences/Sciences/Medical Sciences/Pharmacy
Attendance Requirement	75%
Examination System	Semester
Marks Allocation	• Theory courses of 04 credits = 100 marks • Theory courses of 02 credits = 50marks • Practical courses of 02 credits = 50 marks
Minimum Credits for Award of Degree	• 90
Programme Structure	1. Compulsory Foundation Course 2. Core Courses 3. Elective Courses 3.1. Discipline Specific Elective Courses 3.2. Generic Elective Courses 4. Ability Enhancement Courses 5. Skill Enhancement Courses

Programme Structure

1. **Compulsory Foundation Course:** This course is a foundation course designed with the object to enhance the knowledge base of students.

2. **Core Courses:** These courses are compulsory courses studied by students as core requirement of the programme. These courses aim to impart students the basics of the MSc. Clinical Research programme.

3. **Discipline Specific Elective (DSE) Courses:** Discipline specific elective courses comprise a pool of courses offered under the main discipline/subject of study. Students will choose DSE courses from a pool of courses provided to them.

4. **Generic Elective (GE) Courses:** Generic elective comprise a pool of courses designed with a purpose to offer the students the opportunity to explore disciplines of interest beyond the choices they make in core and discipline specific elective courses. Students will choose GE courses from a pool of courses provided to them.

5. **Ability Enhancement Courses:** These courses are designed with the aim to improve the knowledge base and skills of the students to facilitate employability.

6. **Skill Enhancement Courses:** These courses are designed with the aim to improve the knowledge base and skills of the students to facilitate employability.

Dr. Rajneesh Sachdev
Head, DFST

Internal Assessment

- The internal assessment will have two components i.e. **Continuous Mode** and **Sessional Exams**

1. For Theory Courses having Internal of 30 Marks the scheme of internal award is:
    - Sessional Exams: 20 Marks
    - Continuous Mode: 10 Marks

Sessional Exams

- The number of sessional exams and criteria for computation i.e. average marks or best of sessional exams conducted shall be according to guidelines provided by Academic Council IKG-PTU from time to time.
- Sessional exam shall be **conducted for 30 marks** for theory and shall be **computed for 20marks**.

Continuous Mode Scheme

Criteria	Maximum Marks
*Attendance (as per table given below)	4
Academic activities (Average of any 3 activities e.g. quiz, assignment, open book test, field work, group discussion and seminar)	6
Total	**10**

2. For Theory Courses having Internal of 15 Marks the scheme of internal award is:
    - Sessional Exams: 10 Marks
    - Continuous Mode: 05 Marks

Sessional Exams

- The number of sessional exams and criteria for computation i.e. average marks or best of sessional exams conducted shall be according to guidelines provided by Academic Council IKG-PTU from time to time.
- Sessional exam shall be **conducted for 20 marks** for theory and shall be **computed for 10marks**.

Continuous Mode Scheme

Criteria	Maximum Marks
*Attendance (as per table given below)	2
Academic activities (Average of any 3 activities e.g. quiz, assignment, open book test, field work, group discussion and seminar)	3
Total	**5**

Evaluation Scheme of Laboratory Courses

Internal (30 Marks)	Continuous and Comprehensive Evaluation (class performance/practical record/viva etc.) = 26
	*Attendance (as per table given below) = 04
External (20 Marks)	Synopsis = 05
	Performance = 10
	Viva = 05
Total	**50 Marks**

*Guidelines for the Allotment of Marks for Attendance

Percentage of Attendance	Theory (Attendance Maximum Marks 04)	Theory (Attendance Maximum Marks 02)	Practical (Attendance Maximum Marks 04)
More Than 93	4	2	4
87 – 92	3	1.5	3
81– 86	2	1	2
75 – 80	1	0.5	1
Less than 75	0	0	0

Evaluation Scheme Journal Club

Paper Selection and Content Delivery	10
Power Point Presentation	05
Post Presentation Discussion	10
Total	25

Note: Student will present minimum two papers in each semester

Question Paper Pattern for Theory Sessional Examinations of 30 Marks

Objective Type Questions (5x2) (Answer all the questions)	5x2=10
Short Answers (Answer 2out of 3)	2x5 =10
Long Answers (Answer 1 out of 2)	1x10=10
Total	**30 Marks**

Question Paper Pattern for Theory Sessional Examinations of 20 Marks

Objective Type Questions(5x1) (Answer all the questions)	5x1= 05
Short Answers(Answer 1out of 2)	1x5 = 05
Long Answers(Answer1out of 2)	1x10=10
Total	**20 Marks**

Question Paper Pattern for Theory External Exam of 70 Marks

Objective Type Question (10 x 2) (Answer all the questions)	10 x 2 = 20
Short Answer (Answer 4 out of 5)	4 x 5 = 20
Long Answer (Answer 3 out of 4)	3 x 10 = 30
Total	**70 Marks**

Question Paper Pattern for Theory External Exam of 35 Marks

Objective Type Question (5 x 1) (Answer all the questions)	5 x 1 = 05
Short Answer (Answer 2 out of 3)	2 x 5 = 10
Long Answer (Answer 2 out of 3)	2 x 10 = 20
Total	**35 Marks**

First Semester

Course Code	Course Type	Course Name	Load			Marks			Credits
			L	T	P	Internal	External	Total	
UC-MSCR101-19	Foundation Course	Foundation Course	3	1	-	30	70	100	4
UC-MSCR102-19	Core Theory	Fundamentals of Clinical Research	3	1	-	30	70	100	4
UC-MSCR103-19	Core Theory	General Pharmacology	3	1	-	30	70	100	4
UC-MSCR 104-19	Core Practical	Clinical Research Lab I	-	-	4	30	20	50	2
UC-MSCR 105-19	Ability Enhancement	Professional Communication	2	-	-	15	35	50	2
UC-MSCR 106-19	Skill Enhancement	Journal Club	-	-	4	50	-	50	2
UC-MSCR XXX	Discipline Specific Elective Theory	Elective –I	2	-	-	15	35	50	2
UC-MSCRYYY	Generic Elective Theory	Elective –II	2	-	-	15	35	50	2
		Total	**15**	**3**	**8**	**215**	**335**	**550**	**22**

Discipline Specific Elective Theory (Elective-I)

Subject Code	Subject Name
UC-MSCR 111-19	Intellectual Property Rights
UC-MSCR 112-19	Different Systems of Medicine

Generic Elective Theory (Elective-II)

Subject Code	Subject Name
UC-MSCR 113-19	Clinical Pharmacokinetics
UC-MSCR 114-19	Alternatives in Toxicity Testing
UC-MSCR 115-19	Fundamentals of Physiology

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Head, DFST

Second Semester

Course Code	Course Type	Course Name	Load			Marks			Credits
			L	T	P	Internal	External	Total	
UC-MSCR201-19	Core Theory	Pharmacotherapeutics - I	3	1	-	30	70	100	4
UC-MSCR202-20	Core Theory	Clinical Research Regulations & Ethics	3	1	-	30	70	100	4
UC-MSCR203-19	Core Practical	Clinical Research Lab II	-	-	4	30	20	50	2
UC-MSCR 204-19	Ability Enhancement	Professional Communication Lab	-	-	4	30	20	50	2
UC-MSCR 205-20	Skill Enhancement	Medical Writing	2	-	-	15	35	50	2
UC-MSCR 206-19	Skill Enhancement	Journal Club	-	-	4	50	-	50	2
UC-MSCR XXX	Discipline Specific Elective Theory	Elective –III	2	-	-	15	35	50	2
UC-MSCRYYY	Generic Elective Theory	Elective –IV	2	-	-	15	35	50	2
		Total	**12**	**2**	**12**	**215**	**285**	**500**	**20**

Discipline Specific Elective Theory (Elective-III)

Subject Code	Subject Name
UC-MSCR 211-19	Fundamentals of Epidemiology
UC-MSCR 212-19	International Regulatory Affairs

Generic Elective Theory (Elective-IV)

Subject Code	Subject Name
UC-MSCR 213-19	Biostatistics in Clinical Research
UC-MSCR 214-19	Poisoning and Management

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Head, DFST

Third Semester

Course Code	Course Type	Course Name	Load			Marks			Credits
			L	T	P	Internal	External	Total	
UC-MSCR301-19	Core Theory	Pharmacotherapeutics -II	3	1	-	30	70	100	4
UC-MSCR302-20	Core Theory	Clinical Study Design	3	1	-	30	70	100	4
UC-MSCR303-19	Core Theory	Research Methodology	2	-	-	15	35	50	2
UC-MSCR304-19	Core Theory	Pharmacovigilance	2	-	-	15	35	50	2
UC-MSCR 305-19	Core Practical	Clinical Research Lab III	-	-	4	30	20	50	2
UC-MSCR 306-19	Skill Enhancement	ICT Skills Lab	-	-	4	30	20	50	2
UC-MSCR 307-19	Skill Enhancement	Journal Club	-	-	4	50	-	50	2
UC-MSCR 308-19	Research Work	Synopsis	-	-	4	50	-	50	2
UC-MSCR XXX	Discipline Specific Elective Theory	Elective –V	2	-	-	15	35	50	2
UC-MSCRYYY	Generic Elective Theory	Elective –VI	2	-	-	15	35	50	2
		Total	**14**	**2**	**16**	**280**	**320**	**600**	**24**

Discipline Specific Elective Theory (Elective-V)

Subject Code	Subject Name
UC-MSCR 311-20	Clinical Trial Operations
UC-MSCR 312-19	Medical Coding

Generic Elective Theory (Elective-VI)

Subject Code	Subject Name
UC-MSCR 313-19	Pharmacoeconomics & Health Technology Assessment
UC-MSCR 314-20	Quality Management in Clinical Trials

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Fourth Semester

Course Code	Course Type	Course Name	Load			Marks			Credits
			L	T	P	Internal	External	Total	
UC-MSCR401-19	Seminar	Seminar	-	-	4	50	-	50	2
UC-MSCR402-19	Research Work	Dissertation	-	-	36	200	100	300	18
--	Co-curricular Activities	--	--	--	--	*Satisfactory/Unsatisfactory			--
		Total	**-**	**-**	**40**	**250**	**100**	**350**	**20**

Semester Wise Credits Distribution

Semester	Credits
I	22
II	20
III	24
IV	20
Co-curricular Activities (Attending Conference, Scientific Presentations and Other Activities)	04
Total Credit Points	**86 + 4* = 90**

- *Credits for Co-curricular Activities
- *Credits not included towards calculation of CGPA
- The award of credits for co-curricular activities will have only internal component
- The student will earn the credits for co-curricular activities anytime during the duration of MSc.
- Head of Department will award the credits based upon the submission of relevant documents pertaining to criteria as below by student.

Dr. Rajneesh Sachdev
Head, DFST

Guidelines for Awarding Credits for Co-curricular Activities

Name of the Activity	Credit Points
Successful completion of MOOCs Courses (4 weeks)	04
Successful completion of MOOCs Courses (2 weeks)	02
Hospital Training (minimum 4weeks)	02
Participation in Seminar/ Conference/ Symposium (related to the specialization of the student)	01
Participation in Workshop/ Training Programs of duration one week (05 days) or more (related to the specialization of the student)	02
Presentation in Seminar/ Conference/ Symposium / (related to the specialization of the student)	02
Presentation in Seminar/ Conference/ Symposium / (related to the specialization of the student) and with award	03
Research / Review Publication in indexed in Scopus / Web of Science*	03
Research / Review Publication in peer reviewed journals*	02
Minimum ten days residential camp organized by NSS/ Youth Affairs	02
Inter University participation in cultural or sports activity	02
Inter University award in cultural or sports activity	03
Inter College participation in cultural or sports activity	01
Inter College award in cultural or sports activity	02

**Only those research / review publications will be considered which have been published during the tenure of M. SC. Course.*

FIRST SEMESTER

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 101-19	Foundation Course	3	1	-	30	70	1.5	3	4

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is based upon the content that leads to knowledge enhancement. This course is mandatory for bringing the student of different background on a common platform.

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

CO1	Understand the basics of chemistry and analytical techniques
CO2	Develop an understanding in the basics of biochemistry and cell biology of the human body
CO3	Understand the significance of the environment related issues in the new drug discovery and development
CO4	Develop an understanding of contribution of genetic factors involved in the holistic treatment of the diseases
CO5	Apply the knowledge of biotechnology in the field of drug discovery and clinical trials

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	3	1	2	1	2	1
CO2	2	1	2	3	3	1	2	1	1
CO3	1	2	3	2	1	1	1	3	1
CO4	3	1	2	3	3	2	2	1	1
CO5	2	1	1	3	2	2	1	1	1

Module-I **08 Hrs**

Chemistry

Solution — Methods of expressing the concentration (molality, molarty, normality, formality etc)

Laws of mass action, reaction quotient, chemical equilibrium constant, relation of Kp & Kc, pH, buffer, buffer index, buffer capacity, arrhenius equation

Principles, classification and applications of chromatographic techniques

Basics of Spectroscopy and applications

Module-II **15 Hrs**

Biochemistry and Cell Biology

Biomolecules - carbohydrates, amino acids/proteins, lipids and nucleotides; enzymes: characteristics and nomenclature

Introductory cell biology & microbiology: prokaryotes & eukaryotes; the cell and its composition; cell organelles and subcellular fractionation; viruses, viroid's, virusoids and prions: bacterial culture and growth curve

Immunology – natural and acquired immunity; humoral and cellular immunity; vaccines and immunization; Clonal selection theory; Cells of immune system; immunoglobulins, haptens, antigens and immunogens; monoclonal & polyclonal antibodies

Clinical biochemistry: common biochemical tests; acid base disorders; liver function tests; kidney function tests

Module-III **08 Hrs**

Environmental Sciences

Biodiversity — concept, levels and conservation of biodiversity

Climate change and its consequences

Ecosystem - producers, consumers and decomposers of food chain

Environmental pollution, bioremediation

Module-IV **14 Hrs**

Genetics and Biotechnology

Genetics of inheritance - laws of inheritance, recombination and segregation of traits, segregation ratio, interaction between traits and quantitative inheritance

Molecular Biology - the genetic material, RNA as genetic material, fidelity of DNA replication, transcription, translation and transduction, mutation and mutagenesis, ames test

Genetic Engineering - essentials of gene manipulation, vectors & enzymes used in recombinant technology

Biotechnology: stem cell, its application and ethical aspects

Suggested Readings/Recommended Books (Latest Editions)

1. AI Vogel, Text Book of Quantitative Inorganic analysis, Pearson.
2. Wilson and Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University.
3. Bentley and Driver's Textbook of Pharmaceutical Chemistry, Oxford University Press.
4. Anand and Chatwal, Inorganic Pharmaceutical Chemistry, Himalaya.
5. DRFerrier, Lippincott's Illustrated Reviews: Biochemistry, Wolters Kluwer India Pvt. Ltd.
6. Principles of Biochemistry by Lehninger, W H Freeman & Co.
7. Harper's Biochemistry by Robert K. Murry, Daryl K. Granner and Victor W. Rodwell, Lange.
8. Biochemistry by Stryer, WH Freeman.
9. Bharucha Erach, The Biodiversity of India, Mapin Publishing Pvt. Ltd., Ahmedabad – 380 013, India.
10. Agarwal, K.C. Environmental Biology, Nidhi Publ. Ltd. Bikaner.

11. Cunningham, W.P. Cooper, T.H. Gorhani, E and Hepworth, M.T., Environmental Encyclopedia, Jaico Publishing House, Mumbai.
12. Instrumental Methods of Chemical Analysis by B.K. Sharma, Krishna Prakashan Media (P) Ltd.
13. Quantitative Analysis of Drugs by D.C. Garrett, Springer.
14. Lodish, Molecular Cell Biology. New York :WH Freeman.
15. TA Brown, Gene Cloning and DNA Analysis: An Introduction, Wiley Blackwell.
16. GM Cooper, The Cell: A Molecular Approach, ASM Press.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 102-19	Fundamentals of Clinical Research	3	1	-	30	70	1.5	3	4

Pre-requisite: None

Co- requisite: General Pharmacology (UC-MSCR103-19)

Course Objectives: The objective of the course is to create understanding of basic concepts of clinical research, clinical terminology and clinical trial definition. Further to give overview of the documentations in clinical research.

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

CO1	Understand the strategies and techniques involved in drug discovery process
CO2	Appreciate the impact of pharmaceutics science in new drug development and clinical use of drugs
CO3	Understand the preclinical phase of drug development
CO4	Understand different phases of clinical trials
CO5	Understand the importance of use of placebo controls and placebo response in clinical trials

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	3	3	2	2	3	2	1	1
CO2	1	2	1	3	1	2	3	1	1
CO3	1	1	1	3	2	2	3	1	1
CO4	2	3	3	3	3	2	1	3	1
CO5	2	3	3	2	3	2	2	2	1

Module-I **14 Hrs**

Drug Discovery Process

Approaches to drug development
Combinatorial chemistry
Lead optimization, target-centred drug design
The drug development process high throughput screening (HTS)

Module-II **09 Hrs**

Formulation Development

Introduction to different formulations, advantages and disadvantages of common formulations
Introduction to manufacturing of drugs and Good Manufacturing Practices (GMP)
Quality assurance and quality control during manufacturing a drug
Biopharmaceutical classification on drugs

Module-III **12 Hrs**

Pre-Clinical Testing

Acute, sub-acute and chronic toxicity
Mutagenicity, teratogenecity and carcinogenicity
Effect on reproductive system
Bioassays

Module-IV **10 Hrs**

Drug Evaluation and Clinical Development

Phases of developmental clinical trials: Phase 0, Phase-I, Phase-II, Phase-III, Phase-IV
Placebo response, nocebo, advantages and disadvantages of placebo

Suggested Readings/Recommended Books (Latest Edition)

1. BE Blass, Basic Principles of Drug Discovery and Development, Academic Press, Elsevier.
2. D Wang and A Bakhai, Clinical Trials A Practical Guide to Design, Analysis, and Reporting, Remedica.
3. LD Edwards, AJ Fletcher, AW Fox, Principles and practice of Pharmaceutical Medicine, Wiley-Blackwell.
4. AA Rubin, M Dekker, New Drugs: Discovery and development, Wiley-Interscience.
5. SK Gupta, Basic Principles of Clinical Research and Methodology, Jaypee Brothers, Medical Publishers Pvt. Ltd.
6. SK Gupta, Drug Discovery and Clinical Research, Jaypee Brothers, Medical Publishers Pvt. Ltd.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 103-19	General Pharmacology	3	1	-	30	70	1.5	3	4

Pre-requisite: None

Co- requisite: None

Course Objectives: To develop essential understanding of molecular basis of drug action and relationship between drug dose and pharmacological action. The students will also learn about, adverse drug reactions and therapeutic monitoring of drugs.

