

Tribhuvan University
Institute of Science and Technology



B. Tech Food Technology
CURRICULUM
2061 (2005)

Curriculum of B. Tech Food Technology

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Introduction

The first food technology course (certificate level) was introduced in Nepal in 1973 (2030 B.S.). The objective of this course was to produce middle level food technology manpower. The programme was terminated in 1979 whence new bachelor degree programme of B.Tech. Food was introduced in the same year. It is a four-years degree course after I.Sc. or 10+2 Science. The B.Tech. Food is being run by Central Campus of Technology (CCT), Dharan under Institute of Science and Technology, Tribhuvan University.

The course was last revised in 2050 B.S. (1994).

Objectives:

The main objectives of the course are:

1. to provide knowledge in food science and the principles underlying food processing.
2. to give wider knowledge to students in advanced food engineering.
3. to acquaint students with industrial management practices.
4. to train the students in product specific specialization areas.

Eligibility for Admission:

The candidates who have passed in second division I.Sc. or 10+2 science and certificate level of food technology / laboratory technology from Tribhuvan University

or an institute recognized by this university shall be considered eligible to apply for admission to B.Tech.(Food).

Admission Criteria:

Students are selected based on their merit in the entrance examination.

Course structure:

B.Tech. (Food) is based on annual examination system and it is a four years course with total of 2000 marks.

First year courses comprise of basic sciences, engineering and microbiology. Food science courses and other courses fundamental to food processing are taught in the second year. Third and fourth years are devoted to teaching product technology, quality control and food plant management. Besides, dissertation is compulsory.

Some relevant information with regard to the curriculum are as following:

1. During 3rd Year students will be making 10 days Industrial Visit as per the schedule prepared by the Campus. Students shall submit the report after their industrial tour.
2. Dissertation work duration - 2 full months lab. Work & total duration 6 months. Topics for the dissertation work will be decided after recommendation from the food Technology Instruction Committee and approval from the Chairman of the Food Technology Subject Committee.
3. Student will be sent for 45 days in-plant training programme to different food industries in Nepal. The programme will be set by Campus.
4. In each subject (Except Dissertation work) 25% marks will be allotted to the practical work carried out in laboratories & pilot plants.

The detailed structure of the course is as follows:

Course of Study

First Year

Full Marks

1. Physics	100
2. Chemistry	100
3. Math & Statistics	100
4. Instrumental Techniques of Analysis	100
5. Basic & Food Microbiology	100
6. Basic Principle of Engineering	<u>50</u>

Total: 550

Second Year

1. Food Chemistry	100
2. Principle of Food Processing	100
3. Food Engineering (Unit Operation and Process Engineering)	100
4. Biochemistry & Human Nutrition	100(50+50)
5. TFP-I (Cereals, Legumes, Oilseed & Protein Foods)	<u>100</u>

Total: 500

Third Year

1. TFP-II (Fruits & Vegetables, Chocolate & Sugar Confectionary, Tea, Coffee & Spices)	100
2. TFP-III (Meat, Fish & Poultry)	100
3. Biochemical Engineering	100
4. Industrial Microbiology	100
5. Food Quality Control & Analysis	<u>100</u>

Total: 500

Fourth Year

1. Storage & Packaging Technology	100(50+50)
2. Operation Research & Food Plant Management	100
3. Dairy Technology	100
4. Dissertation	100
5. In-plant Training & Class Seminar	<u>50</u>

Total: 450

Grand Total: 2000

Hours of Instruction :

Working days : 150 days in an academic year.

Class hour :

Theory : One theory paper of 100 marks will have 4 lectures per week. A lecture class has duration of 50 min.

Practical : One practical paper of 25 marks will have 4 hours of practical per week.

Attendance : 70 percent attendance in the class is compulsory.

Exam :

A 100-marks paper is divided into theory paper of 75 marks and practical paper of 25 marks. Students will appear in three hours examination for theory paper of 75. The student will have to pass separately in theory and practical examinations.

Evaluation :

Pass Marks : Theory – 35%, Practical – 40%

A student having passed his/her four years of study will be graded as follows:

Distinction – 75% and above (four years' average).

1st division – 60% (four years' average).

2nd division – 45% (four years' average).

3rd division – 35% (four years' average).

FIRST YEAR

PHYSICS

Full Marks : 100

GROUP - A

MECHANICS:

1. *Elasticity*: Concept of safety factor, different types of elastic constants and their relations, twisting of a cylinder and Barton's apparatus, depression of beam under its own weight, I-section girders. 4
2. *Rigid body dynamics*: Solid sphere, fly wheel, uses of fly wheel. 3
3. *Surface tension*: Introduction, surface tension and surface energy, pressure difference across a spherical surface, excess pressure inside a liquid drop or an air bubble, excess pressure inside a soap bubble, angle of contacts, capillarity, velocity of a wave of the surface of a liquid, effect of gravity, surface tension effect. 4
4. *Fluid motion, viscosity and low pressure*: Stream line motion and rate of flow, Equation of continuity, Bernoulli's theorem, Venturimeter, Bunsen burner, Atomiser, Filter pump, Carburetor, Viscosity, Stoke's law, Poiseuille's method for coefficient of viscosity, Ostwald's viscometer, Rotation viscometer, Air pump, Rotary oil pump, Mercury diffusion pump, Pirani gauge, Kaudsen gauge. 5
5. *Waves*: Simple harmonic motion, Helmholtz resonator, torsional pendulum, Compound pendulum, Longitudinal and transverse waves, Pulses and wave trains Wave fronts, production properties and use of ultrasonic waves. 4

Heat and Thermodynamics:

6. *First law of thermodynamics*: Perpetual Motion machine of the first kind, Application of the first law, Analysis of flow process, Control volume, analysis of steady process, Throttling coefficient. 4
7. *Second law of thermodynamics*: Various statements, Carnot's engine and its efficiency, Carnot's theorem, Absolute scale of temperature, Entropy, S-T diagram, Entropy of a perfect gas, Principle of entropy increase, Availability in terms of entropy change. 5
8. *Power and refrigeration cycles*: Vapour power cycles, Carnot's cycle, Rankine cycle, Reheat and regeneration, Gas power cycle, Otto cycle, Diesel cycle, Brayton cycle, Ericson cycle. 6
9. *Refrigeration cycles*: The reversed Carnot's cycle, Vapour compression refrigeration, Gas cycle refrigeration, Absorption refrigeration, Electroflux absorption refrigerator. 4
10. *Thermal radiation*: Concept of black body radiation, Prevost's theory of heat exchange, Stefan's law Kirchhoff's law of black body radiation, Wien's displacement law, Plank's quantum theory of radiations.
11. *Solar radiations*: Composition and temperature of the sun, solar constants, application of solar radiations for water and space heating, basic principle of solar drier and cookers. 4