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

CO1	Understand the basic concepts and signal transduction mechanisms of drugs
CO2	Comprehend the relationship between dose and pharmacological action in terms of therapeutic effect and toxic effect of drugs
CO3	Understand the basic pharmacokinetic parameters and their significance in drug development process
CO4	Understand the basic concepts of neurohumoral transmission and neurotransmitters involved in drug action
CO5	Understand the different types of adverse drug reactions and significance and methods of therapeutic drug monitoring

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	2	1	3	1	1	3	1	1
CO2	1	3	2	3	2	2	2	1	1
CO3	1	1	1	2	3	1	1	1	1
CO4	1	1	1	2	3	1	1	1	1
CO5	1	1	3	2	3	2	3	3	2

Module-I **09 Hrs**

Basic Pharmacokinetics
Drug passage across cell membranes

Order of reaction or process
Time course of drug concentration and effect
Absorption, distribution, metabolism and elimination of drugs
Bioavailability, presystemic elimination
Routes of drug administration

Module-II **14 Hrs**

Basic Pharmacodynamics

Mechanism of drug action: full agonist, partial agonist, inverse agonist, competitive antagonist, non-competitive antagonist
Dose response relationship, potency, efficacy, ED_{50}, LD_{50}, EC_{50}, LC_{50}, therapeutic index
Receptors, transduction process, second messengers
Tachyphylaxis
Chemical interactions (additive effect, potentiation, synergism)

Module-III **06 Hrs**

Special Topics

Adverse drug reactions (ADRs)
Drug interactions
Therapeutic Drug Monitoring

Module-IV **16 Hrs**

Autonomic Nervous System

General concepts- neurohumoral transmission, neurotransmitters
Cholinergic pharmacology
Adrenergic pharmacology

Suggested Readings/Recommended Books (Latest Edition)

1. BG Katzung AJ Trevor, Basic and Clinical Pharmacology, Mc Graw-Hill.
2. HP Rang, MM Dale, JM Ritter, RJ Flower, G Henderson, Rang & Dale's Pharmacology, Elsevier.
3. PN Bennett, MJ Brown and P Sharma, Clinical Pharmacology, Churchill Livingstone Elsevier.
4. KD Tripathi, Essentials of Medical Pharmacology, Jay Pee Medical.
5. PM Conn, Animal Models for the Study of Human Disease, Academic Press Elsevier.
6. FJ Hock, Drug Discovery and Evaluation: Pharmacological Assays, Springer.
7. MJ Derelanko and MA Hollinger, Handbook of Toxicology, Taylor & Francis.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 104-19	Clinical Research Lab I	-	-	4	30	20	3	3	2

Pre-requisite: None

Co- requisite: Fundamentals of Clinical Research (UC-MSCR102-19) & General Pharmacology (UC-MSCR103-19)

Course Objectives: To give students hands on training for preparing standard operating procedures and clinical trial protocols. To acquaint students with different routes of drug exposure and pre-clinical non-invasive techniques in drug testing.

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

CO1	Prepare standard drug solutions of various concentrations
CO2	Perform common biochemical test of clinical significance
CO3	Prepare clinical trial protocol
CO4	Perform validation and prepare standard operating procedures of laboratory equipments
CO5	Understand the different routes of drug administration and pre-clinical non-invasive techniques for drug testing

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	2	1	1	3	3	1
CO2	1	3	2	2	2	1	3	3	1
CO3	3	3	3	3	3	3	3	3	3
CO4	1	2	3	1	1	3	3	3	2
CO5	1	2	1	3	3	1	3	3	1

1. To prepare molar, molal and normal solutions
2. To prepare buffer solutions and determination of their pH
3. Validation of machines and analytical instruments
4. Extraction of DNA
5. Biochemical test: renal function test

6. Biochemical test: lipid profile
7. Preparation of manuals as per GLP for biochemical tests
8. Demonstration of routes of exposure/administration of drugs
9. Demonstration of some non – invasive techniques in preclinical screening of drug
10. Bioethics- do's and don'ts, confidentiality, cultural/social ethics
11. Preparation of SOPs for various equipments

Suggested Readings/Recommended Books (Latest Edition)

1. A.I. Vogel, Text Book of Quantitative Inorganic analysis, Pearson.
2. Shruti Mohanty and Aparna Verma, Practical Clinical Biochemistry, Jaypee Brothers Medical Publishers (P) Lt d.
3. Vijay Kumar and Kiran Dip Gill, Basic Concepts in Clinical Biochemistry: A Practical Guide, Springer
4. Kathleen Deska Pagana and Timothy J. Pagana, MOSBY'S Manual of Diagnostic and Laboratory Tests, Elsevier
5. D Wang and A Bakhai, Clinical Trials A Practical Guide to Design, Analysis, and Reporting, Remedica.
6. D Rosenbaum and M Dresser, Clinical Research Coordinator Handbook, CRC Press.
7. EDeRenzo, Writing Clinical Research Protocols: Ethical Considerations, Academic Press Elsevier.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 105-19	Professional Communication	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The objective of the course is to help the students become the independent users of English language.

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

CO1	Acquire basic proficiency in reading, comprehension and writing
CO2	Understand spoken and written English language, particularly the language of their chosen technical field
CO3	Produce on their own clear and coherent texts
CO4	Learn about the standard organization of the essay
CO5	Develop the skills to master in the writing formal e-mails and letters

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	1	2	1	2	3	1	3
CO2	3	3	1	2	1	3	3	1	3
CO3	2	1	3	1	2	2	1	1	3
CO4	1	1	2	1	1	2	2	1	3
CO5	3	1	3	1	1	1	1	1	3

Module-I **12 Hrs**

Reading

Long texts where the subject matter ranges from the descriptive and factual to the discursive and analytical (the texts taken should be from books, journals, magazines and newspapers). Reading extracts from books, magazines, newspapers, notices, advertisements, company handbooks and guidelines encounter on a daily basis in an English-speaking environment.

Module-II **14 Hrs**

Writing

Topics of general interest and suitable for candidates planning to work in Clinical Research Organisations

Describe, summarise or explain the information in own words based on a graph, table, chart or diagram. The writing would be based on the description and explanation of the given data, describe the stages of a process, flowchart of how something works or describe an object or event in a formal and academic style.

Essay writing in response to a point of view, argument or problem in a formal and academic style. Arguments should be supported by relevant examples.

Letter writing: requesting information or explaining a given situation.

Suggested Readings/Recommended Books (Latest Edition)

1. Practical English Usage. Michael Swan. OUP
2. Remedial English Grammar. F.T. Wood. Macmillan
3. On Writing Well. William Zinsser. Harper Resource Book
4. Study Writing. Liz Hamp-Lyons and Ben Heasly. Cambridge University Press
5. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press
6. Exercises in Spoken English. Parts. I-III. CIEFL, Hyderabad. Oxford University Press
7. DL Plung and Tracy, Professional Communication: The Corporate Insider's Approach to Business Communication, South-Western College Pub
8. M Agarwal, Professional Communication, Krishna Prakashan Media (P) Ltd
9. NR Blyler, Professional Communication: The Social Perspective, SAGE Publications

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 111-19	Intellectual Property Rights	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to sensitize students towards the significance of intellectual property laws in drug development process

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

CO1	Understand of the core doctrines of intellectual property law
CO2	Understand the appropriate procedures for obtaining intellectual property protection
CO3	Describe the international treaties, conventions on IPR
CO4	Appreciate importance of compulsory licensing
CO5	Understand the patent infringement related issues

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	3	3	1	1	3	2	1
CO2	3	1	3	2	1	1	3	1	2
CO3	3	2	3	1	2	1	3	1	2
CO4	2	1	1	2	1	1	3	1	2
CO5	2	1	2	1	1	1	3	1	2

Module-I **12 Hrs**

General concepts Intellectual Property Rights & International Institutions

Intellectual Property overview and its theory
Requirement for Protecting Intellectual Property- a national and international comparison
Types of Intellectual Property- Origin and Development
World Intellectual Property Organization (WIPO)
Role of WIPO and its association with World Trade Organization (WTO)

Commercialization of Intellectual Property Rights by Licensing
Financial values of IPR

Module-II **12 Hrs**

Patent Laws Introduction to Copyrights and Trademarks

Indian Patent Law
The Patents Act, 1970 and its amendments
Criteria for Patentability
Filing Patent Applications and its Granting procedure
Patent Infringement
International Laws
Paris Convention and Patent Cooperation Treaty
WTO - TRIPS agreement
Indian copyright law, types of copyright
Types of trademarks, Indian trademark law

Suggested Readings/Recommended Books (Latest Edition)

1. IP Act & Rules from ipindia.nic.in
2. CDSO publications and updates of drug and Cosmetics act and rules (Govt. of India)
3. Kanfer , L. Shargel, Generic Product Development BE issued Publisher; Informa Healthcare
4. WTO; www.wto.org

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 112-19	Different Systems of Medicine	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To sensitize students regarding the importance of different systems of medicine that has played a crucial factor in meeting the global health care needs.

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

CO1	Understand the basic aspects about historical background, conceptual basis, different disciplines studied in the AYUSH.
CO2	Understand principles of prevention and treatment of diseases in alternative systems of medicine
CO3	Understand recent developments in the validation of different systems of medicine
CO4	Understand the use of medicinal plants and the utilization of different herbs in treatment of various ailments
CO5	Learn about drug manufacturing aspects and impact of globalization on Ayurveda

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	2	3	3	1	1	2	1
CO2	1	1	2	3	3	2	2	1	1
CO3	1	1	2	2	2	3	3	3	1
CO4	1	1	1	2	2	3	3	3	1
CO5	1	1	3	3	2	1	2	2	1

Module-I **12 Hrs**

Historical background of the different systems of medicines and different traditional practices

Principles of prevention and treatment of diseases in alternative systems of medicine

Uses of medicinal plants and the utilization of different herbs

Module-II **12 Hrs**

Medicinal plants and their different system of medicine
Recent developments in the validation of different systems of medicine
Regulations governing herbal drug development

Suggested Readings/Recommended Books (Latest Edition)

1. Marc Micozzi, Fundamentals of Complementary and Alternative Medicine, Elsevier
2. Arya Vaidya Sala, Medicinal Plants: A Compendium of 500 Species, Orient Blackswan Pvt Ltd. New Delhi
3. Mayo Clinic Book of Alternative Medicine & Home Remedies
4. www.fda.gov
5. www.ema.europa.eu
6. Ministry of AYUSH: Central Council for Research in Ayurvedic Sciences

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 113-19	Clinical Pharmacokinetics	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To sensitize students regarding significance of pharmacokinetic principles in new drug development.

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

CO1	Apply pharmacokinetic information in clinical drug development
CO2	Contribute at planning, design and analysis of clinical studies, from pharmacokinetics perspective
CO3	Describe various types of variables that are used to measure and model drug effects
CO4	To use relevant clinical pharmacokinetic data to demonstrate the ability to determine doses of drugs in special patient populations
CO5	Understand significance of pharmacogenomics in clinical pharmacokinetics

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	3	3	1	2	1	1
CO2	3	1	1	3	3	1	1	2	1
CO3	3	1	1	1	1	1	1	1	1
CO4	3	1	1	2	3	1	2	1	1
CO5	2	1	1	3	2	1	1	1	1

Module-I **13 Hrs**

Basic Concepts

Clinical pharmacokinetic and pharmacodynamic concepts
Clinical pharmacokinetic equations and calculations
Pharmacogenomics in pharmacokinetics
Rational use of drug concentration measurements

Module-II **13 Hrs**

Drug Dosing in Special Populations

Renal and Hepatic Disease
Dialysis
Heart Failure
Obesity
Paediatric Patients
Therapeutic drug monitoring in geriatric patient

Suggested Readings/Recommended Books (Latest Edition)

1. Larry A. Bauer, Applied Clinical Pharmacokinetics, McGraw-Hill Companies, Inc.
2. John E. Murphy, Clinical Pharmacokinetics, American Society of Health-System Pharmacists.
3. Robin L. Southwood, Virginia H. Fleming, Gary Huckaby, Concepts in Clinical Pharmacokinetics, American Society of Health-System Pharmacists.
4. PN Bennett, MJ Brown and P Sharma, Clinical Pharmacology, Churchill Livingstone Elsevier.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 114-19	Alternatives in Toxicity Testing	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To provide the clear understanding of various regulations involving animal use and the various models of toxicity testing

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

CO1	Relate the toxicological findings in clinical safety
CO2	Support in selecting species
CO3	Sensitize students in selecting treatment regimen and designing subsequent non clinical toxicity studies
CO4	Animal ethics and regulatory requirements, CPCSEA guidelines
CO5	Concept of 4Rs (reduce, refine, replacement and rehabilitation)

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	2	2	2	1	1	1	1
CO2	1	1	2	2	2	2	1	1	1
CO3	1	1	2	2	2	2	1	1	1
CO4	1	2	2	1	1	1	1	2	1
CO5	1	1	1	1	1	1	1	1	1

Module-I **12 Hrs**

Animal ethics and regulatory requirements, CPCSEA guidelines
Concept of 4Rs (reduce, refine, replacement and rehabilitation)
Alternative models in toxicity testing (non-mammalian and non-animal models)

Module-II **12 Hrs**

ARRIVE guidelines: reporting of animal trials
QT interval screening in drug development

Examples of successful replacement: Draize test
Examples of successful replacement: Zebra fish
Examples of successful replacement: Drosophilae
Examples of successful replacement: *C. elegans*

Suggested Readings/Recommended Books (Latest Edition)

1. Frank A Barile, Principles of Toxicology Testing, CRC Press
2. Pal Grave, Animals and Alternatives in Toxicity Testing: Present Status and Future Prospects, Palgrave Macmillan

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 115-19	Fundamentals of Physiology	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To make students understand the basic physiology of human body. To improve the foundation of students for better understanding and comprehension of subject matters related to drug discovery, pre-clinical and clinical testing of drugs.

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

CO1	Understand the anatomy and physiology of the systems of the human body
CO2	Appreciate the changes in normal physiology occurring in diseased states
CO3	Better understand the pharmacological principles involved in clinical testing of drug
CO4	Apply the understanding of functions of different parts of gastrointestinal tract in drug absorption and development of new drugs
CO5	Apply the knowledge of physiology of different organs in toxicity testing of drugs

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	1	3	3	1	2	1	1
CO2	1	1	2	3	2	2	2	2	1
CO3	1	1	2	3	3	3	2	3	3
CO4	1	1	2	3	2	2	2	1	1
CO5	1	1	2	3	2	3	2	2	1

Module-I

Smooth Muscles **02 Hrs**

Morphology, electrical and mechanical activity, molecular basis of contraction, relation of length to tension and plasticity.

Gastrointestinal System **05 Hrs**

Gross anatomy of the gastro-intestinal tract, functions of its different parts including those of liver, pancreas and gall bladder, various gastrointestinal secretions and their role in the absorption and digestion of food

Haemopoietic System **03 Hrs**

Composition and functions of blood and its elements, their disorders, blood groups and their significance, mechanism of coagulation, disorders of platelets and coagulation.

Module-II

Cardiovascular System **05 Hrs**

Morphology, electrical properties of cardiac muscle, pacemaker tissue, basic anatomy of the heart, physiology of heart, blood vessels and circulation, cardiac cycle, heart sounds, cardiac cycle, blood pressure and its regulation

Central Nervous System **05 Hrs**

Basic anatomy and physiology of brain, spinal cord

Endocrine System **06 Hrs**

Basic anatomy and physiology of pituitary, thyroid, parathyroid, adrenals, pancreas, testes and ovary, their hormones and functions

Suggested Readings/Recommended Books (Latest Edition)

1. A Waugh and A Grant, Ross and Wilson Anatomy and Physiology in Health and Illnes, Churchill Livingstone Elsevier
2. K E Barrett, SM Barman, S Boitano, H Brooks, Ganong's Review of Medical Physiology, Lange
3. AC Guyton, JE. Hall, Guyton and Hall Textbook of Physiology, Saunders-Elsevier

Course Code	Course Title	Teaching Load			Marks		Exam	Credits
		L	T	P	Int.	Ext.	Internal	
UC-MSCR 106-19 UC-MSCR 206-19 UC-MSCR 307-19	Journal Club	-	-	4	50	-	Continuous Mode	2

Pre-requisite: None

Co- requisite: Professional Communication (UC-MSCR 105-19), Professional Communication Lab (UC-MSCR 204-19), ICT Skills Lab (UC-MSCR 305-19)

Course Objectives: The course is designed to instil an analytical temperament in the students for critical review of the existing literature and better understanding of clinical research.

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

CO1	Critically review the literature
CO2	Develop an approach to analyse the various types of articles
CO3	Become familiar with sources of bias and types of study designs
CO4	Comprehend how results of study are clinically significant
CO5	Demonstrate skill in scientific communication both orally and in writing

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	3	2	2	3	2	1
CO2	2	1	3	3	3	3	3	2	1
CO3	2	1	1	2	2	3	3	2	1
CO4	2	1	2	2	3	3	3	2	1
CO5	1	1	1	1	1	1	1	1	3

Instructions

1. Students are to work with assigned mentor to chose and analyze an appropriate article followed by a power point presentation.
2. Power-point presentations should be organized as follows: 10 minutes background, 10 minutes article 15 minutes analysis 5 minutes discussion
3. Students are encouraged to critically appraise the literature, and develop their own independent criticisms

SECOND SEMESTER

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 201-19	Pharmacotherapeutics-1	3	1	-	30	70	1.5	3	4

Pre-requisite: General Pharmacology (UC-MSCR 103-19)

Co- requisite: None

Course Objectives: The course is designed to introduce to the learners about the common diseases and effect of target drugs on human body system. The aim would be to introduce the pharmacological basis of treatment.

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

CO1	Develop an understanding of the basic concepts of common diseases prevalent in the society
CO2	Apply their knowledge and understanding of the pathophysiology and management (pharmacological and non-pharmacological) of diseases
CO3	Choose and justify appropriate drug and treatment duration to a given patient with regard to current recommendations and patient-related factors such as other diseases, age, organ functions and other drug treatment
CO4	Integrate pharmacology, pathophysiology, pharmacodynamic, pharmacokinetics and other biomedical and pharmaceutical sciences as they pertain to clinical therapeutics of certain disorders
CO5	Identify the need for further knowledge and formulate relevant learning outcomes

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	3	3	2	3	3	2	1	1
CO2	1	2	1	3	1	2	3	1	1
CO3	1	1	3	1	1	1	3	1	1
CO4	2	3	3	3	3	2	1	3	1
CO5	2	3	3	2	3	2	2	2	3

Module-I **12 Hrs**

Basic Concepts

Quality of Life and Pharmacotherapy

Measuring Quality of Life
Pharmacogenetics
Paediatrics- ADME, factors affecting paediatric drug therapy, issues in paediatric drug therapy
Geriatrics- Epidemiology of Aging, Human Aging and Changes in Drug Pharmacokinetics and Pharmacodynamics, Altered Pharmacokinetics, Clinical Geriatrics, Provision of Comprehensive Geriatric Assessment
Pharmacoepidemiology- limits of knowledge at the time of new drug approval, role of the FDA and pharmacoepidemiology
Clinical Toxicology

Module-II **12 Hrs**

Neurologic and Psychiatric Disorders

Etiology, Pathophysiology and Pharmacotherapy of Neurologic Illness – Depression; Epilepsy; Mania; Pain; Schizophrenia; Alzheimer's disease; and Parkinson's disease

Module-III **12 Hrs**

Gastrointestinal Disorders

Etiology, Pathophysiology and Pharmacotherapy of Gastrointestinal illness- Gastroesophageal Reflux Disease; Inflammatory Bowel Disease; Drug-Induced Liver Disease; Pancreatitis

Module-IV **12 Hrs**

Cardiovascular Disorders

Etiology, Pathophysiology and Pharmacotherapy of cardiovascular illness - Hypertension, Ischemic Heart Disease, Congestive Heart Failure, Venous Thromboembolism, Hyperlipidaemia

Suggested Readings/ Books

1. Pharmacotherapy: A Pathophysiologic Approach. Di Piro JT (Eds) New York, NY, The Mc-Graw Hill Co., Inc
2. L.Y. Young MAK-K, et.al., (Eds). Applied Therapeutics: Clinical Use of Drugs. Vancouver: Applied Therapeutics, Inc
3. Textbook of Therapeutics: Drug and Disease Management, Eighth Edition edited by Richard A. Helms
4. Pharmacotherapy Principles and Practice. Chishlom-Burns (Eds). NewYork, The Mc Graw-Hill Co., Inc
5. Clinical Pharmacy and Therapeutics. Roger Walker and Cate Whittlesea (Eds). Churchill Livingstone Elsevier
6. Virginia Poole Arcangelo, Andrew M. Peterson, Veronica Wilbur, Jennifer A. Reinhold, Pharmacotherapeutics for Advanced Practice: A Practical Approach, Wolters Kluwer Health

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 202-20	Clinical Research Regulations & Ethics	3	1	-	30	70	1.5	3	4

Pre-requisite: Fundamentals of Clinical Research (UC-MSCR102-19)

Co- requisite: Clinical Research Lab II (UC-MSCR203-19)

Course Objectives: To educate the students about drug regulatory affairs and significance of regulatory guidelines in drug development and marketing

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

CO1	Comprehend clinical trial regulations and appreciate their importance
CO2	Understand the practical use and evolution of these regulations
CO3	Be familiar with the documents required to be compiled for an ethical & regulatory clinical trial application
CO4	Appreciate the importance of quality system and SOPS
CO5	Make comparison between the regulatory guidelines applicable in different regions

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	3	1	1	1	2	3	1
CO2	2	1	3	1	1	1	2	3	1
CO3	3	3	3	1	1	2	2	3	1
CO4	3	3	2	2	1	2	1	3	1
CO5	1	1	3	1	1	2	3	3	1

Module-I **09 Hrs**

Evolution of Regulatory Control

European Medicines Agency (EMA)

Vaccine Act, Biological Control Act, Pure food drugs act, Food and Drug Administration (FDA), Kefauver Harris amendments act, Waxman Hatch act, Code of federal regulations, Prescription Drug User Fee Amendments (PDUFA)

International Council for Harmonisation (ICH)

Drugs and cosmetic act 1945

Module-II **13 Hrs**

Regulatory Aspects of Different Regions

Investigational New Drug (IND), New Drug Application (NDA), Abbreviated New Drug Application (ANDA), Paper NDA
Market authorization holders (MAH), its procedures
Regulation of medical devices
Regulation of vaccines
Safety Report filing
Regulation of Complementary Medicine
Regulation of non-prescription drugs

Module-III **14 Hrs**
Regulatory Guidelines

International Conference on Harmonization (ICH) GCP guidelines
Overviews of good laboratory practice (GLP)
Schedule Y of Indian Drugs and Cosmetic Act, New Drugs and Clinical Trials Rules (2019)
Basic regulation of bioavailability/ bioequivalence (BA/BE) studies

Module-IV **09 Hrs**
Ethics in Clinical Research

Evolution of ethics in clinical research: Thalidomide disaster, Tuskegee experiment, Nuremberg Code, Declaration of Helsinki, Belmont report
Establishment of Council for International Organizations of Medical Sciences (CIOMS), National Institutes of Health (NIH) and Indian Council of Medical Research (ICMR) guidelines
Compensation to subjects/patients for clinical trial related injuries

Suggested Readings/Recommended Books (Latest Edition)

1. John. P. Griffin, Textbook of Pharmaceutical Medicine, Wiley Blackwell
2. John I, Gallin, Principles and Practice of Clinical research, Academic Press
3. Ira R. Berry, Robert P. Martin, The Pharmaceutical Regulatory Process, Publisher; Informa Healthcare
4. Guidelines: Drugs and Cosmetics Act, EMA
5. www.ich.org
6. www.fda.gov
7. Central Drugs Standard Control Organization: www.cdsco.gov.in
8. SK Gupta, Drug Discovery and Clinical Research, Jaypee Brothers, Medical Publishers Pvt. Ltd.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 203-19	Clinical Research Lab II	-	-	4	30	20	1.5	3	4

Pre-requisite: Fundamentals of Clinical Research (UC-MSCR102-19)

Co- requisite: Clinical Research Regulations (UC-MSCR 202-20)

Course Objectives: The course is designed to impart practical knowledge to students about the various aspects of clinical research in accordance to GCP, GLP and clinical trial regulations

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

CO1	Understand the practical application of clinical trial regulations for conduct of clinical trials
CO2	Trained about the sample collection and analysis and interpretation of lab data in compliance with GLP
CO3	Develop SOPs and various documents required for conduct of quality clinical studies
CO4	Apply GCP in collection of clinical data
CO5	Appreciate the significance of statistical analysis in clinical research

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	1	1	2	1
CO2	2	1	2	2	3	3	1	1	2
CO3	3	2	2	3	2	2	3	2	1
CO4	2	2	2	3	3	3	2	3	1
CO5	3	1	1	3	2	2	3	2	2

1. Measurement of pulse rate and body temperature
2. Effect of exercise on blood pressure
3. Biochemical tests: protein estimation by Lowry's method
4. Biochemical tests: liver function test
5. Biochemical tests: blood glucose

6. Demography: assessment of age, sex, height, weight, waist, BMI, smoking, educational attainment, area-based measure (eg. index of deprivation or disadvantage, rurality distance from health centres etc)
7. Application of simple statistical test to the results obtained in above experiments
8. Haematology tests: haemoglobin, total leukocyte count, differential leukocyte count, erythrocyte sedimentation rate
9. Interpreting Electrocardiography (ECG)
10. Case studies solutions
11. Summary of Product Characteristics (SmPC) development

Suggested Readings/Recommended Books (Latest Edition)

1. Shruti Mohanty and Aparna Verma, Practical Clinical Biochemistry, Jaypee Brothers Medical Publishers (P) Lt d.
2. Vijay Kumar and Kiran Dip Gill, Basic Concepts in Clinical Biochemistry: A Practical Guide, Springer
3. Kathleen Deska Pagana and Timothy J. Pagana, MOSBY'S Manual of Diagnostic and Laboratory Tests, Elsevier
4. John G. Brock-Utne, Clinical Research: Case Studies of Successes and Failures, Publisher; Springer.
5. Duolao Wang and Ameet Bakhai, Clinical Trials: A Practical Guide to Design, Analysis, and Reporting, Remedica
6. Guidelines: ICH, USFDA, Drugs and Cosmetics Act, EMA
7. Electronic Medicines Compendium (eMC): https://www.medicines.org.uk/emc/

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 204-19	Professional Communication Lab	-	-	4	30	20	3	3	2

Pre-requisite: Professional Communication Theory Course

Co- requisite: None

Course Objective: The objective of the course is to help the students become the independent users of English language.

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

CO1	Acquire basic proficiency in listening and speaking English language
CO2	Understand spoken and written English language, particularly the language of their chosen technical field
CO3	Produce on their own clear and coherent texts
CO4	Develop the skills to communicate in English language with clients at work place
CO5	Identify the need for further knowledge and formulate relevant learning outcomes

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	3	3	2	3	3	2	1	1
CO2	1	2	1	3	1	2	3	1	1
CO3	1	1	3	1	1	1	3	1	3
CO4	2	3	3	3	3	2	1	3	1
CO5	2	3	3	2	3	2	2	2	1

Module-I **12 Hrs**

Listening English

A conversation between two people set in an everyday social context, e.g. a conversation in an accommodation agency

A monologue set in an everyday social context, e.g. a speech about local facilities
A conversation between up to four people set in an educational or training context, e.g. a tutor and a student discussing an assignment
A monologue on an academic subject, e.g. a classroom lecture

Module-II **12 Hrs**

Speaking English

Candidates will be asked to answer general questions about themselves and a range of familiar topics, such as their home, family, work, studies and interests. This activity lasts between 4 and 5 minutes
Candidates will be given a minute to prepare their thoughts on an assigned topic, before being invited to speak for up to two minutes. The examiner will then ask one or two questions on the same topic to finish this part of the test
Candidates will be asked further questions connected to the topic in Part 2. These questions will provide an opportunity to discuss more abstract issues and ideas. This part lasts between four and five minutes

Suggested Books/ Manuals

1. Listen Here! Intermediate Listening Activities; Clare West; Georgian Press and Cambridge University Press
2. Skillful Foundation Level Listening & Speaking Digital Student's Book Pack; Macmillan Education

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 205-20	Medical Writing	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objective: The course is designed to explore the basic skills of medical writing. Medical writing is an essential part of clinical research and drug development programme. The goal of this module is to provide overview in both medical science and writing fundamentals.

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

CO1	Improve medical writing skills and better understanding the biomedical publication process
CO2	Demonstrate writing, reading, editing, and reviewing skills
CO3	Become ready to be absorbed Professionals
CO4	Understand about clinical research and the latest techniques and trends in the industry
CO5	Understand career prospects in the medical writing

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	3	3	2	2	2	3	1	1
CO2	1	2	1	2	1	2	2	1	3
CO3	3	2	3	1	1	1	3	1	3
CO4	2	3	3	3	3	2	1	3	1
CO5	2	3	3	2	2	2	2	2	2

Module-I **12 Hrs**

Introduction to Medical writing and Healthcare Communication
The Writing Process: prewriting strategies and steps in writing process
Online search techniques
Rules of writing: basic structure of write up; plagiarism and copyrights

Module-II **12 Hrs**

Scientific Writing: writing case reports, drug monograph and abstract writing
Regulatory writing: medical writing in clinical research, study design, observational studies, experimental studies
ICH-E3: structure and content of clinical study reports
Common Technical Document: Format of dossier, eCTD

Suggested Readings/ Books

1. Medical Writing: A Guide for Clinicians, Educators, and Researchers, Springer
2. The Complete Guide to Medical Writing by Mark C. Stuart, Mark Stuart Pharmaceutical Press
3. Guidelines for Reporting Health Research by David Moher Doughlas Altman BMJ books
4. Medical writing a good practice guide by Justina-Orleans; Wiley-Blackwell
5. Successful scientific writing: a step-by-step guide for the biological and medical sciences, Cambridge University Press.
6. ICH: https://www.ich.org

Suggested Software

1. MS Office especially the subscription-based Office 365.
2. Google Docs
3. Scrivener
4. ReadCube
5. Endnote
6. RefMan
7. PerfectIt3 (and PerfectIt Pro)
8. Medical spellcheckers: (Spellex and Stedman's)
9. Dragon Naturally Speaking
10. Statistical analysis: R, SAS, MS SQL Server
11. Adobe Creative Cloud (Acrobat, Photoshop, Audition, etc)

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 211-19	Fundamentals of Epidemiology	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To cover concepts of molecular epidemiology and its applications in effective clinical outcome

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

CO1	Understand measures of disease occurrence and disease association, mortality indicators and morbidity indicators
CO2	Understand different mechanisms of bias in clinical research
CO3	Implicate evidence-based clinical medicine, including the specifications of diagnostic tests, screening tests, and prognostic tests
CO4	Interpret and assess the genetic measures in research
CO5	Understand the significance of pharmacogenomics in clinical research

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	2	1	1	2	2	2	1	1
CO2	1	1	1	2	2	2	2	1	2
CO3	1	2	1	1	1	2	1	1	1
CO4	1	2	1	1	2	1	1	2	1
CO5	1	2	1	1	1	1	2	1	1

Module-I **13 Hrs**

Measures of disease occurrence and disease association

Mortality indicators and morbidity indicators

The different mechanisms of bias in clinical research (study, response, information, interviewer, site selection, measurement, and confounding); and a conceptual approach to multivariable analysis

Instruction in the research implications of evidence-based clinical medicine, including the specifications of diagnostic tests, screening tests, and prognostic tests
Pharmacoepidemiological studies
Calculation of relative risk and odds ratio

Module-II **13 Hrs**

Introduction to the concepts, principles, and use of molecular and genetic methods in epidemiology and clinical research
Human Genome Project
Framework for interpreting, assessing, and incorporating molecular and genetic measures in research
Meaning of race, ethnicity, social class, and culture, their effects on the conduct and interpretation of clinical research
Pharmacogenomics and its application in clinical research, genome-wide association study (GWAS)

Suggested Readings/Recommended Books (Latest Edition)

1. David Duncan Collier, Epidemiology: Basis for Disease Prevention and Health Promotion, Macmillan Publishers.
2. Robert H. Fletcher and Suzanne W. Fletcher, Clinical Epidemiology: The Essentials, WHO Press
3. Brian MacMahon and Thomas F Pugh, Epidemiology Principles and methods, Lippincot William and Wilkins
4. Japhet Killewo, Epidemiology and Demography in Public Health, Elsevier

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 212-19	International Regulatory Affairs	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to impart advanced knowledge and skills required to learn the concept of various regulatory filings in different countries, different phases of clinical trials and submitting regulatory documents

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

CO1	Understand the regulatory guidance's and guidelines for filing and approval process applicable in different regions
CO2	Participate as an effective member in pharmaceutical regulatory affairs team
CO3	Understand preparation of dossiers and their submission to regulatory agencies in different countries
CO4	Understand clinical trials requirements for approvals for conducting clinical trials
CO5	Make comparison between the regulatory guidelines applicable in different regions

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	1	1	1	2	1	2
CO2	3	1	1	1	1	2	2	1	1
CO3	3	1	3	2	1	1	2	2	2
CO4	3	1	3	2	2	1	2	3	1
CO5	1	1	3	1	1	2	3	3	1

Module-I **12 Hrs**

Introduction to regulatory bodies

Organisation for Economic Co-operation and Development (OECD)
Brazilian Health Surveillance Agency (ANVISA)
Therapeutic Goods Administration (TGA)

Pharmaceuticals and Medical Devices Agency (PMDA)

Module-II **12 Hrs**

Introduction to regulatory bodies

Gulf Co-Operation Council: Central Drug Registration
New Zealand Medicines and Medical Devices Safety Authority (Medsafe)
Health Canada
South African Health Products Regulatory Authority (SAHPRA)
Ministry of Health of the Russian Federation

Suggested Readings/Recommended Books (Latest Edition)

1. Ira R. Berry and Robert P. Martin, The Pharmaceutical Regulatory process, Drugs and the Pharmaceutical Sciences, Informa Health Care
2. Richard A Guarino, New Drug Approval Process: Accelerating Global Registrations Drugs and the Pharmaceutical Sciences
3. Sandy Weinberg, Guidebook for drug regulatory submissions, John Wiley & Sons.lnc.
4. https://www.sahpra.org.za/
5. https://www.tga.gov.au/
6. https://www.pmda.go.jp/
7. https://www.canada.ca/en/services/health/drug-health-products.html
8. http://portal.anvisa.gov.br/english
9. http://ghc.sa/en-us/pages/centraldrugregistration.aspx
10. https://www.medsafe.govt.nz/
11. https://www.oecd.org/chemicalsafety/

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 213-19	Biostatistics in Clinical Research	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to impart ability to think critically about data, make valid inferences, and understand how statisticians are an essential element of clinical investigations

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

CO1	Apply an appropriate statistical test
CO2	Demonstrate skills in the analysis of clinical research data
CO3	Demonstrate skills in interpreting and communicating the results of statistical analysis, orally and in writing
CO4	Acquire practical understanding of parametric and nonparametric assumptions and tests
CO5	Understand and apply statistical considerations when preparing a protocol

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	2	3	3	2	1	1
CO2	3	1	1	2	3	3	3	2	1
CO3	3	1	1	2	3	3	3	1	3
CO4	2	1	1	2	3	3	1	1	1
CO5	3	1	1	3	2	2	3	2	1

Module-I **12 Hrs**

Types of data and its analysis (categorical *vs* quantitative)
Organization of data, distribution of data and calculation of central tendencies
Confidence interval, SD, SE, regression and correlation
Comparison of data between different groups: using null hypothesis and test of significance (paired t-test, unpaired t-test, Analysis of variance (ANOVA), Analysis of covariance (ANCOVA)

Module-II **12 Hrs**

Comparison of data between different groups: Coefficient of Variation, chi-square test, Fischer exact, Mann-Whitney, Wilcoxon, McNemar test, Kruskal Wallis
Intention-to-treat (ITT) and Per-protocol (PP) and Treatment-received (TR) analyses of results in clinical research, sample size calculation
Introduction to common statistical software packages used in clinical research (e.g. SAS, SPSS)

Suggested Readings/Recommended Books (Latest Edition)

1. Geoffrey R. Norman, David L. Streiner, Biostatistics: The Bare Essentials, Publisher; PMPH USA
2. Beth Dawson, Robert G. Trapp, Basic & Clinical Biostatistics, Publisher; McGraw-Hill
3. Marcello Pagano, Kimberlee Gauvreau, Principles of Biostatistics, Publisher; CRC Press
4. Antonella Bacchieri, Giovanni Della Cioppa, Fundamentals of Clinical Research, Publisher; Springer
5. Katsumi Kobayashi, K. Sadasivan Pillai, A Handbook of Applied Statistics in Pharmacology, Publisher; CRC Press

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 214-19	Poisoning and Management	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to provides the understanding on the general concepts and the various types of drug poisoning and its management

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

CO1	Understand the general concepts of poisoning
CO2	Identify various types of poisoning
CO3	Understand toxicology of heavy metals
CO4	Learn about treatment and management of poisoning
CO5	Understand the science of chelating agents

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	1	1	2	2	1	1	1	1
CO2	1	2	2	1	1	1	1	1	1
CO3	1	2	2	1	1	1	1	1	1
CO4	1	2	2	1	1	1	1	1	1
CO5	1	1	1	1	1	1	1	1	1

Module-I **12 Hrs**

General concepts and some common types of drug poisoning

Introduction to science of poisons, pollutants, industrial solvents etc.

Poisoning and its types

Some common poisoning: atropine poisoning, paracetamol, aspirin, organophosphorous compounds, barbiturates, cyanides, benzodiazepines, methyl alcohol, digoxin, opioids

Management of poisoning: general measures and treatment of poisoning poison control/information centre's

Module-II **12 Hrs**

Heavy metal poisoning and its management

Toxicology of heavy metals: mercury, lead, arsenic, iron

Chelating agents: dimercaprol, succimer, unithol, edentate calcium disodium (EDTA), d-penicillamine

Suggested Readings/Recommended Books (Latest Edition)

1. Andrew L. Reeves, Toxicology: Principles And Practice, Wiley Blackwell
2. Raymond Niesink and Mannfred A. Hollinger, Toxicology: Principles and Applications, American Chemical Society
3. Frank A. Barile, Barile's Clinical Toxicology: Principles and Mechanisms, CRC Press
4. Bev-Lorraine True, Dreisbach's Handbook of Poisoning: Prevention, Diagnosis and Treatment, CRC Press

Course Code	Course Title	Teaching Load			Marks		Exam	Credits
		L	T	P	Int.	Ext.	Internal	
UC-MSCR 106-19 UC-MSCR 206-19 UC-MSCR 307-19	Journal Club	-	-	4	50	-	Continuous Mode	2

Pre-requisite: None

Co- requisite: Professional Communication (UC-MSCR 105-19), Professional Communication Lab (UC-MSCR 204-19), ICT Skills Lab (UC-MSCR 305-19)

Course Objectives: The course is designed to instil an analytical temperament in the students for critical review of the existing literature and better understanding of clinical research.