GROUP - B

OPTICS

12. *Interference*: Young's double slits experiment, optical path length, coherence, Newton's rings, colour in thin films due to transmitted and reflected light. 6
13. *Diffraction*: Frasn timer's assumption zone plate, diffraction at a slit, Fresnel and Fraunhofer diffraction, diffraction pattern due to a narrow slit, maxima and minima in diffraction patterns, theory of plane transmission grating resolving power. 5
14. *Polarization*: Polarization of light, polarization by refraction and reflection, Brewster's laws Malus. law, polarization by absorption and scattering, Nicol's prism. 4
15. *Optical instruments*: The polarizing microscope, ultraviolet microscope, interference microscope, phase contrast microscope, electron microscope. 6
16. *I-R & U-V spectroscopy*: Investigation of I-R spectrum, I-R sources, detectors, I-R spectrographs, applicat timer's of Infrared rays, investiga timer's of U-V spectrum, U-V sources, detectors, properties and applications of U-V radiation, elementary concept of U-V spectrographs. 6

ELECTRICITY

17. *Alternating currents*: Average and r.m.s. value of A.C. form factor, A.C. through R L & C, LC, RC, RL and LCR circuits. Series and parallel resonant circuits, power in A.C. circuits wattless component, skin effect, choke coil, Transformers, A.C. meters, Basic concept of distribution of A.C. single, three phase and poly phase current, star, delta and wye connection, A.C. D.C. dynamics, D.C. Motors, Motor starter, reversal of direction of the rotation uses of electric motors, types of motors. 10

GROUP - C

Modern Physics

18. Thomson's mass spectrograph, Bainbridge and Aston's mass spectrographs, discovery of isotopes, mass energy equivalence. 6
19. Isotopes, application of radio isotopes, medical, industrial, agricultural and scientific research. 5
20. *High energy radiations and health physics*: X-rays and gamma rays: Study and their practical applications, biological effects of radiations, hazards due to external and internal sources, hazards due to radio isotopes, nuclear weapons, shelter from radiations, food and water supply and decontamination, radio-sensitivity, radiation dose and radioactivity units. 10
21. *Semiconductor physics*:
Transistors: PNP NPN, common emitter, common base and common collector characteristics, common emitter amplifier, phase inversion transistor switch, state of transistors, logic gates. 5
22. *Pollution*:
Air Pollution: Structure of the atmosphere from temperature, chemical and physical point of view, air pollutants, effects of air pollution. 2
Water Pollution: Sources of water pollution, effects of water pollution, standards for fresh water, water pollutants. 2
Thermal Pollution: Sources of thermal pollution, effects of thermal pollution, control of thermal pollution. 1
Noise Pollution: Introduction, effects of noise pollution, prevention and control of noise pollution. 1
Radioactive Pollution: Introduction, Nuclear weapons and testing, effects of radioactive pollution, prevention and control. 1

Environmental Pollution: Effects on humans, animals and plants, global effects, effects on climate. 1

Practicals:

1. Measurement of moment of inertia of a fly wheel.
2. Compound pendulum.
3. Density/sp.gr.of food materials (egg, spices, grains, fats and oils).
4. Surface tension of liquids/milk.
5. Coefficient of viscosity of mustard oil (Stoke's method).
6. Refractive index of transparent liquids.
7. Measurement of c_p/c_v of air by Clement & Desorme's apparatus.
8. Measurement of Young's modulus and Rigidity modulus.
9. Measurement of sp. heat of vegetable oils and grains.
10. To study the characteristics of a triode, diode and NPN & PNP transistors.
11. Melting points of ghee and vegetable ghee.
12. To use a Geiger-Muller counter for the study of background radiations and measurement of half-life of a radioactive source.

Textbooks:

1. J.K. Ghosh, D.N. Basudeo. Electricity.
2. Brijlal Subramanham D.N. Basudeo, D.S. Mathur. Mechanics.
3. Greene Murugesan & J.B. Rajan. Modern physics.
4. Brijlal, Subramanham & Khandelwal. Optics.
5. Brijlal, Subramanham. Heat & thermodynamics.

CHEMISTRY

Full Marks : 100

Group A: Organic Chemistry

40 hours

1. Analysis of organic compounds
 - a. Qualitative and quantitative analysis of carbon, hydrogen, nitrogen and halogens.
 - b. Determination of molecular weight of organic acids and bases.
2. Properties of molecules
 - a. The electronic theory of valency
 - b. Atomic and molecular orbitals, shape of molecules, orbital picture of benzene.
 - c. Electronic displacements in a molecule
 - i. Inductive effect
 - ii. Electromeric effect
 - iii. Mesomeric effect (or resonance)
 - iv. Tautomerism
3. The general nature of organic reaction
 - a. Transition state theory of reaction, energy of activation.
 - b. Homolytic and heterolytic fission of bonds
 - c. Reaction kinetics
 - d. Thermodynamic properties
 - e. Use of isotopes in organic chemistry
4. Different types of organic reactions
 - a. Substitution reaction in aliphatic and aromatic compounds
 - b. Polymerization reactions: Addition polymerization, condensation polymerization, and free radical polymerization.
 - c. Condensation reaction: Aldol condensation and Claisen condensation

- d. Intermolecular reaction (1, 2 shifts rearrangement involving bridged or non-classical carbonium ion)
 - e. Biochemical reaction: Biological oxidation and reduction (ethyl alcohol to acetaldehyde and vice versa), fermentation
5. Stereochemistry
- a. Chirality
 - b. Specification of absolute configuration
 - c. Optical activity
 - d. Optical activity of lactic and tartaric acids
 - e. Geometric isomerism of malic and fumaric acids

Group B: Organic Chemistry

40 hours

- 6. Alicyclic compounds: Nomenclature, Baeyer strain theory, conformational analysis
- 7. Polynuclear hydrocarbons: General introduction and nomenclature, structure, preparation and properties of naphthalene and anthracene
- 8. Heterocyclic compounds: Nomenclature, preparation, properties and molecular orbital picture of furan, thiophene, pyrrole, furfural, and pyridine
- 9. Dyes and photochemistry: Colour and constitution, colour and dyes, classification, general studies on azodyes (methyl red, aniline yellow), phthaleins (phenolphthalein, fluorescein), triarylmethanedyes (crystal violet)
- 10. Alkaloids: Definition, classification, extraction, general properties and structure and uses
- 11. Introduction to anthracynine, flavonoids, flavones and their uses
- 12. Carbohydrate: Introduction, classification, structure elucidation of (+) glucose, configuration, ring structure determination.