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

CO1	Critically review the literature
CO2	Develop an approach to analyse the various types of articles
CO3	Become familiar with sources of bias and types of study designs
CO4	Comprehend how results of study are clinically significant
CO5	Demonstrate skill in scientific communication both orally and in writing

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	3	2	2	3	2	1
CO2	2	1	3	3	3	3	3	2	1
CO3	2	1	1	2	2	3	3	2	1
CO4	2	1	2	2	3	3	3	2	1
CO5	1	1	1	1	1	1	1	1	3

Instructions

1. Students are to work with assigned mentor to chose and analyze an appropriate article followed by a power point presentation.
2. Power-point presentations should be organized as follows: 10 minutes background, 10 minutes article 15 minutes analysis 5 minutes discussion
3. Students are encouraged to critically appraise the literature, and develop their own independent criticisms

THIRD SEMESTER

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 301-19	Pharmacotherapeutics-II	3	1	-	30	70	1.5	3	4

Pre-requisite: Pharmacotherapeutics-I (UC-MSCR 201-19)

Co- requisite: None

Course Objectives: The course is designed to introduce to the learners about the common diseases and effect of target drugs on human body system. The aim would be to introduce the pharmacological basis of treatment.

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

CO1	Develop an understanding of the basic concepts of common diseases prevalent in the society
CO2	Apply their knowledge and understanding of the pathophysiology and management (pharmacological and non-pharmacological) of diseases
CO3	Choose and justify appropriate drug and treatment duration to a given patient with regard to current recommendations and patient-related factors such as other diseases, age, organ functions and other drug treatment
CO4	Integrate pharmacology, pathophysiology, pharmacodynamic, pharmacokinetics and other biomedical and pharmaceutical sciences as they pertain to clinical therapeutics of certain disorders
CO5	Identify the need for further knowledge and formulate relevant learning outcomes

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	1	3	3	2	3	3	2	1	1
CO2	1	2	1	3	1	2	3	1	1
CO3	1	1	3	1	1	1	3	1	1
CO4	2	3	3	3	3	2	1	3	1
CO5	2	3	3	2	3	2	2	2	3

Module-I **12 Hrs**

Endocrine System Disorders

Etiology, Pathophysiology and Pharmacotherapy: diabetes mellitus, thyroid disorders,

obesity
Infertility and antifertility drugs

Module-II **12 Hrs**

Therapeutics in Infectious Diseases

Gastro-intestinal infections, urinary tract infections
Fungal infections
Protozoal and viral infections (HCV, H1N1, rotavirus)
HIV and its management

Module-III **12 Hrs**

Respiratory System Disorders

Etiology, Pathophysiology and Pharmacotherapy: bronchial asthma, chronic obstructive pulmonary disease (COPD), pulmonary hypertension, tuberculosis

Module-IV **12 Hrs**

Cancer therapeutics: chemotherapy
Arthritis: osteoarthritis, rheumatoid arthritis
Drugs avoided during pregnancy and lactation

Suggested Readings/ Books (Latest Edition)

1. Pharmacotherapy: A Pathophysiologic Approach. Di Piro JT (Eds) New York, NY, The Mc-Graw Hill Co., Inc
2. L.Y. Young MAK-K, et.al., (Eds). Applied Therapeutics: Clinical Use of Drugs. Vancouver: Applied Therapeutics, Inc
3. Textbook of Therapeutics: Drug and Disease Management, Eighth Edition edited by Richard A. Helms
4. Pharmacotherapy Principles and Practice. Chishlom-Burns (Eds). NewYork, The Mc Graw-Hill Co., Inc
5. Clinical Pharmacy and Therapeutics. Roger Walker and Cate Whittlesea (Eds). Churchill Livingstone Elsevier
6. Virginia Poole Arcangelo, Andrew M. Peterson, Veronica Wilbur, Jennifer A. Reinhold, Pharmacotherapeutics for Advanced Practice: A Practical Approach, Wolters Kluwer Health

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 302-20	Clinical Study Design	3	1	-	30	70	1.5	3	4

Pre-requisite: Fundamentals of Clinical Research (UC-MSCR102-19)

Co- requisite: None

Course Objectives: The course is designed to provide opportunity to students to learn about regulatory and scientific rationale of designing, conducting, and successfully completing a clinical trial.

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

CO1	Develop an understanding of the basic concepts of different types of clinical study designs
CO2	Apply their knowledge and understanding in choosing the appropriate study design
CO3	Understand the key study design elements for preventing bias
CO4	Understand what are the essential documents required to conduct a clinical trial
CO5	Learn about the trial design for special population

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	1	2	2	3	1	3	1
CO2	3	1	1	2	2	3	2	3	1
CO3	3	1	1	1	1	3	2	3	1
CO4	3	1	3	1	1	1	1	2	1
CO5	3	1	2	2	3	1	2	3	1

Module-I **12 Hrs**

Inclusion and exclusion criteria
Screening and recruitment of subjects
Methods of randomization, blinding
Placebo
Endpoints: primary, secondary, composite, surrogate

Module-II **12 Hrs**

Type of Studies

Observational studies: case report, case series, cross-sectional studies, case control study, cohort study, relative risk and odds ratio

Experimental studies: randomized trial, open label study, cross over, equivalence trials, superiority trials and non-inferiority trials

Module-III **12 Hrs**

Phases of clinical trials

Designing phase I, II, III and IV trials: design types (dose ranging, safety studies, proof of concept studies, cluster randomized, factorial design, sequential design), their characteristics, and parameter to measure

Module-IV **12 Hrs**

Trial designs of common diseases like CVS (anti-hypertensive drugs), CNS (neurodegenerative diseases), cancer and metabolic disorders

BA-BE study designs

Trials for special population: paediatric, geriatric, pregnant women and lactating women

Suggested Readings/ Books (Latest Edition)

1. Stephen B. Hulley, Steven R. Cummings, Warren S. Browner, Deborah G. Grady and Thomas B. Newman, Designing Clinical Research, Lippincott Williams and Wilkins
2. Duolao Wang and Ameet Bakhai, Clinical Trials: A Practical Guide to Design, Analysis, and Reporting, Remedica
3. Shein-Chung Chow, Design and Analysis of Bioavailability and Bioequivalence Studies, CRC Press
4. Stephen P. Glasser, Essentials of Clinical Research, Springer
5. Beth Dawson, Robert G. Trapp, Basic and Clinical Biostatistics, Publisher; McGraw-Hill
6. Richard Chin and Bruce Y. Lee, Principles and Practice of Clinical Trial Medicine, Academic Press
7. John I. Gallin, Frederick P. Ognibene, Laura Lee Johnson, Principles and Practice of Clinical Research, Academic Press.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 303-19	Research Methodology	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: Clinical Study Design (UC-MSCR 302-20)

Course Objectives: The course is designed to provide opportunity to students to learn about some basic concepts of research and its methodologies.

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

CO1	Develop an understanding of the basic concepts of research methodologies
CO2	Apply their knowledge and understanding in defining specific research problems
CO3	Develop an understanding about different research designs
CO4	Differentiate between primary and secondary data and significance of each type of data
CO5	Understand the basics of writing and presenting scientific data

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	2	1	3	2	1	1
CO2	2	1	1	1	3	1	2	2	1
CO3	2	1	1	1	1	2	2	2	1
CO4	2	1	1	1	1	1	3	1	1
CO5	3	1	1	1	1	2	3	3	3

Module-I **12 Hrs**

Definition, general and specific characteristics of research, classification, types and objective of research, research process, criteria of good research, basic concept of experiments and research, significance of research

Planning and designing a research study: choosing a research topic, literature review, research problem formulation articulating hypothesis, selection of variables, research participants

Module-II **12 Hrs**

Meaning, nature and types of data: primary and secondary; observational; experimental
Data Collection: types of sampling design
Experimental designs, quasi-experimental designs, non-experimental or qualitative designs
Art of scientific writing: Steps to better writing, flow method, organization of material and style, drawing figures, graphs, tables, footnotes, references etc. in a research paper
Levels of Evidence for Clinical Studies
Meta-analysis

Suggested Readings/ Books (Latest Edition)

1. Geoffrey Marczyk, David DeMatteo, David Festinger;.Essential of Research Design and Methodology. John Wiley & Sons
2. Kothari, C.R; Research Methodology: Methods and Techniques.. New Age International Publishers, New Delhi
3. Beth Dawson, Robert G. Trapp, Basic and Clinical Biostatistics, Publisher; McGraw-Hill

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 304-19	Pharmacovigilance	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: This course focuses on importance of drug safety issues that have potential to affect public health.

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

CO1	Develop an understanding of early detection of new adverse reactions and to introduce measures to manage those risks
CO2	Define and classify ADRs, detection, reporting and causality assessment
CO3	Demonstrate basic tools used in pharmacovigilance safety studies
CO4	Develop practical understanding of signal detection and communication of safety signals with stakeholders
CO5	Understand drug monitoring, risk management studies and apply statistical considerations when preparing a protocol

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	2	2	3	1	1	1	2
CO2	3	1	1	2	2	1	1	1	2
CO3	3	1	1	2	2	1	1	1	3
CO4	2	2	2	2	1	1	1	1	1
CO5	3	1	1	1	2	1	1	2	1

Module-I **12 Hrs**

Introduction to Pharmacovigilance
Definition and classification of ADRs, Detection, reporting and causality assessment
Pharmacovigilance in India and global perspective
Pharmacovigilance methods, passive surveillance-spontaneous reports and case series, Active surveillance-drug event monitoring and registries

Basic tools used in pharmacovigilance, Safety studies, Importance of pharmacovigilance

Module-II **12 Hrs**

Pharmaceutical preparations (Adverse effects), product surveillance and post marketing
Signal detection and follow-up
Communicating safety signals with stakeholders, Erice Declaration, Risk management studies
Introduction to translational medicine, drug monitoring, pharmacovigilance in drug regulation
Overview of various software used in pharmacovigilance
Introduction to artificial intelligence in pharmacovigilance
Introduction to herbavigilance
Introduction to materiovigilance

Suggested Reading/ Recommended Books (Latest Edition)

1. Brian L. Storm and Stephen K. Kimmel, Textbook of Pharmacoepidemiology, Wiley Blackwell
2. Ronald D. Mann, Elizabeth Andrews, Pharmacovigilance, Wiley Blackwell
3. Andrew Bate, Evidence-Based Pharmacovigilance, Human Press
4. Patrick Waller, Mira Harrison-Woolrych, An Introduction to Pharmacovigilance, Wiley-Blackwell
5. Uppsala Monitoring Centre: https://www.who-umc.org/

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 305-19	Clinical Research Lab III	-	-	4	30	20	1.5	3	2

Pre-requisite: Fundamentals of Clinical Research (UC-MSCR102-19) and Clinical Research Regulations & Ethics (UC-MSCR 202-20)

Co- requisite: Clinical Study Design (UC-MSCR302-19)

Course Objectives: The course is designed to impart practical knowledge to students about the various aspects of clinical research in accordance to GCP, GLP and clinical trial regulations

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

CO1	Understand the practical application of clinical trial regulations for conduct of clinical trials
CO2	Develop SOPs and various documents required for conduct of quality clinical studies
CO3	Develop various documents essential in clinical research
CO4	Develop clinical study protocols
CO5	Comprehend the significance of documentation in clinical research

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	2	3	2	2	1	1	2	1
CO2	3	2	2	3	2	2	3	2	1
CO3	3	1	2	2	2	2	2	3	2
CO4	3	1	1	3	2	2	2	3	2
CO5	3	1	1	1	1	1	2	3	1

1. Development of clinical research documents: SOPs development
2. Development of clinical research documents: investigator brochure
3. Development of clinical research documents: informed consent forms
4. Development of clinical research documents: case record form
5. Development of clinical research documents: preparation of dummy problem-based protocol clinical research protocol

6. Development of clinical research documents: preparation of dummy bioequivalence protocols
7. Preparation of a clinical trial protocol for submission to regulatory agency
8. How to take case history
9. Mock Case report – Causality assessment
10. Use of software used in clinical research

Suggested Readings/Recommended Books (Latest Edition)

1. John G. Brock-Utne, Clinical Research: Case Studies of Successes and Failures, Publisher; Springer
2. Duolao Wang and Ameet Bakhai, Clinical Trials: A Practical Guide to Design, Analysis, and Reporting, Publisher; Remedica
3. Stephen P. Glasser, Essentials of Clinical Research, Publisher; Springer
4. Deborah Rosenbaum and Michelle Dresser, Clinical Research Coordinator Handbook, Publisher; Interpharm/CRC
5. Evan DeRenzo and Joel Moss, Writing Clinical Research Protocols: Ethical Considerations, Publisher; Elsevier
6. Guidelines: ICH, USFDA, Drugs and Cosmetics Act, EMA

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 306-19	ICT Skills Lab	-	-	4	30	20	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to improve the student learning through the technology

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

CO1	Understand the basics of ICT and the terminologies used in ICT
CO2	Appreciate the potential of technologies in modern society
CO3	Learn about and using different kinds of IT tools suitably and safely
CO4	Search information on the internet in digital encyclopedias, repositories, etc., or using search engines, in a systematic and coherent fashion
CO5	Understand basic functions of a search engine and implement search criteria definition strategies for filtering the results obtained

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	1	1	1	2	1	2
CO2	1	1	1	1	1	1	1	1	2
CO3	3	1	1	1	1	1	1	1	1
CO4	3	1	1	1	1	3	3	1	2
CO5	3	1	1	1	1	3	3	1	2

1. ICT: meaning, advantages, disadvantages and uses
2. General abbreviations and terminology of ICT
3. Basics of internet and emailing
4. Use of internet in research works
5. Literature survey of the previous works and searches for articles online and in the library
6. Cyber laws
7. Database, concepts, components and uses

8. Information retrieval system
9. IT based library and information system
10. New developments in Information communication technology

Suggested Readings/ Books (Latest Edition)

1. Arnaudet, ML and Barrett, Communication Research Techniques: Methods and Applications, Wadsworth California
2. Donal Carburg, Distinctive Qualities in Communication and Research, Taylor and Francis
3. Chrisanthi Avgerou, Robin Mansell, Danny Quah, and Roger Silverstone, The Oxford Handbook of Information and Communication Technologies, Oxford University Press

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 311-20	Clinical Trial Operations	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To sensitize students regarding significance of real time planning and coordination of clinical trials

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

CO1	Understand the criteria for selection of clinical trial site and clinical investigators
CO2	Understand roles and responsibilities of various stakeholders in clinical trial
CO3	Conduct activities at the site related to maintenance of clinical trial documents
CO4	Understand the roles and responsibilities of monitors and auditors
CO5	Conduct activities related to trial site closure and submission of site close out report

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	1	3	3	1	3	1	2
CO2	2	1	3	1	1	2	3	2	3
CO3	1	1	3	3	1	3	3	3	1
CO4	1	1	1	2	2	3	3	3	1
CO5	1	1	1	1	3	3	3	2	2

Module-I **12 Hrs**

Selection of clinical trial sites, site-initiation visits, clinical investigators and making budget and outsourcing clinical trial related work and selection of vendor

The roles and responsibilities of the following in CT: sponsor, institution, clinical trial coordinator, clinical investigator

Documents required at site, site initiation and conduct activities, protocol, CRF, ICD, investigator brochure, clinical trial agreement, ethics committee and regulatory approval, site-initiation visits

Recruitment, IP/IMP/pharmacy file receipt and storage, clinical trial site master file,

databases, SOPs
Roles and responsibilities of monitors and auditors/inspectors, monitoring visits, audits and inspections, independent data monitoring activities

Module-II **12 Hrs**

Contingency planning to prepare for unexpected situations
Site close-out activities, suspending and premature termination of a trial
Handling missing data, query and resolution, database lock
Site close-out report, clinical study report, submission to ethics committee and regulatory agency, publication of results

Suggested Reading (Latest Edition)

1. Principles and practice of Clinical Research by John. I Gallin.; Academic Press
2. Principles and practice of clinical trial medicine by Richard Cin and Bruce Y. Lee; Academic Press
3. Guidelines like GCP, USFDA, EMEA, Indian GCP etc.
4. SK Gupta, Drug Discovery and Clinical Research, Jaypee Brothers, Medical Publishers Pvt. Ltd.
5. JoAnn Pfeiffer, Cris Wells, A Practical Guide to Managing Clinical Trials, CRC Press.
6. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier, Principles and Practice of Pharmaceutical Medicine, Blackwell Publishing Ltd.
7. Graham D. Ogg, A Practical Guide to Quality Management in Clinical Trial Research, CRC Press.
8. Delva Shamley, Brenda Wright, A Comprehensive and Practical Guide to Clinical Trials, Academic Press.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 312-19	Medical Coding	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: This course is designed to instruct the students about various medical dictionaries used worldwide for the representation of the data

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

CO1	Categorize the medical terms appropriately
CO2	Analyze medical clinical narratives and correctly assign medical codes
CO3	Assign and understand diagnostic and procedure codes using ICD coding systems
CO4	Develop an understanding of medical coding as a data collection tool
CO5	Demonstrate entry level skills in coding

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	1	1	3	1	3	3	1
CO2	3	1	1	1	3	1	3	3	1
CO3	3	1	1	1	3	1	1	1	1
CO4	3	1	1	1	1	3	1	3	1
CO5	3	1	1	1	1	1	1	3	1

Module-I **12 Hrs**

MedDRA- Medical dictionary for regulatory activities
WHO-DDE-World Health Organization Drug dictionary
WHO-ART-World Health Organization Adverse reaction terminology

Module-II **12 Hrs**

International Classification of Diseases

Suggested Reading

1. ICH: M1 guidelines
2. https://www.who.int/classifications/icd/en/
3. https://www.cdc.gov/nchs/icd/

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 313-19	Pharmacoeconomics & Health Technology Assessment	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: To make students understand the basics concept and significance of pharmacoeconomics in clinical research

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

CO1	Outline the steps for conducting a pharmacoeconomic analysis
CO2	Identify strengths and issues associated with current pharmacoeconomic methods
CO3	Critique current pharmacoeconomic literature
CO4	Describe the rationale of pharmacoeconomic analysis
CO5	Understand impact of pharmacoeconomics of pharmaceutical care services on the health and health care of a community

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	1	2	2	2	1	1	1	1
CO2	3	1	3	1	1	1	1	1	1
CO3	3	1	1	3	3	1	3	1	1
CO4	3	1	2	3	3	1	3	1	1
CO5	1	1	1	3	3	1	2	1	1

Module-I **12 Hrs**

Introduction to pharmacoeconomics

Definitions, costs and consequences in pharmacoeconomic studies, perspectives, difference between pharmacoeconomics and outcomes research

Types of pharmacoeconomic analysis: cost-effective analysis, cost-minimization analysis, cost- benefit analysis, cost-utility analysis, cost-offset analysis

Health related quality of life, health utilities index

Module-II **12 Hrs**

Health Technology Assessment

International Network of Agencies for Health Technology Assessment (INHATA)
Health Technology Assessment (HTA) system: practice and process
Models of Health Technology Assessment agencies
Structure of the Health Technology Assessment report: principles, practice and process

Suggested Readings/Recommended Books (Latest Edition)

1. Thomas E. Getzen, Health Economics: Fundamentals and Flow of Funds, Wiley
2. Michael Drummond, Mark Sculpher, George Torrence, Bernie O'Brien and Greg, Methods for the Economic Evaluation of Health Care Programmes, Oxford University Press
3. Andrew Briggs, Karl Claxton, Mark Sculpher, Decision Modeling for Health Economic Evaluation, Oxford University Press
4. http://www.inahta.org/

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
UC-MSCR 314-20	Quality Management in Clinical Trials	2	-	-	15	35	1	2	2

Pre-requisite: None

Co- requisite: None

Course Objectives: The course is designed to sensitize students regarding significance of quality control, and quality management in clinical trials

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

CO1	Contribute effectively in conduct of clinical studies taking into consideration the aspects of quality control and management.
CO2	Understand importance of clinical quality assurance department in industry
CO3	Conduct activities at the site related to maintenance source documents
CO4	Understand the roles and responsibilities of monitors and auditors/ inspectors in monitoring visits/ audits and inspections
CO5	To manage the clinical study appropriately for audits and regulatory inspections

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	3	3	2	1	1	2	1	3	2
CO2	3	1	3	1	1	2	1	3	2
CO3	3	1	2	1	1	2	1	3	1
CO4	1	3	2	1	1	2	1	2	2
CO5	2	1	2	1	1	3	1	2	2

Module-I **12 Hrs**

Quality Control, Quality Assurance and Total Quality Management
Overview of QA and QC in clinical trials and their comparison
Total quality management
Good clinical practice guidelines for quality assurance
Corrective and Preventive Action (CAPA) program, Root Cause Analysis (RCA)

Module-II **12 Hrs**

Audits/Inspections
Audits, its process and important aspects, types of audits
Clinical Quality Assurance Audit
Regulatory inspections
Source document verification
Risk based quality management & monitoring

Suggested Readings/Recommended Books (Latest Edition)

1. Graham D, Ogg, A practical guide to quality management in clinical trial research, CRC Press.
2. VM Madzarevic, Clinical Trial Audit preparation: A guide for Good clinical practice inspections, Wiley.
3. Regulatory guidelines: ICH, USFDA, Indian GCP.
4. JoAnn Pfeiffer, Cris Wells, A Practical Guide to Managing Clinical Trials, CRC Press.
5. Lionel D. Edwards, Anthony W. Fox, Peter D. Stonier, Principles and Practice of Pharmaceutical Medicine, Blackwell Publishing Ltd.
6. Graham D. Ogg, A Practical Guide to Quality Management in Clinical Trial Research, CRC Press.
7. Delva Shamley, Brenda Wright, A Comprehensive and Practical Guide to Clinical Trials, Academic Press.