13. Protein: Classification and function, denaturation. structure of amino acid, isoelectric point, geometry of peptide linkage, analysis of amino acid from protein hydrolysates (C-terminal and N-terminal)-amino acid determination.

Group C: Physical Chemistry

40 hours

14. Atomic structure: Bohr's theory of atomic structure. derivations of equations for radius and energy of electron in hydrogen atom, explanation of hydrogen spectra. limitations of Bohr's theory, Sommerfeld extension of Bohr's model.
15. Radioactivity: Types of radiation, types of radioactivity decay, the group displacement law, half life and average life. radioactive disintegration series of uranium. artificial radioactivity
16. Ionic equilibrium: Autoionization of water, pH and pH scale, acid base indicators, theories of acid base indicators, choice of indicators in acid base titration, buffer solution. Henderson equation, hydrolysis of salt
17. Thermodynamics: Scope and limitations of thermodynamics. energy and its units, some thermodynamic terms, reversible and irreversible process, First law of thermodynamics, mathematical formulation, sign convention of work and energy, isothermal reversible and irreversible expansion of ideal gas, enthalpy and enthalpy changes, Hess's law of constant heat summation, enthalpy change from bond energy, heat capacities, relation between C_p and C_v , temperature dependence of heat capacities (Kirchhoff's law). calorific values of fuel and calorific values of food. Second law of thermodynamics, entropy, entropy and spontaneity of a process, entropy change for a non-

spontaneous process, Third law of thermodynamics, evaluation of absolute entropy, free energy, work function, and their significance, criteria of spontaneity.

Practicals

Identification of functional groups ($-\text{COOH}$, $-\text{CHO}$, $=\text{CO}$, $-\text{NH}_2$, NO_2 and -phenol).

Organic preparation: Acetanilide or aspirin, benzoic acid.

Isolation of lactose from milk, caffeine from tea, citric acid from lemon. Volumetric analysis involving redox reaction (use of permanganate, dichromate, and iodine), and use of EDTA.

Gravimetric analysis: Estimation of Ca, Fe, Ni, chloride and sulphate.

Text and reference books:

1. R.T. Morrison and R.N. Boyd, *Organic Chemistry*, Prentice Hall of India.
2. I.L. Finar, *Organic Chemistry* Vol I and II, ELBS, Longman.
3. N.K. Visnoi, *Advanced Practical Organic Chemistry*, Vikash Pub Ltd, India.
4. B.S. Bahl, G.D. Tuli and Arun Bahl, *Essential of Physical Chemistry*, S. Chand & Company, New Delhi.
5. M.K. Sthapit, *Selected Topics in Physical Chemistry*, Taleju Prakashan, Kathmandu, Nepal.
6. M.K. Sthapit and R.R. Pradhananga, *Elementary Chemical Calculations*, 2nd edition, Taleju Prakashan, Kathmandu
7. S.H. Maron & F. Prutton, *Principle of Physical Chemistry*, Oxford & IBH Pub. Co.
8. *Vogel's Textbook of Quantitative Analysis* revised by G.H. Jeffry, J. Bassett, J. Mendham and R.C. Denney, ELBS with Longman.

MATHEMATICS AND STATISTICS

MATHEMATICS

Full Marks : 25

GROUP-A

Unit 1. Differential calculus: 12

- * Revision of the notion of differential coefficient and derivative.
- * Successive derivatives and the use of Leibnitz's theorem.
- * Rolle's theorem, Lagrange's mean value theorem and their uses.
- * Indeterminate forms and L. Hopital's rule.
- * Maxima and minima.
- * Partial differentiation, higher order derivatives, use of Euler's theorem, total differential coefficient and approximate calculation.

Unit 2. Integral calculus: 12

- * Revision of rules and different standard methods of integration.
- * Anti-derivatives of some standard forms and rational fractions.
- * Anti-derivatives of some standard forms and rational fractions.
- * Properties of definite integral, area under plane curves (with reference to under plane curve, ellipse, parabola, circle and between curves and lines).
- * Double integral (simple problems).

Unit 3. Differential equation and industrial math: 12

- * Definition and classification, formulation of differential equations.
- * Solutions of differential equation of first order first degree (by variable separation, homogeneous equation, exact equation and linear equation method).
- * Linear differential equation with constant coefficients (equation of second order).
- * Homogeneous linear equation.
- * Application of math in food industry (industrial math).

STATISTICS

Full Marks : 50

GROUP-B

Unit 1: Descriptive Statistics

- 1.1 Data Presentation: 5
- * Nature and sources of statistical information.
 - * Frequency distribution.
 - * Tabular, diagrammatic and graphic presentation of data.
- 1.2 Fundamental statistical measures: 10
- * Measures of location, partition values and dispersion.
 - * Concepts of moments, measures of skewness and kurtosis.
- 1.3 Correlation, regression and least square fitting: 10
- * Scatter diagram, correlation, coefficient of correlation and coefficient of determination, Spearman's rank correlation.
 - * Linear regression, coefficients of regression, multiple and partial correlation coefficient, fitting of multiple regression up to 3 variables.

- * Principle of least square, fitting of polynomials and exponential curves.

Unit 2: Probability

2.1 Introduction to probability and random variables: 10

- * Random experiment, events, types of events and sample space.
- * Definitions, axioms, interpretation and properties of probability.
- * Additive and multiplicative laws of probability, conditional probability and Bay's theorem.
- * Definition of random variable (discrete and continuous).
- * Distribution function (discrete and continuous).
- * Mathematical expectations of r.v., sums and averages.
- * Jointly distributed r.v. and their expectations, covariance and correlation.

2.2 Probability distributions: 12

- * Discrete Probability Distributions: – Concept, definition, derivations of distribution functions properties, and applications of binomial and Poisson's distribution.
- * Continuous Probability Distribution: – Concept, definition, properties, importance and applications of normal distribution.

Unit 3: Statistical methods:

3.1 Sampling and Estimation: 8

- * Concept of sample and population, principles of sampling, random and non-random sampling, types of random sampling, methods of sampling, sampling error, standard error, concepts of sampling distribution.

- * Theory of estimation, Properties of good estimator (definitions only), point and interval estimates, confidence interval for population mean and proportion, determination of sample size.

3.2 Significance testing: 9

- * Concept of null and alternative hypothesis, formulation of hypothesis, hypothesis testing procedure, two types of error in hypothesis testing, one tailed and two tailed tests.
- * Chi squared tests.
- * T and Z tests.
- * F value.

3.3 Analysis of variance: 5

- * Concept of design of experiment in field and laboratory.
- * Analysis of variance of one way and two way classification.
- * Comparison of mean by LSD and DMRT.

3.4 Statistical quality control: 7

- * Importance of statistical method in industrial research and practices, causes of variations, control limits and tolerance limits.
- * Control charts for variables (mean and range chart).
- * Control charts for attributes (p-chart, C-chart, np chart).
- * Acceptance sampling plans for attribute and variables (single and double sampling plan).

Practicals: Statistical Computations

Full Marks : 25

- * Construction of tables, bar diagrams, pie charts and graphs (frequency polygon and curve, histogram and Ogive).
- * Computations of mathematical and non-mathematical averages.
- * Computations of measures of dispersion (Q.D., M.D., S.D. and C.V.).
- * Computation of moments, coefficients of skewness and kurtosis.
- * Computation of regression and correlation coefficients.
- * Fitting multiple regression line; finding multiple and partial correlation coefficients.
- * Least square fitting of up to 3 degree, fitting exponential curves.
- * Computation of probabilities in different conditions.
- * Fitting binomial, Poisson's and normal distribution.
- * Finding areas under normal curve in different conditions.
- * Test of single mean for large and small sample (variance known/unknown case).
- * Test of equality of two population means for large and small samples (variance known/unknown case).
- * Test for a proportion and the test for equality of two proportions.
- * Test for a population variance and two population variances.
- * Test for goodness of fit and test for consistency in 2×2 table.
- * Carry out one way and two way ANOVA.

- * Construction of mean and range chart, p-chart, c-chart, np-chart.
- * Exercises on statistical computation using software packages like Excel, d-Base and SPSS.

Textbooks:

Das, B.C. & Mukherjee, B.N. Differential Calculus, U.N. Dhur & sons Pvt. Ltd. India.

Das, B.C. & Mukherjee, B.N. Integral calculus and Differential equation, U. N. Dhur & sons Pvt. Ltd. India.

Pant, G.d. & Shrestha, G.S. Integral calculus and Differential equation, Sunila Prakasan, Kathmandu, Nepal.

Singh M.B., & Bajracharya, B.C. Differential Calculus, Sukunda Pustak Bhawan, Kathmandu, Nepal.

Thomas, G.B. & Finney, R.L. Calculus and analytical geometry, Pearson Education Asia, India.

Saxena, H.C. Statistics and Probability - concepts and techniques, Ekta books Distributors, Nepal.

Snedecor, G.W. & Cochran, W.G. Statistical Methods, East West Press New Delhi, India.

Montgomery, D.C. Introduction to Quality Control, John Willey & sons.

Instrumental Techniques of Analysis

Full Marks : 100

GROUP-A

1. Visible and Ultraviolet Spectroscopy: 7
 - a) Introduction and elementary theory.
 - b) Instrumentation, measurement and sample handling.
 - c) Applications: 1) Chromophores- Isolated functional groups. 2) Quantitative studies concentration, rate measurements and acid/base dissociation.
2. Infrared Spectroscopy: 5
 - a) Introduction and elementary theory.
 - b) Instrumentation and sample handling.
 - c) Applications: i) Identification ii) Purity iii) Kinetic Studies.
3. Flame Emission Spectroscopy: 5
 - a) Introduction and elementary theory of flame photometry.
 - b) Instrumentations.
 - c) Applications: Qualitative and Quantitative.
4. Atomic Absorption Spectroscopy: 5
 - a) Introduction and elementary theory.
 - b) Principle and instrumentation.
 - c) Applications: Qualitative and Quantitative.
5. Absorption Flame photometry: 5
 - a) Introduction and elementary theory.
 - b) Instrumentation and preparation of samples.
 - c) Applications: Qualitative and Quantitative.
6. Conductometry Titrations: 5
 - a) Introduction and principle.
 - b) Applications: i) Acid/base titrations
ii) Dissociation constant of an acid.

7. pH-Titrations: 5
 - a) Introduction and determination of pH.
 - b) Hydrogen electrode, Quinhydrone electrode and Glass electrode.
 - c) Applications: i) Preparation of Buffer solutions and determination of pH. ii) Acid/base titrations.
8. Potentiometric Titrations: 5
 - a) Introduction and principle.
 - b) Instrumentation and different types of potentiometric titrations.
 - c) Applications: Determination of the end points in redox titrations and precipitation reaction.
9. Refractometry: 5
 - a) Introduction, specific and molecular refractivity and factors affecting refractive index measurement.
 - b) Instrumentations.
 - c) Applications: Qualitative and Quantitative analysis, Molecular refractivity and Chemical constituents.
10. Chromatography: 7
 - a) Introduction and classification.
 - b) Principles-Techniques and Instrumentation and applications.
 - c) Paper chromatography, TLC, Column chromatography and Gas chromatography, HPLC.
11. ELISA Technique: Introduction, instrumentation, applications. 3
12. Nuclear Magnetic resonance: Introduction, construction and instrumentation, principle, applications. 3
13. Electrophoresis: Introduction, types, construction and instrumentation, principle, applications. 7
14. Amino acid Analyser: Introduction, construction and instrumentation, principle, applications. 4