Course Code	Course Title	Teaching Load			Marks		Exam	Credits
		L	T	P	Int.	Ext.	Internal	
UC-MSCR 106-19 UC-MSCR 206-19 UC-MSCR 306-19	Journal Club	-	-	4	50	-	Continuous Mode	2

Pre-requisite: None

Co- requisite: Professional Communication (UC-MSCR 105-19), Professional Communication Lab (UC-MSCR 204-19), ICT Skills Lab (UC-MSCR 305-19)

Course Objectives: The course is designed to instil an analytical temperament in the students for critical review of the existing literature and better understanding of clinical research.

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

CO1	Critically review the literature
CO2	Develop an approach to analyse the various types of articles
CO3	Become familiar with sources of bias and types of study designs
CO4	Comprehend how results of study are clinically significant
CO5	Demonstrate skill in scientific communication both orally and in writing

Mapping of course outcomes with the programme outcomes

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9
CO1	2	1	3	3	2	2	3	2	1
CO2	2	1	3	3	3	3	3	2	1
CO3	2	1	1	2	2	3	3	2	1
CO4	2	1	2	2	3	3	3	2	1
CO5	1	1	1	1	1	1	1	1	3

Instructions

1. Students are to work with assigned mentor to chose and analyze an appropriate article followed by a power point presentation.
2. Power-point presentations should be organized as follows: 10 minutes background, 10 minutes article 15 minutes analysis 5 minutes discussion

3. Students are encouraged to critically appraise the literature, and develop their own independent criticisms
4. Minimum two presentations in a semester by each student

Scheme & Syllabus of

Pre-Ph.D. Course Work -Biotechnology

IK Gujral Punjab Technical University

I.K. GUJRAL PUNJAB TECHNICAL UNIVERSITY

Estd. Under Punjab Technical University Act, 1996
(Punjab Act No. 1 of 1997)

Ref. No. : IKGPTU/Reg/N/ *Dated :*

NOTIFICATION

Sub: **Regarding Pre-Ph.D Course work.**

This is for information of all concerned that Pre-Ph.D course work from 2016-17 will be conducted in the IKGPTU main campus Kapurthala in regular mode. The PhD course work will consists of minimum 15 credits. The structure of the course work is as under.

Sr. No.	Nature of course	Name of course	Credits	Remarks
1.	Core	1.Research Methodology	4	The syllabus of RM should be formulated faculty wise such as Engineering, Science, Management/ Humanities and Life sciences
		2.Subject related theory paper	4	Discipline specific related to advancements in theoretical methods for research
		3. Presentation	3	Discipline specific
2.	Interdisciplinary	4. Elective	4	From list of subjects from allied fields
	Total Minimum credits		**15**	

-Sd-
Registrar

Endorsement No: IKGPTU/REG/N/ 4244-4251 Dated: 22.08.2016

1. Secretary to Vice Chancellor: For kind information of Vice Chancellor
2. Dean (P&D)
3. Dean (RIC)
4. Dean (Academics)
5. Finance Officer
6. Controller of Examination
7. DR (Computers): For uploading on website
8. File Copy

Registrar 19/8/16

I. K. Gujral Punjab Technical University, Jalandhar
Jalandhar Kapurthala Highway, Near Pushpa Gujral Science City, Kapurthala - 144 603
Ph. No. 01822 - 662521, 662501 Fax No. : 01822-255506, 662526. Email : revistrar@ptu.ac.in

Dr. Rajneesh Sachdev
Head, DFST

Research Methodology	The already approves syllabus of RM for PhD course work
Core Subjects	**Options**
	Biochemical and Separation Techniques
	Bioprocess Technology
	Recombinant Biotechnology
	Plant Tissue Culture
Interdisciplinary Subjects	Modern Pharmaceutical Analytical Techniques
	Intellectual Property Rights
	Pharmacological and Toxicological Screening Methods

CORE SUBJECTS

Option-I

BIOCHEMICAL AND SEPARATION TECHNIQUES

1 Chromatography

1.1 Introduction, Principles, Types- paper, two dimensional, HPLC, Ion exchange chromatography, Uses, Advantages and Limitations

2 Spectroscopy

2.1 UV/Visible

2.2 Spectrophotofluorimeter

2.3 Scope, basic principle and uses in biotechnology of different types of spectrometry (NMR, Magnetic resonance spectroscopy)

3 Radioisotopy

3.1 Use of radioisotope

3.2 Detection and measurement of radioactivity

3.3 Specific activity

3.4 Applications in biological system

3.5 Autoradiography

4 Microscopy

4.1 Brief introduction

4.2 Types of microscopes and role in microbiology

4.3 Structure and function of microscopes (compound microscope, dissecting microscope, phase contrast microscope, scanning electron microscopy)

5 Filtration

5.1 Theory and application

6 Centrifugation

6.1 Theory and application

7 Electrophoresis

7.1 Different methods for proteins and nucleic acids

8 Molecular Diagnostic Techniques

8.1 PCR

8.2 Southern, Nothern, Western Blotting

8.3 Microarray

Suggested Reading/Reference Books:

- Principles and Techniques of Biochemistry and Molecular Biology. Keith Wilson and John Walker. Cambridge University Press.

- Laboratory Techniques in Biochemistry and Molecular Biology. P.C. van der Vliet and S. Pillai. Elsevier

Option II

BIOPROCESS TECHNOLOGY

1 Microbial Growth Kinetics
1.1 Batch Culture
1.2 Continuous culture
1.3 Fed-batch culture
1.4 Biomass productivity
1.5 Metabolite productivity
1.6 Kinetics of microbial growth

2 Enzymes
2.1 Classification
2.2 Uses
2.3 Methods for immobilization

3 Fermentation
3.1 Raw materials used as media for industrial fermentations
3.2 Development of inocula for industrial fermentations
3.3 Isolation and preservation of industrially important microorganisms

4 Design of a Fermenter
4.1 Aseptic operation and containment
4.2 Construction materials
4.3 Temperature control
4.4 Aeration and agitation
4.5 Sterilization of the fermenter
4.6Air supply and exhaust gas from a fermenter

5 Recovery and Purification of Fermentation Products
5.1 Centrifugation
5.2 Cell Disruption
5.3 Chromatography
5.4 Ultra filtration
5.5 Drying

Suggested Reading/Reference Books

- Principles of fermentation technology by Stanbury, Whitaker & Hall.
- Bioprocess Engineering by Shuler M. L. and Kargi F.
- Microbiology by Pelczar, Chan & Krieg.
- Microbiology by Prescott, Harley & Klein.
- Modern Industrial Microbiology & Biotechnology by Nduka Okafor.

Option III
RECOMBINANT BIOTECHNOLOGY

1 Tools of Genetic Engineering
1.1 Cloning vehicles
1.2 Modifying enzymes
1.3 DNA ligase
1.4 DNA polymerase
1.5 Polynucleotide kinase
1.6 T4 DNA ligase
1.7 Nick translation system
1.8 Terminal deoxynucleotidy1 transferase
1.9 Reverse transcriptase
1.10 Restriction endonucleases Type I & II. etc.

2 Cloning Vectors
2.1 Plasmids
2.2 Lambda phage
2.3 Phagemids
2.4 Cosmids
2.5 Artificial chromosomes
2.6 Yeast vectors
2.7 Shuttle vectors
2.8 Virus based vectors

3 Methods of Gene Transfer
3.1 Transformation
3.2 Transduction
3.3 Particle gun
3.4 Electroporation
3.5 Liposome mediated
3.6 Microinjection
3.7 *Agrobacterium* mediated gene transfer

4 Preparation and Application of Molecular Probes
4.1 DNA probes
4.2 RNA probes
4.3 Radioactive labelling
4.4 Non radioactive labelling
4.5 Use of molecular probes
4.6 DNA fingerprinting

5 Analysis and Expression of Cloned Gene In Host Cells
5.1 Expression vectors
5.2 Restriction enzyme analysis

5.3 Southern blotting
5.4 Northern blotting
5.5 Western blotting
5.6 *In-situ* hybridization
5.7 Colony and plaque hybridization
5.8 Factors affecting expression of cloned genes
5.9 Reporter genes
5.10 Fusion proteins

6 Gene Libraries
6.1 cDNA synthesis
6.2 Genomic DNA libraries
6.3Amplification of gene libraries
6.4 Identifying the products of cDNA clones

7 Isolation, Sequencing and Synthesis of Gene
7.1 Different methods of gene isolation
7.2 Techniques of DNA sequencing
7.3 Artificial DNA synthesis

8 Applications of r-DNA Technology
8.1 Gene cloning in medicine (Insulin, Blood clotting factor VIII)
8.2 High level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells)
8.3 Limitation and advantages and novel technologies generation of transgenic animals 8.4 Applications of PCR (DNA finger printing)

9 Gene Therapy
9.1 *Ex vivo & In vivo* gene therapy
9.2 Case study of ADA as an example
9.3 Gene therapy prospect and future
9.4 DNA vaccine
9.5 Transgenic plants
9.6 Advantages and limitations of gene therapy
9.7 Antisense and ribozyme technology
9.8 Micro RNA Technology
9.9 Human genome project and its application
9.10 Current production of rDNA products
9.11 Bio-safety measures and regulations for rDNA work

Suggested Reading/Reference Books

- Principles of Gene Manipulation by R.W.Old and S.B.Primrose Sixth Edition Blackwell Scientific Publication (2001)
- Genes VIII by B.Lewin

- From Genes to Clones by E.L.Winnecker
- Gene Cloning by T.A.Brown
- Glick B., Pasternak J. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 3rd Ed. ASM Press

Option IV

PLANT TISSUE CULTURE

1 Introduction to Cell and Tissue Culture
1.1 Conventional plant breeding
1.2 Tissue culture as technique to produce novel plants and hybrids
1.3 Tissue culture media (composition and preparation)
1.4 Initiation and maintenance of callus and suspension cultures
1.5 Single cell clones

2 Organogenesis: Somatic embryogenesis
2.1 Transfer and establishment of whole plants in soil
2.2 Shoot tip culture
2.3 Rapid clonal propagation
2.4 Embryo culture and embryo rescue

3 Protoplast
3.1 Isolation
3.2 Culture and fusion
3.3 Selection of hybrid cell and regeneration of hybrid plants
3.4 Symmetric and asymmetric hybrids, cybrids
3.5 Cryopreservation
3.6 Slow growth and DNA banking for germplasm conservation

4 Plant Transformation Technology
4.1 Basis of tumor formation
4.2 Hairy root
4.3 Features of TI and RI plasmids
4.4 Mechanism of DNA transfer
4.5 Role of virulence genes
4.6 Use of TI and RI as vectors
4.7 Binary vectors
4.8 Genetic markers
4.9 Use of reporter genes
4.10 Reporter gene with intron
4.11 Methods of nuclear transformation
4.12 Viral vectors and their application
4.13 Multiple gene transfer
4.14 Vectorless or direct DNA transfer (particle bombardment, elctroporation, microinjection)
4.15 Transformation of monocots
4.16 Transgene stability and gene silencing

5 Application of Plant Transformation for Productivity and Performance
5.1 Herbicide resistance (phosphoinothricin, glyphosphate, sulfonyl urea, atrazine)
5.2 Insect resitance (Bt genes,non-Bt like protease inhibitors, alpha amylase inhibitor)
5.3 Virus resistance (coat protein mediated, nucleocapsid gene)
5.4 Disease resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins,PR proteins)
5.5 Nematode resistance
5.6 Abiotic stress

5.7 Post harvest losses
5.8 Use of ACC synthase (polygalactrouranase, ACC oxidase)
5.9 Male sterile lines
5.10 Bar and barnase systems
5.11 Carbohydrate composition and storage
5.12 ADP glucose pyrophosphatase
5.13 Biosafety and ethical issues associated with transgenic plants

6 Chloroplast Transformation
6.1 Advantages
6.2 Vectors
6.3 Success with tobacoo and potato

7 Metabolic Engineering and Industrial Products
7.1 Plant secondary metabolites
7.2 Role of bioreactors for scaling up
7.3 Biotransformation
7.4 Biodegradable plastics, polyhydroxybutyrate

8 Molecular Pharming in Plants
8.1 Production of therapeutic proteins
8.2 Edible vaccines antibodies
8.3 Purification strategies

Suggested Reading/Reference Books

- Biotechnology in Crop Improvement by H.S Chawla
- Plant Biotechnology BY J.Hammond , P.McGravey and V.Yusibov
- Elements of Biotechnology by P.K Gupta
- Practical application of Plant Molecular Biology by R.J Henry

INTERDISCIPLINARY SUBJECTS

Option-I

MODERN PHARMACEUTICAL ANALYTICAL TECHNIQUES

1. UV-Visible spectroscopy

1.1Introduction, Theory, Laws, Instrumentation associated with UV-Visible spectroscopy
1.2 Choice of solvents and solvent effect and Applications of UV-Visible spectroscopy

2. IR spectroscopy

2.1 Theory, Modes of Molecular vibrations, Sample handling
2.2 Instrumentation of Dispersive and Fourier - Transform IR Spectrometer
2.3 Factors affecting vibrational frequencies and Applications of IR spectroscopy

3. Spectroflourimetry

3.1 Theory of Fluorescence, Factors affecting fluorescence, Quenchers
3.2 Instrumentation and Applications of fluorescence spectrophotometer

4. NMR spectroscopy

4.1 Quantum numbers and their role in NMR
4.2 Principle, Instrumentation, Solvent requirement in NMR
4.3 Relaxation process
4.4 NMR signals in various compounds
4.5 Chemical shift, Factors influencing chemical shift
4.6 Spin-Spin coupling, Coupling constant
4.7 Nuclear magnetic double resonance
4.8 Brief outline of principles of FT-NMR and $_{13}C$ NMR
4.9 Applications of NMR spectroscopy

5. Mass Spectroscopy

5.1 Principle, Theory, Instrumentation of Mass Spectroscopy
5.2 Different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI Analyzers of Quadrupole
5.3 Time of Flight, Mass fragmentation and its rules
5.4 Meta stable ions, Isotopic peaks
5.5 Applications of Mass spectroscopy

6. Chromatography

Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of the following: a) Paper chromatography b) Thin Layer chromatography c) Ion exchange chromatography d) Column chromatography e) Gas chromatography f) High Performance Liquid chromatography g) Affinity chromatography

7. X ray Crystallography

7.1 Production of X rays

7.2 Different X ray methods
7.3 Bragg‘s law
7.4 Rotating crystal technique
7.5 X ray powder technique
7.6 Types of crystals
7.7 Applications of X-ray diffraction

Suggested Readings

- Spectrometric Identification of Organic compounds - Robert M Silverstein, Sixth edition, John Wiley & Sons, 2004.
- Principles of Instrumental Analysis - Doglas A Skoog, F. James Holler, Timothy A. Nieman, 5th edition, Eastern press, Bangalore, 1998.
- Instrumental methods of analysis – Willards, 7th edition, CBS publishers.
- Practical Pharmaceutical Chemistry – Beckett and Stenlake, Vol II, 4th edition, CBS Publishers, New Delhi, 1997.
- Organic Spectroscopy - William Kemp, 3rd edition, ELBS, 1991.
- Quantitative Analysis of Drugs in Pharmaceutical formulation - P D Sethi, 3rd Edition, CBS Publishers, New Delhi, 1997.
- Pharmaceutical Analysis- Modern methods – Part B - J W Munson, Volume 11, Marcel Dekker Series.

Option-II

INTELLECTUAL PROPERTY RIGHTS

1. Definition, need for patenting, Types of Patents, Conditions to be satisfied by an invention to be patentable, Introduction to patent search. Parts of patents. Filling of patents. The essential elements of patent; Guidelines for preparation of laboratory note book, Non-obviousness in Patent.

2. Role of GATT, TRIPS, and WIPO

3. Brief introduction to Trademark protection and WHO Patents. IPR's and its types, Major bodies regulating Indian Pharmaceutical sector

4. Brief introduction to CDSCO. WHO, USFDA, EMEA, TGA, MHRA, MCC, ANVISA

5. Regulatory requirements for contract research organization. Regulations for Biosimilar

Suggested Readings

- Pharmaceutical Process Validation: By Fra R. Berry and Robert A. Nash, Vol 57, 2nd Edition
- Applied Production and Operation Management By Evans, Anderson and Williams
- GMP for pharmaceuticals Material Management by K.K. Ahuja Published by CBS publishers
- ISO 9000-Norms and explanations
- GMP for pharmaceuticals- Willing S.H. Marcel and Dekker

Option-III

PHARMACOLOGICAL AND TOXICOLOGICAL SCREENING METHODS

1. Laboratory Animals

1.1 Common lab animals: Description, handling and applications of different species and strains of animals
1.2 Transgenic animals: Production, maintenance and applications
1.3 Anaesthesia and euthanasia of experimental animals
1.4 Maintenance and breeding of laboratory animals
1.5 CPCSEA guidelines to conduct experiments on animals
1.6 Good laboratory practice

2. Preclinical screening of new substances for the pharmacological activity

2.1 General principles of preclinical screening
2.2 CNS Pharmacology: behavioral and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, anti epileptics and nootropics. Drugs for neurodegenerative diseases like Parkinsonism, Alzheimers and multiple sclerosis. Drugs acting on Autonomic Nervous System
2.3 Respiratory Pharmacology: anti-asthmatics, drugs for COPD and anti allergics
2.4 Reproductive Pharmacology: Aphrodisiacs and antifertility agents
2.5 Analgesics, antiinflammatory and antipyretic agents
2.6 Gastrointestinal drugs: anti ulcer, anti -emetic, anti-diarrheal and laxatives
2.7Cardiovascular Pharmacology: antihypertensives, antiarrythmics, antianginal, antiatherosclerotic agents and diuretics. Drugs for metabolic disorders like anti-diabetic, antihyperlipidemic, and agents. 2.8 Anti cancer agents
2.9 Immunosuppressants and immunomodulators

3. Limitations of Animal Experimentation and Alternate animal Experiments

4. Extrapolation of in vitro Data to Preclinical and Preclinical to Humans

5. Regulatory guidelines for conducting toxicity studies

5.1 OECD
5.2 ICH
5.3 EPA
5.4 Schedule Y
5.5 OECD principles of Good laboratory practice (GLP)

Suggested Readings

- Biological standardization by J.H. Burn D.J. Finney and I.G. Goodwin
- Screening methods in Pharmacology by Robert Turner. A
- Evaluation of drugs activities by Laurence and Bachrach
- Methods in Pharmacology by Arnold Schwartz
- Fundamentals of experimental Pharmacology by M.N.Ghosh
- Pharmacological experiment on intact preparations by Churchill Livingstone

- Drug discovery and Evaluation by Vogel H.G.
- Hand book on GLP, Quality practices for regulated non-clinical research and development (http://www.who.int/tdr/publications/documents/glp-handbook.pdf)
- Schedule Y Guideline: drugs and cosmetics (second amendment) rules, 2005, ministry of health and family welfare (department of health) New Delhi
- Drugs from discovery to approval by Rick NG.
- Animal Models in Toxicology, 3rd Edition, Lower and Bryan
- OECD test guidelines.
- Principles of toxicology by Karen E. Stine, Thomas M. Brown.
- Guidance for Industry M3(R2) Nonclinical Safety Studies for the Conduct of Human Clinical Trials and Marketing Authorization for Pharmaceuticals (http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073246.pdf)

Study Scheme & Syllabus of

PhD Course Work in Pharmaceutical Sciences

Batch 2019 Onward

By

Board of Study Pharmacy

Department of Academics

IK Gujral Punjab Technical University

Study Scheme

Course Code	Course Type	Course Name	Load			Marks			Credits
			L	T	P	Internal	External	Total	
PHP-101	Compulsory Course	Research Methodology	3	1	-	30	70	100	4
PHP-201	Core Theory (Any One)	Pharmaceutics	3	1	-	30	70	100	4
PHP-202		Pharmaceutical Chemistry	3	1	-	30	70	100	
PHP-203		Pharmacology	3	1	-	30	70	100	
PHP-204		Pharmacognosy	3	1	-	30	70	100	
PHP-301	Interdisciplinary Course (Any One)	Modern Pharmaceutical Analytical Techniques	3	1	-	30	70	100	4
PHP-302		Intellectual Property Rights	3	1	-	30	70	100	
PHP-303		Pharmacology & Toxicological Screening Methods	3	1	-	30	70	100	
PHP-304		Biochemical & Separation Techniques	3	1	-	30	70	100	
PHP-305		Bioprocess Technology	3	1	-	30	70	100	
PHP-306		Recombinant Biotechnology	3	1	-	30	70	100	
PHP-307		Plant Tissue Culture	3	1	-	30	70	100	
PHP-401	Presentation	*Presentation	-	-	6	75	-	75	3
		Total	**09**	**03**	**06**	**165**	**210**	**375**	**15**

**Minimum three presentations related to proposed research area of the candidate*
**Non-University Exam*

Dr. Rajneesh Sachdev
Head, DFST

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-101	Research Methodology	3	1	-	30	70	1.5	3	4

Overview of Research **10 Hrs**

Research and its type, identifying and defining research problems, introduction to different types of research designs. Essential constituents of literature review. Basic principles of experimental design, completely randomized, randomized block, Latin square, factorial

Methods of Data Collection **04 Hrs**

Primary and secondary data, methods of primary data collection, classification of secondary data

Sampling Methods **10 Hrs**

Probability sampling: simple random sample, systematic sampling, stratified sampling, cluster sampling and multistage sampling; Non-probability sampling: convenience sampling, judgement sampling, quota sampling; sampling distribution

Processing and Data Analysis **15 Hrs**

Statistical measures and their significance: central tendencies, measures of variability, skewness, kurtosis, correlation and regression; hypothesis testing: parametric test (z, t, F), Chi square, ANOVA and non-parametric test

Reliability and Validity **03 Hrs**

Test- retest reliability, alternative form reliability, internal-comparison reliability, and scorer reliability; content validity, criterion- related validity and construct validity

Essentials of Report Writing **05 Hrs**

Suggested Readings/Recommended Books (Latest Editions)

1. Geoffrey R. Norman, David L. Streiner, Biostatistics: The Bare Essentials, PMPH USA
2. Beth Dawson, Robert G. Trapp, Basic & Clinical Biostatistics, McGraw-Hill
3. Marcello Pagano, Kimberlee Gauvreau, Principles of Biostatistics, CRC Press
4. Antonella Bacchieri, Giovanni Della Cioppa, Fundamentals of Clinical Research, Springer
5. Katsumi Kobayashi, K. Sadasivan Pillai, A Handbook of Applied Statistics in Pharmacology, CRC Press

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-201	Pharmaceutics	3	1	-	30	70	1.5	3	4

Pre-formulation Studies **07 Hrs**
Introduction, pre-formulation testing criteria, regulatory requirements, testing systems, solid-state characterization, transport across biological membranes

Polymers **05 Hrs**
Polymer classification, physiochemical properties and polymer solutions, biodegradable and non-biodegradable polymers, application of polymers in controlled release of drugs, transport of small molecules in polymers, ionic polymers as drug carriers, polymer drug interactions

Controlled Drug Delivery **07 Hrs**
Introduction, basic concept, rationale of SR/CR drug delivery, physicochemical and biological factors influencing design and performance of CR products, therapeutic status of CDDS, targeting through nano-particles, monoclonal antibodies, vitreous body, colon targeting, lung targeting

Pharmaceutical Process Validation **08 Hrs**
Basic concept, regulatory basis of validation , benefits of validation, types of process validation related to prospective retrospective and concurrent process validation , re-validation of validation process and scale-up and post approval changes (SUPAC), analytical Validation

Optimization **05 Hrs**
Introduction to statistical methods and factorial design, quality by design

Bioequivalence Studies **07 Hrs**
Basic pharmacokinetic concepts, *in vitro* and *in vivo* methods in establishment of bioequivalence

Pharmaceutical Packaging **08 Hrs**
Introduction, quality control, paper and board-based packaging materials and their use in pack security systems, sterile products, closures and closure systems, sterile product and the role of rubber components, blister strip, child resistant, sachet packaging, present and future trends

Suggested Reading/Reference Books (Latest Edition)

1. J.R. Robinson & V.H.L. Lee (Eds), Controlled Drug Delivery, Fundament and applications, Vol. 29&Vol. 31, Marcel Dekker, N.Y.
2. Y.W. Chien (Ed.), Transdermal Controlled Systemic Medications, Marcel Dekker, N.Y.
3. N.K. Jain, Controlled and novel drug delivery, CBs, New Delhi.

4. N.K. Jain, Advances in Controlled and novel drug delivery, CBS, New Delhi.
5. J.I. Wells, Pharmaceutical Preformulation: The Physicochemical Properties of Drug Substances, Ellis Horwood, Chiechester (UK)
6. S.P.Vyas and R.K.Khar, Controlled Drug Delivery, concept and advances
7. J.G. Wagner, Pharmacokinetics for the Pharmaceutical Scientist, Technomic, Pa
8. L. Shargel, and A. Yu, Applied Biopharmaceutics and Pharmacokinetics, Appleton and Large, Norwalk, CT.
9. M. Gibaldi and D. Perrier, Pharmacokinetics, J. Swarbrick, ed., Marcel Dekker, N.Y.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-202	Pharmaceutical Chemistry	3	1	-	30	70	1.5	3	4

Stereochemistry **10 Hrs**

Optical isomerisim: chirality and molecular symmetry; stereochemical designation of chiral centre(s) (*R*& *S*); chiral axis; resolution of racemic mixture-techniques including chiral chromatography, geometric Isomerisim: *cis*, *trans*; *E*, *Z* ,conformational analysis: boat-chair conformations; staggered, gauche, eclipsed conformations

Fundamentals of Medicinal Chemistry **05 Hrs**

Basics of drug action: covalent, ionic, ion-diople, hydrogen bonding, vander waals interactions ,bio-isosterism ,drug receptor interaction ,constitution of cell membrane

Drug Design **12 Hrs**

Analogue synthesis versus rational drug design, discovery of lead compounds, pharmacophore identification, structure modifications of lead compound (prototype), physicochemical alterations, pro-drug approach, quantitative structure activity relationship, computer aided drug design, molecular modelling, combinatorial chemistry and high throughput screening

Natural Products **14 Hrs**

Drugs of natural origin: from plants, micro-organisms, animal source, marine products, biosynthesis of natural products, approaches of structure elucidation: degradation and synthetic approaches; spectral analysis (UV, IR, NMR, Mass), hyphenated techniques: GC-MS, LC-MS, chemical modifications of natural products; opiod analgesics, anti-neoplastic agents, anti-malarials

Techniques of Quantitative Estimation of Drugs for Determination of Purity **06 Hrs**

Suggested Reading/Reference Books (Latest Edition)

1. Ernest EI and Samuel H. Stereochemistry of Organic Compounds. John Wiley and Sons, New York.
2. Lehr RE and Marchand AP. Orbital Symmetry: A Problem Solving Approach. Academic Press, New York.
3. March J. Advanced Organic Chemistry: Reactions, Mechanisms and Structures. John Wiley and Sons, New York.
4. Lehr RE and Marchand AP. Orbital Symmetry: A problem solving approach. Academic Press, New York.
5. Mitscher LA and Baker WR. Wiley and Sons
6. A Search for Novel Chemotherapy Against Tuberculosis Amongst Natural Products. Pure and Applied Chemistry (1998), Vol. 70, No.2, pp 365-371.
7. Wermuth CG. The Practice of Medicinal Chemistry. Academic Press, Jordon Hill, Oxford.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-203	Pharmacology	3	1	-	30	70	1.5	3	4

Molecular Aspects of Drug Action **07 Hrs**
Receptor occupancy, types of drug targets, main families of receptors and ion channels, signal transduction mechanisms coupling receptors to cellular function

Cellular Mechanisms of Drug Action **08 Hrs**
Short-term regulation of cellular function (excitation, contraction and secretion), slower mechanisms of cell response (cell proliferation, apoptosis) and their pathophysiological significance

Inflammation and Immune Reactions **04 Hrs**
Acute inflammatory reaction, mediators of inflammation and immune response, therapies based on manipulation of immune response

Antioxidants **02 Hrs**
Reactive oxygen intermediates , antioxidants and their therapeutic implications

Toxicity Studies **06 Hrs**
Acute, sub-acute, sub-chronic, chronic toxicity

Advances in Transgenic Animals **02 Hrs**
Regulatory Guidelines **06 Hrs**
Guidelines for maintenance and experimentation using laboratory animals **(**CPCSEA, OECD, ICH, ICMR, Schedule Y)

***In-vitro* Experimentation Techniques** **06 Hrs**
Animal cell lines and their uses, radioligand binding assay, patch clamp, ELISA

Molecular Techniques **06 Hrs**
PCR, blotting, immunostaining, cloning, RIA

Suggested Reading/Reference Books (Latest Edition)

1. BG Katzung AJ Trevor, Basic and Clinical Pharmacology, Mc Graw-Hill.
2. HP Rang, MM Dale, JM Ritter, RJ Flower, G Henderson, Rang & Dale's Pharmacology, Elsevier.
3. PN Bennett, MJ Brown and P Sharma, Clinical Pharmacology, Churchill Livingstone Elsevier.
4. KD Tripathi, Essentials of Medical Pharmacology, Jay Pee Medical.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-204	Pharmacognosy	3	1	-	30	70	1.5	3	4

Organoleptic Evaluation of Plant Drugs **08 Hrs**
Gross morphology, detection of foreign matter, quantitative microscopy: vein islet number, vein termination number, stomatal number, stomatal index, palisade ratio, micrometry: measurement of fibers, trichomes, starch grains, calcium oxalate crystals, lycopodium spore analysis, fluorescence analysis, determination of moisture content, ash values, extractive values, swelling index, refractive index, optical rotation

Primary and Secondary Plant Metabolites **05 Hrs**
Classification of secondary metabolites (e.g. alkaloids, glycosides, terpenoids, saponins, flavonoids, coumarins, phenolics, etc.), biogenetic theories

Extraction Techniques **04 Hrs**
Maceration, percolation, sonication, soxhlet assisted extraction, ultrasound assisted extraction, super critical fluid extraction, microwave assisted extraction, enzyme assisted extraction

Isolation of Plant Constituents **10 Hrs**
Column Chromatography (adsorbents, eleutropic series of solvents), paper chromatography, TLC, HPLC, HPTLC, GLC, preparative chromatography

Phytoconstituent Characterization **10 Hrs**
Basic concepts of spectroscopy (UV, IR, NMR and Mass), interpretation of spectral data

Cultivation of Medicinal Plants and Harvesting **01 Hrs**

WHO Guidelines for Assessment of Crude Drugs **02 Hrs**
Evaluation of identity, purity, quality of crude drugs, determination of pesticide residue, determination of microorganisms, aflotoxins, determination of arsenic and heavy metals (Hg, Pb, Cd)

Herbal Drug Standardization **06 Hrs**
Phytochemical reference standards (PRS), botanical reference standards (BRS), TLC fingerprint profile along with PRS, quantitative estination of biomarker by HPTLC or GC, GC-MS, LC-MS

Nutraceuticals **01 Hrs**

Suggested Reading/Reference Books (Latest Edition)

1. W.C.Evans, Trease and Evans Pharmacognosy, 15th edition, W.B. Sounders & Co., London.
2. Egon Stahl, Thin Layer chromatography -A laboratory handbook, Springer-Verlag, Berlin.
3. M.J. Cupp, Toxicology and Clinical Pharmacology of Herbal Products, Humana Press New-Jersy.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-301	Modern Pharmaceutical Analytical Techniques	3	1	-	30	70	1.5	3	4

UV-Visible Spectroscopy **05 Hrs**
Introduction, theory, laws, instrumentation associated with UV-Visible spectroscopy, choice of solvents and solvent effect and applications of UV-Visible spectroscopy

IR Spectroscopy **05 Hrs**
Theory, modes of molecular vibrations, sample handling, instrumentation of dispersive and fourier - transform IR Spectrometer, factors affecting vibrational frequencies and applications of IR spectroscopy

Spectroflourimetry **04 Hrs**
Theory of fluorescence, factors affecting fluorescence, quenchers, instrumentation and applications of fluorescence spectrophotometer

NMR Spectroscopy **10 Hrs**
Quantum numbers and their role in NMR; principle, instrumentation, solvent requirement in NMR, relaxation process, NMR signals in various compounds, chemical shift, factors influencing chemical shift, spin-spin coupling, coupling constant, nuclear magnetic double resonance, brief outline of principles of FT-NMR and ^{13}C NMR, applications of NMR spectroscopy

Mass Spectroscopy **10 Hrs**
Principle, theory, instrumentation of mass spectroscopy, different types of ionization like electron impact, chemical, field, FAB and MALDI, APCI, ESI, APPI analyzers of quadrupole, time of flight, mass fragmentation and its rules,meta stable ions, isotopic peaks, applications of mass spectroscopy

Chromatography **08 Hrs**
Principle, apparatus, instrumentation, chromatographic parameters, factors affecting resolution and applications of: paper chromatography, thin layer chromatography, ion exchange chromatography, column chromatography, gas chromatography, high performance liquid chromatography, affinity chromatography

X ray Crystallography **05 Hrs**
Production of X rays, different X ray methods, Bragg's law, rotating crystal technique, X ray powder technique, types of crystals, applications of X-ray diffraction

Suggested Reading/Reference Books (Latest Edition)

1. Robert M Silverstein, Spectrometric Identification of Organic Compounds, John Wiley & Sons.
2. Doglas A Skoog, F. James Holler, Timothy A. Nieman, Principles of Instrumental Analysis Eastern press, Bangalore.

3. Willards Instrumental methods of analysis, CBS Publishers.
4. Beckett and Stenlake, Practical Pharmaceutical Chemistry, CBS Publishers, New Delhi.
5. William Kemp, Organic Spectroscopy, ELBS.
6. P D Sethi, Quantitative Analysis of Drugs in Pharmaceutical formulation, CBS Publishers, New Delhi.
7. J W Munson, Pharmaceutical Analysis- Modern Methods, Marcel Dekker Series.