15. Electric & Electronic balance: Introduction, construction and instrumentation, principle, applications. 3
16. Polarography: Introduction, construction and instrumentation, principle, applications. 4
17. ESR: Introduction, construction and instrumentation, principle, applications. 3
18. NQR: Introduction, construction and instrumentation, principle, applications. 4

GROUP-B

19. Solutions: 6
 - a) Introduction and types of solutions.
 - b) Theory of fractional distillation and experimental details.
 - c) Theory of steam distillation and experimental details.
20. Theory of Dilute Solutions: 4
 - a) Introduction and colligative properties.
 - b) Experimental determinations of molecular weight & calculations.
21. Distribution Law: 4
 - a) Nernst's law and explanation and modification.
 - b) Henry's Law and explanation and its applications.
22. The phase rule: 3
 - a) Introduction and derivations.
 - b) One component and two component systems and their applications.
23. Chemical Kinetics: 6
 - a) Introduction and explanations.
 - b) Order of reactions with examples and calculations.
24. The colloidal state: 3
 - a) Classification and preparations.
 - b) Properties and applications.

Practicals:

1. Acid/base titrations by using pH-meter.
2. Redox titrations by using potentiometer.
3. Use of electric and electronic balance.
4. Determination of concentration of unknown solution by using colorimeter.
5. Acid/base titrations by using conductimeter.
6. Separation of mixture by TLC and column chromatography.
7. Separation of mixture by paper chromatography.
8. Separation of mixture by fractional distillation.
9. Purification of crude sample by steam distillation.
10. Determination of total soluble solid and sugar by refractometer.
11. Determination of Na, K and Ca by flame photometer.
12. Determination of molecular weight by Beckman's method.
13. Determination of order of reaction.
14. Drawing of solubility curve of two immiscible liquids.
15. Preparation of colloidal solutions.
16. Estimation of oil Soxhlet extraction method.

Textbooks:

1. Willard Merit and Dean. Instrumental methods.
2. Sylvester. Spectroscopy.
3. Chatwal & Anand. Instrumental analysis.
4. R.L. Stock. Chromatographic method.
5. Camp. Spectroscopy.
6. A.I. Vogel. Experimental inorganic chemistry.
7. A.I. Vogel. Experimental organic chemistry.

BASIC AND FOOD MICROBIOLOGY

Full Marks : 100

1. Introduction & scope of microbiological science. 4
2. Use of different types of microscope. 5
3. Morphology, reproduction and cytology of bacteria, yeast, mould, Rickettsia, virus & protozoa. 12
4. Nomenclature, classification, diagnostic features of major groups. 8
5. Physical and chemical factors influencing the control of microorganisms including thermal death time, Z, F and D value. 10
6. General principal and application of serology and immunology. 8
7. Bacterial nutrition and metabolism. 10
8. Growth, reproduction, transformation, conjugation, transaction, mutation and spore formation of microorganism and study of growth curve. 18
9. Microbiology of meat and meat products, milk and milk products, fruits and vegetables and their products, cereals and their products, egg and egg products, spices and food additives. 25
10. Principles of food plant sanitation. 4
11. Food contamination, infections, intoxication and mycotoxin 10

Practicals:

1. Microscopy and micrometry.
2. Cleaning and sterilization of glasswares.
3. Preparation of nutrient media and technique of inoculation.
4. Staining techniques:- a) Monochrome staining
b) Negative staining c) Gram staining d) Acid fast staining e) Spore staining f) Fazole staining g) Flagella staining.
5. Isolation of pure culture.
6. Identification of bacteria: a) Culture characteristics
b) Morphological characteristics c) Agglutination test for Salmonella d) Biochemical characteristics e) Acid and gas production from sugar f) Starch hydrolysis g) IMVIC test h) Gelatine liquifacation i) Hydrolysis j) Catalase test.
7. Anaerobic culture method.
8. Growth characteristics of bacteria: a) Direct and plate count method b) Generation time c) Factors influencing (pH, temp., acid, sugar, and salt etc) the growth of microorganisms, examination of moulds important in foods.
9. Microbiological examination of water, sugar, spice, salt, different types of fresh and processed foods.
10. Microbiological examination of tablewares and kitchenwares.
11. Microbial examination of meat and milk products.

Textbooks:

1. W.C. Frazier a& D.C. Westhoff. Food Microbiology. Tata Mcgraw Hill publishing company Ltd. New Delhi.
2. James M. Jay. Modern Food Microbiology. CBS publisher and Distributors, New Delhi.
3. Pelczar, Reid & Chan. Microbiology. Tata McGraw Hill publishing, New Delhi.
4. Thomas D. Brock and Modigan. Biology of Microorganisms.

Reference Books:

1. M.R. Adams & M.O. Moss. Food Microbiology. New age international (P) Ltd. Publisher New Delhi.
2. R.K. Robinson. Dairy Microbiology Vol.-I, II Elsevier Applied Science Publishers, London.
3. M.H. Brown. Meat Microbiology. Elsevier Applied Science Publishers, London.
4. Betty C. Hobbs. Food Poisoning and Food Hygiene.

Practical Books:

1. W.T. Harrigan & Margaret E. Mccance. Laboratory Methods in Food and Dairy Microbiology.
2. S.P. Gupta. Laboratory Methods in Food and Dairy Microbiology. Academic Press, London.
3. Association of official Analytical Chemists. Bacteriological Analytical Manual, 7th edn.
4. Maheswari & Debey. Practical Microbiology. Tata MacGraw Hill Publishing House, New Delhi.
5. J.B.K.C. & B.K. Rai, Experiments in Basic Food Microbiology., Ekta Book.

BASIC PRINCIPLES OF ENGINEERING

Full Marks : 50

Introduction: The graphic language, principles of projection of points, straight lines, planes, solids, isometric projection, and intersection.