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-302	Intellectual Property Rights	3	1	-	30	70	1.5	3	4

Definition, need for patenting, types of patents, conditions to be satisfied by an invention to be patentable, introduction to patent search. **10 Hrs**

Parts of patents, filling of patents, the essential elements of patent, guidelines for preparation of laboratory note book, non-obviousness in patent **10 Hrs**

Role of GATT, TRIPS, and WIPO **05 Hrs**

Brief introduction to trademark protection and WHO Patents, IPR's and its types, major bodies regulating Indian pharmaceutical sector **07 Hrs**

Brief introduction to CDSCO, WHO, USFDA, EMEA, TGA, MHRA, MCC, ANVISA **08 Hrs**

Regulatory requirements for contract research organization, regulations for biosimilar **07 Hrs**

Suggested Reading/Reference Books (Latest Edition)

1. Ira R. Berry and Robert A. Nash, Pharmaceutical Process Validation, CRC Press
2. Willing S.H. Marcel and Dekker, GMP for pharmaceuticals, Marcel Dekker Inc
3. Parikshit Bansal, IPR Handbook for Pharma Students and Researchers, BSP Books Private Limited
4. Josef Drexl, Nari Lee, Pharmaceutical Innovation, Competition and Patent Law: A Trilateral Perspective, Edward Elgar
5. Rashmi Aggarwal and Rajinder Kaur, Patent Law and Intellectual Property in the Medical Field, IGI Global
6. Arthur Miller and Michael Davis, Intellectual Property, Patents, Trademarks, and Copyright in a Nutshell (Nutshells), West Academic Publishing

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-303	Pharmacology & Toxicological Screening Methods	3	1	-	30	70	1.5	3	4

Laboratory Animals **07 Hrs**

Common lab animals: description, handling and applications of different species and strains of animals; transgenic animals: production, maintenance and applications; anaesthesia and euthanasia of experimental animals; maintenance and breeding of laboratory animals; CPCSEA guidelines to conduct experiments on animals; good laboratory practice

Preclinical Screening of New Substances for the Pharmacological Activity **22 Hrs**

General principles of preclinical screening; CNS pharmacology: behavioural and muscle coordination, CNS stimulants and depressants, anxiolytics, anti-psychotics, anti epileptics and nootropics; drugs for neurodegenerative diseases like parkinsonism, alzheimers and multiple sclerosis; drugs acting on autonomic nervous system; respiratory pharmacology: anti-asthmatics, drugs for COPD and anti-allergic; reproductive pharmacology: aphrodisiacs and anti-fertility agents; analgesics, anti-inflammatory and antipyretic agents; gastrointestinal drugs: anti ulcer, anti-emetic, anti-diarrheal and laxatives; cardiovascular pharmacology: anti-hypertensives, anti-arrythmics, anti-anginal, anti-atherosclerotic agents and diuretics; drugs for metabolic disorders like anti-diabetic, anti-hyperlipidemic, and agents; anti cancer agents; immunosuppressants and immunomodulators

Limitations of Animal Experimentation and Alternate animal Experiments **04 Hrs**

Extrapolation of in vitro Data to Preclinical and Preclinical to Humans **02 Hrs**

Regulatory Guidelines for Conducting Toxicity Studies **12 Hrs**

OECD, ICH, EPA, Schedule Y, OECD principles of Good laboratory practice (GLP)

Suggested Reading/Reference Books (Latest Edition)

1. J.H. Burn D.J. Finney and I.G. Goodwin, Biological standardization, Oxford University Press, New York
2. Robert A. Turner, Screening methods in Pharmacology, Academic Press
3. Laurence and Bachrach, Evaluation of Drugs Activities: Pharmacometrics, Academic Press
4. Arnold Schwartz, Methods in Pharmacology , Springer
5. M. N. Ghosh, Fundamentals of experimental Pharmacology, Hilton Company
6. L. J. McLeod, Pharmacological experiment on intact preparations, Churchill Livingstone
7. Vogel H.G., Drug discovery and Evaluation by, Springer
8. Hand book on GLP, Quality practices for regulated non-clinical research and development (http://www.who.int/tdr/publications/documents/glp-handbook.pdf)

9. Schedule Y Guideline: drugs and cosmetics (second amendment) rules, 2005, ministry of health and family welfare (department of health) New Delhi
10. Rick N.G., Drugs from discovery to approval by, Wiley-Blackwell.
11. Shayne C. Gad, Animal Models in Toxicology, CRC Press
12. OECD test guidelines.
13. Karen E. Stine, Thomas M. Brown, Principles of toxicology by, CRC Press
14. Guidance for Industry M3(R2) Nonclinical Safety Studies for the Conduct of Human Clinical Trials and Marketing Authorization for Pharmaceuticals (http://www.fda.gov/downloads/drugs/guidancecomplianceregulatoryinformation/guidances/ucm073246.pdf)

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-304	Biochemical & Separation Techniques	3	1	-	30	70	1.5	3	4

Chromatography **12Hrs**
Introduction, Principles, Types- paper, two dimensional, HPLC, Ion exchange chromatography, Uses, Advantages and Limitations

Spectroscopy **12 Hrs**
UV/Visible spectroscopy, spectrophotofluorimeter, scope, basic principle and uses in biotechnology of different types of spectrometry (NMR, Magnetic resonance spectroscopy)

Radioisotopy **05 Hrs**
Use of radioisotope, detection and measurement of radioactivity, specific activity, applications in biological system, autoradiography

Microscopy **06 Hrs**
Brief introduction, types of microscopes and role in microbiology, structure and function of microscopes (compound microscope, dissecting microscope, phase contrast microscope, scanning electron microscopy)

Filtration **02 Hrs**
Theory and application

Centrifugation **02 Hrs**
Theory and application

Electrophoresis **02 Hrs**
Different methods for proteins and nucleic acids

Molecular Diagnostic Techniques **06 Hrs**
PCR, southern, nothern, western blotting, microarray

Suggested Reading/Reference Books (Latest Edition)

1. Keith Wilson and John Walker, Principles and Techniques of Biochemistry and Molecular Biology, Cambridge University Press
2. P.C. van der Vliet and S. Pillai, Laboratory Techniques in Biochemistry and Molecular Biology, Elsevier

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-305	Bioprocess Technology	3	1	-	30	70	1.5	3	4

Microbial Growth Kinetics **10Hrs**
Batch culture, continuous culture, fed-batch culture, biomass productivity, metabolite productivity, kinetics of microbial growth

Enzymes **07 Hrs**
Classification, uses, methods for immobilization

Fermentation **10 Hrs**
Raw materials used as media for industrial fermentations, development of inocula for industrial fermentations, isolation and preservation of industrially important microorganisms

Design of a Fermenter **10 Hrs**
Aseptic operation and containment, construction materials, temperature control, aeration and agitation, sterilization of the fermenter, air supply and exhaust gas from a fermenter

Recovery and Purification of Fermentation Products **10 Hrs**
Centrifugation, cell disruption, chromatography, ultra filtration, drying

Suggested Reading/Reference Books (Latest Edition)

1. Stanbury, Whitaker & Hall, Principles of fermentation technology, Butterworth Heinemann
2. Shuler M. L. and Kargi F, Bioprocess Engineering,Pearson
3. Pelczar, Chan & Krieg, Microbiology, McGraw-Hill Inc., US
4. Prescott, Harley & Klein, Microbiology, McGraw Hill Education
5. Nduka Okafor, Modern Industrial Microbiology & Biotechnology , CRC Press

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-306	Recombinant Biotechnology	3	1	-	30	70	1.5	3	4

Tools of Genetic Engineering **10Hrs**

Cloning vehicles, modifying enzymes, DNA ligase, DNA polymerase, polynucleotide kinase, T4 DNA ligase, nick translation system, terminal deoxynucleotidy1 transferase, reverse transcriptase, restriction endonucleases Type I & II. etc.

Cloning Vectors **04 Hrs**

Plasmids, lambda phage, phagemids , cosmids, artificial chromosomes, yeast vectors, shuttle vectors, virus based vectors

Methods of Gene Transfer **05 Hrs**

Transformation, transduction , particle gun, electroporation, liposome mediated, microinjection, *Agrobacterium* mediated gene transfer

Preparation and Application of Molecular Probes **06 Hrs**

DNA probes, RNA probes, radioactive labelling, non radioactive labelling, use of molecular probes, DNA fingerprinting

Analysis and Expression of Cloned Gene In Host Cells **10 Hrs**

Expression vectors, restriction enzyme analysis, southern blotting, northern blotting, western blotting, *in-situ* hybridization, colony and plaque hybridization, factors affecting expression of cloned genes, reporter genes, fusion proteins

Gene Libraries **04 Hrs**

cDNA synthesis, genomic DNA libraries, amplification of gene libraries, identifying the products of cDNA clones

Isolation, Sequencing and Synthesis of Gene **04 Hrs**

Different methods of gene isolation, techniques of DNA sequencing, artificial DNA synthesis

Applications of r-DNA Technology **04 Hrs**

Gene cloning in medicine (Insulin, Blood clotting factor VIII), high level expression of proteins in different host systems (*E. coli*, yeast, Insect, mammalian cells), limitation and advantages and novel technologies generation of transgenic animals, applications of PCR (DNA finger printing)

Suggested Reading/Reference Books (Latest Edition)

1. R.W. Old and S.B. Primrose, Principles of Gene Manipulation , Blackwell Scientific Publication
2. B. Lewin Genes VIII, Benjamin Cummings; United States
3. E. L. Winnecker, From Genes to Clones, Vch Pub
4. T.A. Brown, Gene Cloning, Wiley
5. Glick B., Pasternak J., Molecular Biotechnology: Principles and Applications of Recombinant DNA, ASM Press

Course Code	Course Title	Teaching Load			Marks		Exam (hrs)		Credits
		L	T	P	Int.	Ext.	Int.	Ext.	
PHP-307	Plant Tissue Culture	3	1	-	30	70	1.5	3	4

Introduction to Cell and Tissue Culture **06 Hrs**
Conventional plant breeding, tissue culture as technique to produce novel plants and hybrids, tissue culture media (composition and preparation), initiation and maintenance of callus and suspension cultures, single cell clones

Organogenesis: Somatic Embryogenesis **06 Hrs**
Transfer and establishment of whole plants in soil, shoot tip culture, rapid clonal propagation, embryo culture and embryo rescue

Protoplast **08 Hrs**
Isolation, culture and fusion, selection of hybrid cell and regeneration of hybrid plants, symmetric and asymmetric hybrids, cybrids, cryopreservation, slow growth and DNA banking for germplasm conservation

Plant Transformation Technology **06 Hrs**
Basis of tumor formation, hairy root, features of TI and RI plasmids, mechanism of DNA transfer, role of virulence genes, use of TI and RI as vectors, binary vectors, genetic markers, use of reporter genes, reporter gene with intron, methods of nuclear transformation , viral vectors and their application, multiple gene transfer, vectorless or direct DNA transfer (particle bombardment, elctroporation, microinjection), transformation of monocots, transgene stability and gene silencing

Application of Plant Transformation for Productivity and Performance **07 Hrs**
Herbicide resistance (phosphoinothricin, glyphosphate, sulfonyl urea, atrazine), insect resitance (Bt genes, non-Bt like protease inhibitors, alpha amylase inhibitor), virus resistance (coat protein mediated, nucleocapsid gene),disease resistance (chitinase, 1-3 beta glucanase, RIP, antifungal proteins, thionins,PR proteins), nematode resistance, abiotic stress, post harvest losses, use of ACC synthase (polygalactrouranase, ACC oxidase), male sterile lines, bar and barnase systems, carbohydrate composition and storage, ADP glucose pyrophosphatase, biosafety and ethical issues associated with transgenic plants

Chloroplast Transformation **04 Hrs**
Advantages, vectors, success with tobacoo and potato

Metabolic Engineering and Industrial Products **06 Hrs**
Plant secondary metabolites, role of bioreactors for scaling up, biotransformation, biodegradable plastics, polyhydroxybutyrate

Molecular Pharming in Plants **04 Hrs**
Production of therapeutic proteins, edible vaccines antibodies, purification strategies

Suggested Reading/Reference Books (Latest Edition)

1. H.S Chawla, Biotechnology in Crop Improvement, CRC Press
2. J. Hammond , R. McGravey and V. Yusibov, Plant Biotechnology, Springer
3. P.K Gupta, Elements of Biotechnology, Rastogi Publications
4. R.J Henry, Practical application of Plant Molecular Biology, CRC Press

Scheme & Syllabus of

Ph.D. - Food Science & Technology

Batch 2020 onwards

By

Board of Study (Food Science & Engineering)
Department of Food Science & Technology (Main Campus)
IK Gujral Punjab Technical University

Program Outcomes

PO1 Learning to conduct innovative and high quality research to solve emerging problems in Food Science and Technology through applying the fundamental scientific knowledge and designing and conducting research experiments and analysing the findings.

PO2 Conceptualizing and solving scientific and technological problems through lateral and original thinking and evaluating a wide range of potential solutions for those problems to arrive at feasible and optimal solutions after considering public health, food safety, food preservation, novel value-added product development, nutritional enhancement and food security as core areas of expertise.

PO3 Doctoral students will attain professional and leadership skills for professional positions in food and allied industries, government, or research institutes.

PO4 Communication skills and professional approach to convey technical information and defend scientific findings within the scientific community by presenting research to local, regional, and national audiences through publications, report writings and presentations will be enhanced.

PO5 Developing skills and competencies in budding researchers and inculcating the requisite aptitude in them to conduct advanced research in the emerging areas of food science and technology with a rigorous and scientific approach.

Corse Code	Course Type	Course Title	Load Allocation			Marks Distribution		Total	Credits
			L	T	P	Internal	External		
PHDFT-101-20	Compulsory Course	Research Methodology	3	1	0	40	60	100	4
PHDFT-101-20		Research and Publication Ethics	2	0	0	20	30	50	2
PHDFT-201-20	Core Theory Course (Any one)	Advances in Food Processing Technology	3	1	0	40	60	100	4
PHDFT-202-20		Advances in Food Analysis	3	1	0	40	60	100	
PHDFT-203-20		Advances in Food Packaging	3	1	0	40	60	100	
PHDFT-204-20		Processing Technology for Bioactive Compounds	3	1	0	40	60	100	
PHDFT-301-20	Interdisciplinary Course (Any One)	Intellectual Property Rights	3	1	0	40	60	100	4
PHDFT-302-20		Product Design & Development	3	1	0	40	60	100	
PHDFT-303-20		Project Planning & Implementation	3	1	0	40	60	100	
PHDFT-304-20		Food Supply Chain Management	3	1	0	40	60	100	
PHDFT-401-20	Core Presentation	*Presentation	0	0	6	75	-	75	3
		Total	**11**	**3**	**6**	**215**	**200**	**425**	**17**

***Minimum two presentation related to proposed research area of the candidate**

***Non-University Exam**

Dr. Rajneesh Sachdev
Head, DFST

COMPULSORY COURSE

PHDFT-101-20: Research Methodology

Total Marks: 100

L	T	P
3	1	0

Objectives:

1. To acquire the knowledge of fundamental of research.
2. To develop understanding about planning and designing a research problem.
3. To understand various statistical tools for data analysis.
4. To develop the skills related to research publication and thesis writing.

Course outcome:

1. The students would be acquainted with knowledge related to concept, types and objective of research.
2. Knowledge of fundamentals of planning and hypothesising a research problem and designing the experiments would be helpful in effective pursuance of the research objectives.
3. The students would be acquainted with the effective means of writing, compiling, presenting and discussing the findings of the experiments and their further publications in the reputed journals.
4. Knowledge of statistical tools would be instrumental in drawing inferences and conclusive reports from the laboratory experiment results.

Course Content:

Unit I

Introduction: Definition, general and specific characteristics of research, classification, types and objective of research, steps in research process, criteria of good research, basic concept of experiments and research, significance of research.

Planning and designing a research study: choosing a research topic, literature review, research problem formulation, articulating hypothesis, selection of variables, formulation of objectives, research participants.

Unit II

Research methodology and experimental design: Materials and methods, Meaning, nature and types of data: primary and secondary; observational; experimental. Data Collection: types of sampling design and sampling techniques**,** characteristics of a good sample**,** sampling and non sampling errors, preparation of samples, Principles of research design and methodology, general types of research designs and approaches, compilation and documentation of data.

Unit III

Statistical applications and data analysis: An overview of application of central tendency and dispersion, standard deviation, standard error of mean, coefficient of variation, variance, population null hypothesis, level of significance and confidence, power of test, one tail and two tail test, parametric tests: definitions and applications of t-test for one and two sample

means, F test for two variances, analysis of variance (ANOVA) (One way and two way), Basic of correlation and regression analysis.

Unit IV

Thesis writing/ research papers/ review articles: significance of writing of thesis/ research papers/ review articles and presentation, Format of the research report**,** style of writing the report**,** references and bibliography, effective presentation and discussion of results/findings, intellectual property rights and plagiarism.

Books Recommended

1 Basotia, G.R. and Sharma, K.K. 2009. *Research methodology*
2 Chaudhary, C.M. 2009. *Research methodology*, RBSA Publications
3 Kothari, C.R. 2004. *Research methodology: Methods and Techniques*
4 Gupta, S. P. 2008. *Statistical Methods,* Sultan Chand and Sons, New Delhi.
5 Gupta, S.C. & Kapoor, V.K. 2003. *Fundamentals of Mathematical Statistics.* S. Chand & sons.

Mapping of course "Research Methodology – PHDFT-101-20" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	3	3	2	3
	CO 2	3	3	3	3	3
	CO 3	2	2	3	3	1
	CO 4	3	3	3	3	2

PHDFT-102-20: Research and Publication Ethics

Total Marks: 50	L	T	P
	2	0	0

Objective:

1. Awareness of students about philosophy and ethics about publication.
2. Introduce students to the Intellectual honest and research integrity.
3. To impart knowledge of various tools for plagiarism checking.
4. To know about the databases and research metrics.

Course Outcome: After the completion of the course, the students will be able to:

1. Learn the best practices for publication ethics
2. Understand the Ethics with respect to science and research.
3. To know about the various databases sources.
4. Learn about the various tools for plagiarism checking.

Course Content:

Unit I

PHILOSOPHY AND ETHICS: Introduction to philosophy: definition, nature and scope, concept, branches; Ethics: definition, moral philosophy, nature of moral judgments and reactions

SCIENTIFIC CONDUCT: Ethics with respect to science and research, Intellectual honest and research integrity, Scientific misconducts: Falsification, Fabrication and Plagiarism (FFP),Redundant publication: duplicate and overlapping publications, salami slicing ,Selective reporting and misrepresentation of data

Unit II

PUBLICATION ETHICS : Publications ethics: definition, introduction and importance **,**Best practices/standard setting initiative and guideline: COPE, WAME, etc.**,** Conflicts of interest **,**Publication misconduct: definition, concepts, problems that lead to unethical behavior and vice versa, types**,**Violation of publication ethics, authorship and contributorship **,** Identification of publication misconduct, complaints and appeals**,**Predatory publisher and journals

Unit III

OPEN ACCESS PUBLISHING : Open access publications and initiatives**,** SHERPA/RoMEO online resource to check publisher copyright & self-archiving policies**,** Software tool to indentify predatory publication developed by SPPU, Journal finder/ journal suggestion tools viz. JANE, Elsevier journal finder, Springer Journal suggester, etc.

PUBLICATION MISCONDUCT: Subject specific ethical issues, FFP, authorship **,**Conflicts of interest, Complaints and appeals: examples and fraud from india and abroad

Unit IV

SOFTWARE TOOLS: Use of plagiarism software like Turnitin, Urkund and other open source software tools

DATABASES AND RESEARCH METRICS : Databases : Indexing databases **,**Citation databases: Web of Science, Scopus etc.

RESEARCH METRIC: Impact Factor of journal as per Journal Citation Report, SNIP, SJR, IPP, Cite Score, Metrics: h-Index, g index, i10 index, altmetrics

Mapping of course "PHDFT-102-20: Research and Publication Ethics "outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	3	3	2	3
	CO 2	3	3	3	2	3
	CO 3	3	3	3	2	3
	CO 4	3	3	3	3	3

CORE THEORY COURSE

PHDFT-201-20: Advances in Food Processing Technology

Total Marks: 100	L	T	P
	3	1	0

Objectives:

1. To acquire knowledge of emerging / alternative technologies applied to food processing.
2. To enable a student to know the relative advantages / disadvantages over existing technologies.
3. To understand the economics and commercialization of newer technologies.
4. To study about microbial safety of foods by emerging methods.

Course Outcome: On completion of the subject, the students will be able to:

1. Develop an appreciation about need of different emerging techniques used in food processing and preservation.
2. Apply their knowledge on high pressure processing, pulsed electric processing, and hurdle technology in various food industries.
3. Understand the concepts related to membrane technology, supercritical fluid extraction and quality assessment of food using ultrasonic techniques.
4. Get an overview on principles, mechanism and application of nanotechnology in food.

Course Content:

Unit I

Membrane technology: Introduction to membrane processes: micro- filtration, UF, NF and RO and their industrial application.

Supercritical fluid extraction: Concept, extraction methods and its application.

Unit II

Microwave and radio frequency processing: Definition, Advantages, mechanism of heat generation, application in food processing: microwave blanching, sterilization and finish drying.

Hurdle technology: Types of preservation techniques and their principles, concept of hurdle technology and its application.

Unit III

High Pressure processing: Concept, equipment's for HPP treatment, mechanism of microbial inactivation and its application in food processing.

Ultrasonic processing: Properties of ultrasonic, application of ultrasonic as processing techniques.

Unit IV

Newer techniques in food processing: Application of technologies of high intensity light, pulse electric field, ohmic heating, IR heating, inductive heating and pulsed X-rays in food processing and preservation.