1. Unit, Dimension and their conversion with special emphasis to SI system. 5
2. Refrigeration-Principles of refrigeration, Basic refrigeration cycle and concepts of vapour compression cycle. Refrigerants- Ammonia, freon brines, their properties & comparison. 8
3. Properties of steam and steam generation devices and their utilization. Types and characteristics of fuels used in thermal power generation. 8
4. Psychrometry- Humidity, relative humidity, water activity, dew point applications of psychrometric chart. Importance of humidity in Food. 8
5. Temperature/pressure measuring devices and their application. 8
6. Fluids. Types and uses of valves, types of pumps. 8
7. Electricity- AC/DC concept, converters transformers. Principles & types of electric motor, fuse, switches, basic understanding of electric circuit, composition and engineering properties of constructional materials, insulation materials (cast iron, steel, stainless steel, galvanised iron, copper, aluminium etc.) 8
8. Mechanical power transmission - methods and principles. Gear system and hydraulic transformation, bearings, couplings, cranks, shafts etc.
9. Pumps: type, working principle and industrial application.

Practicals:

1. Simple engineering drawing.
2. Third angle projection method.
3. Exercise in relation to dimensional conversions.
4. Exercise in relation to uses of steam table.
5. Exercise in relation to uses of psychometric charts.
6. To study different parts and refrigeration controls of the following:
 - a) Refrigerator,
 - b) Water cooler,
 - c) Deep freezer compare their cooling coil and internal systems.
7. Measurement of power in 3 phase circuits.
 - a) For balance load.
 - b) For unbalance load by wattmeter and power meters.
8. Polarity test, no load test, efficiency & regulation tests of single phase transformer.
9. Study of various measuring instruments.
10. Calculation of refrigeration load.

Textbooks:

1. S.C. Aror & S. Domkundwar, A course in Refrigeration and air-conditioning. Dhanpat Rai & Co. (Pvt.) Ltd., Delhi.
2. P.K. Nag Engineering Thermodynamics, Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. S.B. Mathur and S. Domkundwar, Mechanical Engineering, Dhanpat Rai & Sons Delhi.
4. N.D. Bhatt. Elementary Engineering Drawing.

SECOND YEAR

FOOD CHEMISTRY

Full Marks : 100

1. Introduction to chemical composition of Food. 3
2. Classification, physical and chemical properties of food carbohydrates, monosaccharides (chemistry of glucose and fructose only), glycose syrup (corn syrup) - general properties, manufacture (both acidic and enzymatic) and its industrial application general review of fructose, mannose and others.

Diasccharides: General comparative studies of sucrose, maltose, lactose and other related compounds. 24

Polysaccharides: Detailed study of starch (physical, chemical properties, industrial uses), general properties of cellulose, hemicellulose and crude fibres, chemistry of glycogen and gums. 16

3. Proteins: Occurrence, physical and chemical properties, peptide bond, amino acid, classification of proteins, their properties and determination of protein. 7
4. Examples of Food protein (comparative studies of milk, meat and wheat proteins). 2
5. Lipids: Definition, occurrence & composition, fatty acids, fats & their physical & chemical properties, identification on natural fats & oils, manufacture of edible oil, hydrogenation. Rancidity- different types of rancidity and antioxidants. Brief discussion on salad, cooking and frying oils, shortening and margarine. 16

6. Pectic substances: Occurrence, structure, pectolytic enzymes, use of pectin as a jellifying agent, theories of gel formation, coagulation & cloud stability, use of pectin in food. 6
7. Minerals in food: Their biochemical function and composition, method of their determination- Ca, Fe, K, Na etc. 6
8. Vitamins in Foods: Occurrence, structure and their importance, effect of processing on vitamins. 6
9. Natural pigments in foods: brief chemistry of chlorophylls, carotenoids, and anthocyanins. Effect of processing and cooking. 8
10. Chemistry of natural food colourants such as turmeric, caramel and annato. 2
11. Moisture in foods: types and chemistry, hydrogen bonding, bound water, free water, water activity, methods of moisture determination. 6
12. Food additives: Synthetic colour, flavour intensifiers- monosodium glutamate (MSG). Emulsifier. Artificial Sweeteners (succharin, cyclamates). 8
13. Browning in food: Nonenzymatic browning-maillard's reaction, ascorbic acid oxidation, caramelization browning mechanism, methods of preventing browning. Enzymatic browning: Mechanism, methods of prevention. 10

Practicals:

1. Proximate analyses of food - determination of moisture, carbohydrate, crude protein, ash, crude fibre and fat.
2. Determination of acidity and pH of food materials.
3. Quantitative test for protein - Formal titration & Kjeldahl method.
4. Carbohydrates: Estimation of reducing sugar, estimation of starch by hydrolysis.
5. Oil & fats: Determination of acid value, saponification value, iodine value, peroxide value. R.M. value, K value.
6. Estimation of ascorbic acid.
7. Estimation of minerals: Ca and Fe.

Textbooks:

1. Lillian Hozland Mayer. Food chemistry.
2. Owen and Fennema. Principle of food science - Food chemistry.
3. Prank A Lee. Basic food chemistry.
4. J.L. Jain. Fundamental of Biochemistry.
5. Z. Berk. Brareman; Introduction to biochemistry of food.
6. G.G. Birch. Sugar - science and technolgy.
7. Glucose syrup.
8. BS Bahl. Organic chemsitry.

Principle of Food Processing

Full Marks : 100

1. Introduction, historical development of food preservation. 4
2. Deterioration and spoilage of foods: Definition, factors, control. 4
3. Post harvest operations: cleaning storage and grading, peeling, trimming and blanching.
4. Hurdles concept of food preservation. 6
5. Food preservation by dehydration: principle, moisture content vs a_w , dehydration process, drying equipments 20
6. Food preservation by high temperatures: principle, pH classification of foods, pasteurization, canning, thermobacteriology, canning process, aseptic processing, spoilage of canned foods. 26
7. Preservation of fresh produce: principle, cellar storage, chilling storage, gas storage (MAS, MAP, CAS), freezing, freezing curves, ice crystal formation, freezing methods freezing equipments, calculation of ton's of refrigeration. 22(13 hrs)
8. Food preservation by preservatives: introduction, chemical, natural and biopreservatives. 10
9. Radiation preservation of foods: introduction, definition of units and terms, dose and dosimetry, mode of action, radiation source, applications, merits and demerits of irradiation. 10
10. Principle of food concentrates such as jam, jelly preserves. 4
11. Principle of food fermentation: Principle, importance, types fermented foods (wine, vinegar, beer, pickle). 6

12. Non-conventional methods of food preservation.
Introduction to high hydrostatic pressure, high intensity pulsed electric fields etc. 4
13. Traditional and indigenous methods of food preservation. 4

Practicals:

1. Preparation and measurement of brines and syrups.
2. Test of adequacy of blanching.
3. Dehydration of different fruits and vegetables.
4. Canning fruits, vegetables and meat.
5. Preparation of squash.
6. Preparation jam, jelly and marmalade.
7. Preparation of wine, brandy and pickles.
8. Freezing of foods.
9. Calculation of processing time (F value)
10. Visits of neighbouring food processing factories.
11. A survey of traditional and indigenous methods of food preservation.

Textbooks:

1. Desrosier, N.W. and Desrosier, J.N. (1987). The technology of food preservation, 4th edn. CBS Pub. Dist., India.
2. Lal G. Siddappa, G.S. and Tendor, G.L. (1998). Preservation of fruits and vegetables, ICAR, New Delhi, India.
3. Potter, N.P. (1987). Food Science, 3rd Edn. CBS pub., Dist., India.
4. Fellows, P.J. (1990). Food processing Technology - Principles and Practice, Ellice Horwood Ltd. UK.
5. Kharel, G.P. Principles of Food Preservation (in press).
6. Rahman, M.S. (1999). Handbook of Food Preservation, Marcel Dekkar, Inc. NY.

Food Engineering

(unit operations and process engineering)

Full Marks : 100

Part A : Unit Operation:

1. *Concept of unit operation:* 4
 - (a) Mass balance (b) heat balance (c) importance and examples of mass and heat balances in food processing operations.
2. *Fluid flow:* 2
 - (a) Fluid pressure: relation between absolute pressure, gauge pressure and vacuum, fundamental equation of hydrostatics, measurement of pressure difference, manometers.
 - (b) Stady Fluid Flow: 3
continuity equation, Bernoulli's eqⁿ and its application (at least two examples).
 - (c) Flow patterns: 4
Laminar and turbulent flow, Reynold number, flow measuring equipments (venturi meter, orifice meter, pitot tube and rotameters).
 - (d) Flow of Fluids in tubes: 4
concept of viscosity, Newtonian and non- Newtonian fluids, velocity profile, friction factors (Fannin's and Darcy), use of Moody's diagram.
 - (e) Head losses: 4
Head losses in tube flow, head loss in bends joint expansion, joint contractions, valves, loss coefficients.
 - (f) Transportation of fluids: 4
Structure and working principle of centrifugal and gear pumps, selecting of pumps.

3. *Heat transfer:* 6
- (a) Conduction: Fourier's law, thermal conductivities, heat transfer through a slab and cylinder, resistances in series. Introduction to unsteady state conduction, thermal diffusivities, Biot and Fourier numbers.
 - (b) Convection: 6
Natural and forced convection, surface heat transfer coefficients, overall heat transfer coefficient, dimensionless numbers and their applications, heat transfer through boiling liquids and condensing vapours (Introduction only)
 - (c) Heat Exchangers: 6
Shell and tube heat exchangers (single shell pass and multi tube passes), LMTD, NTU, NTU analysis, parallel flow and counter flow heat exchangers, fouling factors, plate heat exchanger, design of shell and tube exchangers.
4. *Evaporation:* 6
Boiling point elevation, structure and working principle of central circulating evaporators, climbing and falling film evaporators, mass balance, heat balance relation between feed temperature and live steam consumed, single effect and multi-effect evaporation, accessories of an evaporator.
5. *Distillation:*
- (a) Vapour- liquid relationship, Raoult's law, boiling point diagram (t-x-y graph and x-y graph) of binary mixtures. 3
 - (b) Batch distillation. 2
 - (c) Rectification: rectification column, and its accessories (condensers, reboilers etc working principle of rectification column, equation of operating lines, effect of feed temperature, calculation of ideal plate

calculation of ideal plate numbers (McCabe- Thiele diagram, Lewis method, minimum reflux method), calculation of column diameter. 6

6. *Drying:*

(a) Psychrometry: dry bulb and wet bulb temperatures, humidity and relative humidity, dew point specific weight and specific volume, enthalpy, application of psychrometric chart in drying. 3

(b) Mass balance, equilibrium moisture, critical moisture, drying curve, drying rate curve, calculation of drying rate and drying time. The drying models (characteristic drying curve and moisture diffusivity). 6

(c) Dryers: Tray dryer, tunnel dryer, drum dryer, spray dryer, fluidized bed dryer, uses of dryers in food industry. 5

7. *Crystallization:*

Basic principle of crystallization, super solubility, nucleation and growth rate, factors affecting the growth rate, mass balance, energy balance, draft-tube baffle and vacuum crystallizers.

8. *Separation techniques:*

(a) Filtration: Theory of filtration, constant rate and constant volume filtration, plate and frame filter press and its design, rotary vacuum filter. 4

(b) Sedimentation: Terminal velocity, drag coefficient, free and hindered settling thickeners (working principle and design of thickener). Centrifugal separation, working principle of centrifugal separator and its application in food industry (cream separator as an example). 4

9. *Size Reduction:*

Rittinger, Kick and Bond's laws, equipments for size reduction (Jaw crusher, Gyratory crushers, roll crushers, hammer mill, pin and disk mill, ball mill). Sieve analysis, standard sieves, particle size and its distribution, cut off diameter, fineness modulus, uniformity index. 6

10. *Mixing:*

- (a) Homogeneity of mixing, mechanism of mixing rate of mixing, energy consumption. 2
- (b) Liquid-liquid, solid-liquid and solid-solid mixing, homogenization (example: homogenizer in dairy industries). 2

11. *Conveying:*

Introduction to belt conveyer, bucket elevator, screw conveyer, pneumatic conveyor and their application in food industries. 2

Part B : Process Engineering:

12. *Process design development:*

6

Design: project producer, types of designs, feasibility survey, process development design, construction and operation, flow diagrams, the preliminary design, equipment design and selection economics, comparison of different processes, equipment design and specifications, scale-up in design, safety factors.

13. *General design considerations:*

4

Plant location, plant layout, preparation of lay out, plant operation and control, utilities structural - design storage.