Nanotechnology: Principles and applications in foods.

Suggested Readings

- Barbosa-Canovas 2002. *Novel Food Processing Technologies*. CRC.
- Dutta AK & Anantheswaran RC.1999. *Hand Book of Microwave Technology for Food Applications*.
- Frame ND. (Ed.). 1994. *The Technology of Extrusion Cooking*. Blackie.
- Gould GW. 2000. *New Methods of Food Preservation*. CRC.
- Shi J. (Ed.). 2006. *Functional Food Ingredients and Nutraceuticals:Processing Technologies*. CRC.

Mapping of course "Advanced Food Process Technology- PHDFT-201-20" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	3	2	2	3
	CO 2	3	3	2	2	3
	CO 3	3	3	2	2	3
	CO 4	3	3	2	2	3

PHDFT-202-20: Advances in Food Analysis

Total Marks: 100	L	T	P
	3	1	0

Objectives:

1. To develop an understanding about the advanced analytical and instrumental techniques.
2. To illustrate the principle and mechanism of analytical instruments.
3. To describe bio-chemical analysis of food components.

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

1. Have a thorough knowledge about the applications various analytical and instrumental techniques.
2. Understand the mechanisms and principle behind various analytical techniques.
3. Acquaint with the spectroscopic, chromatographic and microscopic techniques
4. Comprehend the field of electrophoresis and textural properties.

Course Content:

Unit I

Spectroscopy: UV-Visible spectroscopy, Atomic absorption spectroscopy, Flame photometry, Fluorescence spectroscopy, Emission spectroscopy, Mass-spectroscopy, Fourier Transform Infra-Red.

Unit II

Methods of separation and analysis of biochemical compounds and macromolecules: Principles and applications of Gas Chromatography, High Performance Liquid Chromatography, Thin layer chromatography.

Unit III

Microscopic techniques: Light microscopy, Scanning electron microscopy, Transmission electron microscopy, particle size analysis, Thermal techniques in food analysis: Differential scanning calorimetry and Thermo gravimetric analysis.

Unit IV

Electrophoresis: Different kinds of electrophoresis, western blotting, gel documentation, Concept of rheology, Textural properties: Classification, objective methods of texture evaluation, Measurement of texture, structural aspects of food texture, engineering approach and techniques for evaluation of food texture.

Recommended Readings:

1. Pare, J. R. J. and Bélanger, J. M. R. (2015). *Instrumental Methods of Food Analysis*: Elsevier
2. Pomeranz, Y. and Meloan, C. E. (1996). *Food Analysis: Theory and Practice* (3 ed.): CBS Publications, New Delhi.
3. Winton, A. L. (2001). *Techniques of Food Analysis:* Agrobios, Jodhpur.
4. Sharma, B. K. (1994). *Instrumental Methods of Chemical Analysis*: Krishna, Meerut.
5. Skoog, D. A., Holler, F. J. and Nieman, T. A. (1998). *Principles of Instrumental Analysis* (5 ed.): Harcourt, Singapore.

6. Gopalan, R., Subramanian, P. S. and Rangarajan, K. (2008). *Elements of Analytical Chemistry*: Sultan Chand & Sons. Food Texture and Viscosity; Concept and Measurement; Malcolm C. Bourne; An Elsevier Science Imprint.
7. *Rheological Methods in Food Process Engineering*; James F. Steffe; Freeman Press.

Mapping of course "PHDFT-202-20: Advances in Food Analysis" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	2	3	2	3
	CO 2	3	2	3	2	3
	CO 3	3	2	3	2	3
	CO 4	3	2	3	2	3

PHDFT-203-20: Advances in Food Packaging

Total Marks: 100

L	T	P
3	1	0

Objective:

1. The purpose of this course is to explain the various recent techniques of food packaging, applications, principles and requirements of these techniques.
2. Identify the purpose, principle and advance knowledge related to the various packaging technology systems.
3. Awareness of students about the recycling of packaging materials, biodegradable packaging materials and safety and legislative aspects.

Course Outcome: On successful completion of the subject, the students will be able to:

1. Comprehend advance knowledge on the properties and production of various packaging materials and effect of various indicators used in supply chain management to indicate the food quality
2. Understand various types of scavengers and emitters for improving the food shelf life.
3. Learn about consumer response about new packaging systems and safety and legislative requirements
4. Acquaint about food-package interaction between package-flavour, gas storage systems for food storage, recycling and use of green plastics for reducing the pollution and their effect on food quality.

Course Content:

Unit I

Active and intelligent packaging techniques, oxygen, ethylene and other scavengers: Oxygen scavenging technology, selection of right type of oxygen scavengers, ethylene scavenging technology, carbon dioxide and other scavengers, antimicrobial food packaging, antimicrobial packaging system, effectiveness of antimicrobial packaging.

Unit II

Advantages of non-migratory bioactive polymers, Inherently bioactive synthetic polymers: types and application, Polymers with immobilized bioactive compounds, defining and classifying time temperature indicators (TTIs), requirements for TTIs, development of TTIs, maximizing the effectiveness of TTIs to monitor shelf-life during distribution, use of freshness indicator in packaging: Compounds indicating the quality of packaged food products, pathogen indicators, moisture regulation: Silica gel, clay, molecular sieve, humectants, irreversible adsorption.

Unit III

Developments in modified atmosphere packaging (MAP): Novel MAP applications for fresh-prepared produce, novel MAP gases, testing novel MAP applications, Applying high O_2 MAP. Combining MAP with other preservation techniques, packaging-flavor interactions:

Factors affecting flavor absorption, role of the food matrix, role of differing packaging materials.

Unit IV

Modern packaging systems: Green plastics for food packaging, problem of plastic packaging waste, range of biopolymers, developing novel biodegradable materials, Integrating intelligent packaging**:** role of packaging in the supply chain, creating integrated packaging, storage and distribution: alarm systems and time temperature indicators, traceability: radio frequency identification, recycling packaging materials: recyclability of packaging plastics, improving the recyclability of plastics packaging, Testing the safety and quality of recycled material, using recycled plastics in packaging, methods for testing consumer responses to new packaging concepts.

Recommended Readings:

1. Jung, H. H. (2014). *Innovations in Food Packaging*: Oxford, London.
2. Ahvenainen. R. (2003). *Novel Food Packaging Techniques*: CRC Publications.
3. Robertson, G. L. (2010). *Food Packaging and Shelf Life*: CRC Publications, New York.
4. Robertson, G. L. (2006). *Food Packaging: Principles and Practice* (2 ed.): CRC Publications, Boca Raton.

Mapping of course "PHDFT-203-20: Advances in Food Packaging" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	1	3	3	3
	CO 2	1	2	1	2	1
	CO 3	1	1	2	1	2
	CO 4	2	3	1	3	2

PHDFT-204-20: Processing Technology for Bioactive Compounds

Total Marks: 100	L	T	P
	3	1	0

Objective:

Objectives:

1. To know the structural properties, sources and importance of bioactive compounds.
2. To impart knowledge of different extraction methods of bioactive compounds
3. To impart knowledge of different analysis methods of bioactive compounds
4. To impart knowledge of encapsulation methods of bioactive compounds

Course Outcome: On successful completion of the subject, the students will be able to:

1. Comprehend advance knowledge on the properties and extraction of various bioactive compounds
2. Understand various types of free radicals and bioactive compounds.
3. Learn about different analysis methods of bioactive compounds
4. Acquaint about interaction between encapsulation materials and bioactive compounds.

Course Content:

Unit I

Bioactive compounds: Introduction, Definition, Classification of bioactive compounds and Fun bnctional foods, Health benefits. Selection and Preparation of Plant and Plant Parts for Phytochemical Analysis: Introduction, collection and Selection of Plant and Plant Parts, Pre-preparation Technique (Cleaning, Drying, Packaging of Dried Plants, grinding, peeling etc.);

Methods of Extraction: Introduction, Organic Solvent Extraction, Extraction with Supercritical Gases, Steam Distillation, Extraction of Essential Oil, Soxhlet Extractor, Accelerated Solvent Extractor, Purification and Concentration of Miscella, Schemes of procedure for extracting Plant Tissues, Other Minor Extraction Methods, Advances in extraction techniques (Ultrasound extraction, microwave extraction etc).

Unit II

Antioxidants**:** Concept of free radicals and antioxidants; antioxidants role as nutraceuticals and functional foods. Invitro study of antioxidant activities and polyphenols.
Qualitative and Quantitative Estimation of Bioactive compounds: Introduction, Gas Chromatography, Liquid Chromatography, High Performance Liquid Chromatography: Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data.

Introduction, Theoretical Principles, overview of instrument, sample handling, interpretation of the produced data – Spectroscopy; Ultraviolet Spectroscopy; Infrared Absorption Spectroscopy; Near- Infrared Absorption Spectroscopy; Mass Spectroscopy.

Unit III

Properties and functions of various bioactive compounds/functional food ingredients: Sources and role of phenolic acids, flavonoids, carotenoids, lycopene, anthocyanin. tocotrienols, chlorophyll, polyunsaturated fatty acids, terpenoids. Protein, complex carbohydrates like dietary fibers as functional food ingredients; probiotic, prebiotics and symbiotic foods, and their functional role.

Different foods as functional food: cereal products (oats, wheat bran, rice bran, etc.), fruits and vegetables, milk and milk products, legumes, nuts, oil seeds and sea foods, herbs, spices and medicinal plants. Beverages (tea, coffee, cocoa, wine, beer) as functional foods/drinks and their protective effects.

Unit IV

Encapsulation and delivery of bioactive compounds: Introduction, Designing of delivery systems incorporated with food bioactive components encapsulation and delivery systems – Emulsion, spray drying, freeze drying, co-extrusion, microencapsulation and Nano-laminated Biopolymer Structures in Foods;

Reference Books

1. *Functional Foods: Biochemical and Processing Aspects*, Volume 1. Giuseppe Mazza. CRC Press.
2. *Handbook of Nutraceuticals and Functional Foods,* Second Edition. Robert E.C. Wildman. CRC Press.
3. *Dietary Supplements of Plant Origin*. Massimo Maffei. CRC Press.
4. *Nutraceutical beverages Chemistry, Nutrition and health Effects.* Fereidoon Sahidi, Deepthi K. Weerasinghe. American Chemical Society.
5. *Vegetables, fruits, and herbs in health promotion.* Ronald R. Watson. CRC Press.
6. *Fruit and Cereal Bioactives: Sources, Chemistry, and Applications.* Özlem Tokusoglu; Clifford Hall III. CRC Press.
7. *Natural Products from Plants*. Leland J. Cseke; Ara Kirakosyan Peter B. Kaufman; Sara L. Warber James A. Duke; Harry L. Brielmann. CRC Press

Mapping of course "PHDFT-204-20: Processing Technology for Bioactive Compounds" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	3	2	1	3
	CO 2	3	3	2	1	3
	CO 3	3	3	2	2	3
	CO 4	3	3	2	1	3

INTERDISCIPLINARY COURSE

PHDFT-301-20: Intellectual Property Rights

Total Marks: 100	L	T	P
	3	1	0

Objective:

1. To sensitize the students regarding the essentials of Intellectual Property Rights,
2. To describe the fundamentals of Intellectual Property Rights,
3. legislations and significance to it in the development of agriculture, food and nutritional security.
4. To describe the procedure of commercial transfer and acquisition of technology.

Course Outcome: After the completion of the course, the students will be able to:

1. Acquaint the students with different IPR and its their importance in protecting individual rights.
2. Understand the Indian Legislations for the protection of various types of Intellectual Properties.
3. Understand the relation between WTO and IPR with Economic Development.
4. Have knowledge regarding licensing and the technology transfer to industry.

Course Content:

Unit I

Need for the introduction of Intellectual Property Right regime; GATT and WTO, WTO and Economic Development, IPR Protection and Economic Development, 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.

Unit II

Fundamentals of patents, copyrights, geographical indications, designs and layout, trademarks: Introduction, Procedure, Infringement

Unit III

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. Introduction of WIPO.

Unit IV

International Treaty on Plant Genetic; Licensing and the Transfer of Technology: Introduction, The Commercial Transfer and Acquisition of Technology, Negotiation of Licensing Agreements, Remuneration, Material transfer agreements, Research collaboration Agreement.

***Recommended Readings*:**

1. Rashmi Aggarwal and Rajinder Kaur, *Patent Law and Intellectual Property in the Medical Field,* IGI Global
2. Arthur Miller and Michael Davis, *Intellectual Property, Patents, Trademarks, and Copyright in a Nutshell (Nutshells),* West Academic Publishing
3. Silke von Lewinski (Edited), *Indigenous Heritage and Intellectual Property,* Genetic Resources, Traditional Knowledge and Folklore, 2nd Edition, (2008), Wolters Kluwer.
4. Paul L.C. Torremans (edited), *Intellectual Property and Human Rights,* Enhanced edition of Copyright and Human Rights, (2008), Wolters Kluwer.
5. Dr. T. Ramakrishan (Edited), *Biotechnolgy and Intellectual Property Rights* (2003), CIPRA, NLSIU, Bangalore.
6. Pat Roy Mooney, *The Law of the Seed: Another Development and Plant Genetic Resources,* Development Dialogue, 1983
7. Daniel Gervais (edited), *Intellectual Property, Trade and Development* (2007), Oxford University Press.
8. Peter – Tobias Stoll, Jan Busche and Katrin Arend (Edited), *WTO-Trade related Aspects of Intellectual Property Rights* (2009) (Vol. 7), Martinus Nijhoff Publishers.
9. A.H. Qureshi, *Interpreting WTO Agreements*, Cambridge.

Mapping of course "PHDFT-301-20: Intellectual Property Rights"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	**PO2**	**PO3**	**PO4**	**PO5**
Course Outcome (CO)	**CO 1**	**1**	**2**	**3**	**3**	**2**
	CO 2	**1**	**1**	**3**	**3**	**2**
	CO 3	**1**	**1**	**3**	**3**	**2**
	CO 4	**1**	**2**	**3**	**3**	**2**

PHDFT-302-20: Product Design & Development

Total Marks: 100	L	T	P
	3	1	0

Objective:

1. To understand the fundamental of product design and development.
2. To understand the consumer role in product development.
3. To acquire the knowledge about the various steps involved in product development process.
4. To understand the legal aspects of new product launch.

Course Outcome: After the completion of the course, the students will be able to:

1. Understand the concept of product design and development.
2. Grasp the role of consumers in product development.
3. Learn about product development technology and technological knowledge about marketing and distribution.
4. Understand the various product development process.

Course Content:

Unit I

Concept of product development - product success and failure, factors for success, process of product development, managing for product's success.

Innovation strategy - possibilities for innovation, building up strategy, product development programme.

Unit II

The product development process - product strategy, product design and process development, product commercialization, product launch and evaluation.

Role of consumers in product development - consumer behaviour, food preferences, avoiding acceptance, integration of consumer needs in product development and sensory needs.

Unit III

The knowledge base for product development technology - knowledge and the food system, knowledge management, knowledge for conversion of product concept to new product, technological knowledge (product qualities, raw material properties, processing, packaging requirement, distribution and marketing.

Unit IV

Managing the product development process, - principles of product development management, people in product development management, designing the product

development process, key decision points, establishing outcomes, budgets and constraints, managing and organizing product development process.

Improving the product development process - key message, evaluating product development, innovative matrices, striving for continuous improvement, Improving success potential of new products, market exploration and acquisition, Legal aspects of new product launch.

Suggested Readings

1. Clarke & Wright W. 1999. *Managing New Product and Process Development.* Free Press.
2. Earle and Earle 2001. *Creating New Foods.* Chadwick House Group.
3. Earle R, Earle R & Anderson A. 2001. *Food Product Development.* Woodhead Publ.
4. Fuller 2004. *New Food Product Development* - from Concept to Market Place. CRC.

Mapping of course "PHDFT-302-20: Product Design & Development "outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	1	1	1	2
	CO 2	1	2	2	3	1
	CO 3	2	3	1	2	2
	CO 4	1	2	2	1	1

PHDFT-303-20: Project Planning & Implementation

Total Marks: 100	L	T	P
	3	1	0

Objective:

5. Awareness of students about fundamentals of project management.
6. Introduce students to the methodology of project formulations and the implementation procedures and strategic planning of new projects.
7. To impart knowledge of project deliverables
8. To know the execution of the project plan and evaluating project progress.

Course Outcome: After the completion of the course, the students will be able to:

5. Learn the strategies of project management
6. Understand the resources planning, cost and budget management.
7. Execute the project plan and evaluation of project progress.
8. Learn about the project quality standards and measurement of performance of those standards.

Course Content:

Unit I

An introduction to project management: An overview of project management. The differences between Product, Project and Program management, Industrial, R&D and social security projects.

Successful Initialization and Project Planning: Defining the project scope. Establishing the project scope and defining project deliverables. Defining and Sequencing of Project Deliverables. Project scheduling techniques, Market research and forecasting. GMP and HACCP.

Unit II

Resource Planning: Determining resource requirements and acquiring those resources, Source of finance, Debt-equity ratio, Debt service coverage ratio, ROI, RONW, Process of soliciting and selecting vendors for material and services for the project. Cost Management. Establishing the project budget and analyzing budget variances, techno-economic feasibility analysis.

Unit III

Execution of the Project Plan and Evaluating Project Progress: Execution of the project plan and activities required to create the project team, monitor progress against the plan, and keep the project on track. Capacity utilization, Breakeven point.

Unit IV

Risk Identification and Analysis: Identify risky events, measure the element of risk, and develop responses to high-risk events. Establishing the Project Management Team Identifying project team members, and structuring a successful project team. Keeping the Project on Track The quality process, Project's quality standards and how performance to those standards will be measured. Managing Project Change Handling formal and informal change, how to identify and evaluate change, and incorporate change into the project plan.

Suggested Readings

Pavlyak MM.2000. *Systems Survival Guide*. Ruby Moon Press.
Thomsett TC.1990. *The Little Book of Project Management*. American Management Association.

Mapping of course "PHDFT-303-20: Product Design & Development"outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	3	3	3	2	3
	CO 2	3	3	3	2	3
	CO 3	3	3	3	2	3
	CO 4	3	3	3	3	3

PHDFT-304-20: Food Supply Chain Management

Total Marks: 100	L	T	P
	3	1	0

Objective:

1. Study the concept, applications, systems and practices of food supply chain management in food industry.
2. Understanding the primary difference between logistic and supply chain management.
3. Understanding of the management components of supply chain management.
4. Knowledge about the professional opportunities in supply chain management.

Course Outcome: After the completion of the course, the students will be able to:

1. Learn the individual process of supply chain management and their interrelationship within individual companies and across the supply chain.
2. Grasp the supply chain information system and integrating the supply chain
3. Understand the concept of supply chain inventory management.
4. An understanding of tools and techniques useful in implementing the supply chain management.

Course Content:

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.

Suggested Readings

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.

Mapping of course "PHDFT-304-20: Food Supply Chain Management" outcomes and Program outcomes:

Formulation of Course Outcomes-Program Outcomes matrix with correlation values as 1 (Low), 2 (Medium), 3 (High)						
	Program Outcome (PO)					
		PO1	PO2	PO3	PO4	PO5
Course Outcome (CO)	CO 1	1	2	2	1	2
	CO 2	2	2	2	1	2
	CO 3	1	2	2	1	2
	CO 4	2	2	2	1	2