14. *Optimum design and design strategy:*

20

General procedure for determining optimum conditions, comparison of graphical and analytical methods, break even chart for production schedule and its significance

for optimum analysis, optimum conditions in cyclic operations. Accuracy and sensitivity of results (heat transfer and mass transfer). The strategy of linearization for optimization analysis, other mathematical techniques and strategies for establishing optimum conditions.

Practicals (Lab)

1. Mass and energy balance: evaporation, distillation and drying.
2. Determination of Newtonian viscosity using Canon Fenske capillary viscometer, tube flow viscometer and Brookfield viscometer.
3. Determination of Reynolds's number using tube flow viscometer.
4. Measurement of outflow using venturimeter, orificemeter, Vane and hotwire anemometer.
 - (a) Evaluation of pump performance (brake horsepower, efficiency and head loss) of centrifugal and gear pumps.
 - (b) Workshop practice: motors, valves fittings, pumps etc.
5. Determination of thermal conductivity, thermal diffusivity and specific heat capacity of food materials. Determine surface heat transfer coefficient through unsteady (lumped method) heat transfer:
6.
 - (a) Comparative study of countercurrent and parallel heat exchangers. Determine overall heat transfer coefficient and LMTD of the exchange system.
 - (b) Study of plate heat exchanger Study of central circulationg, climbing and falling film evaporators. Study of boiling point elevation.
7.
 - (a) Determination of ideal plate (column) numbers by Lewis and McCabe Thiele method.
 - (b) Study of rectification column.

8. (a) Drying of grains, correlation between temperature ratio and time.
(b) Determination of characteristic drying and drying rate curve for pasty foods.
(c) Production SMP & WMP in a pilot scale dryer and determination of (%) product recovery.
9. Study of constant rate and constant pressure filtration in a plate and frame filter press.
10. Study of centrifugal separators (cream separator), separation efficiency.
11. Determination of terminal velocity and drag coefficient during unhindered settling.
12. Study of pin and disk, hammer and roller mills. Particle size distribution.
13. Study of belt, chain, screw, bucket and pneumatic conveyers.
14. Layout of food plants.
15. Construction and establishment of food plants (Project work)

Textbooks:

1. McCabe, W.L., Smith, J.C., and Harriot, P. Unit operations of chemical engineering.
2. Geankopis, C.J. Transport Processes and Unit Operations.
3. Toledo, R.T. Fundamentals of Food Process Engineering.
4. Rizvi, SSH. And Mittal, G.S. Experimental Methods in Food Engineering.
5. Heldman. D.R. and Singh, R.P. Food Process Engineering, 3rd Edition.
6. Sahay, K.M. and Singh, K.K. Unit Operations of Agricultural Processing.
7. Peters, M.S. and Timmerhaus, K.D. Plant Design and Economics for Chemical Engineering.
8. Holman, J.P. Heat Transfer.

BIOCHEMISTRY AND HUMAN NUTRITION

Full Marks : (50+50)

A. *Biochemistry*

1. Biochemistry and its scope, composition of living matter, biophysical concepts of acid, pH, buffers, oxidation and reduction concepts. 4
2. Introductory cell biochemistry. Separation of subcellular components and their biochemical functions, structure of membranes. 4
3. Enzymes: General properties, coenzymes and factors, kinetics and mechanism of action, inhibitors and activators. 8
4. Carbohydrate metabolism: glycolysis; oxidation, oxidative phosphorylation and elements of bioenergetics. Biosynthesis of starch and glycogen. 10
5. Lipid metabolism and biochemical functions of lipids. Oxidation of fatty acids. Biosynthesis of fatty acids and fats. Lipid metabolism and health. 8
6. Protein metabolism and biochemical functions. End product of protein metabolism. Intermediary metabolism of amino acids and urea cycle. Metabolism of essential and non-essential amino acids with reference to health. 10
7. In-borne errors of metabolism and enzyme deficiency diseases. 2
8. Nucleic acids: biochemical functions. Elementary notions of protein biosynthesis. 4

Human Nutrition:

11. Introduction: Historical development, definition, terminology, nutrition & development. 3
12. Nutritional physiology: Human body composition, parts and functions of the digestive and circulatory systems. 6
13. The Food: Nutrients & their functions, nutritional classification food, energy value of foods, energy and nutrients requirements and allowances, digestion absorption and metabolism of food groups, nutritional aspect of nutrients, nutritional quality of protein, food composition table & its uses. 18
14. Malnutrition and nutrient deficiency disorders: 9
Definition, form & types of malnutrition, protein energy malnutrition, endemic goitre, vitamin A deficiency disorder, nutritional anaemia, ricket & osteomalacia, beriberi, scurvy, pellagra etc.
15. Nutrition of infants, pre-school children, pregnant & lactating mother. 6
16. Nutrition of old people. 2
17. Diet: Balance diet & dietary standards. 1
18. Infant food, weaning food and supplementary foods 4
19. Enrichment and fortification. 1
20. Food habit. 4
21. Nutritional status: Definition and factors affecting the nutritional status, Assessment of nutritional status. 4
22. International organizational activities in the field of nutrition FAO, WHO, UNICEF, ADB. 2

Practicals:

1. Feeding experiments. Determination of PER, NPU.
2. Determination of energy value of food - Bomb calorimeter.
3. Preparation of weaning food.
4. Preparation of balanced diet.
5. Nutrition survey: Anthropometric survey.
6. Food consumption survey.

Textbooks:

1. White, A and Hondler, F. Principle of Biochemistry. Mcgrow Hill Kozakusta Ltd, Kokya, New Delhi. 1978.
2. Lehninger, A.L. Biochemistry. Work Publishing Inc. New York. 1975.
3. J.L. Jain. Fundamental of Biochemistry. S.Chand & Company Ltd. 1992.
4. Swaminathan, M. Advance text book on food and nutrition vol-1 & 2. Printing & Publishing Co. Ltd. Maysore, India. 1993.
5. King F.S. and Burgess, A. Nutrition for Developing Countries. ELBS with Oxford University Press. 1992.
6. Sumati R. Mudambi and Rajgopal, M.V. Fundamental of food and Nutrition. Wiley Eastern Ltd. 1993.
7. Shubhangini A joshi. Nutrition and Dietetics. Tata Mcgrow Publishing Co. Ltd. 1992.
8. Harfog A.P. and Starerer W.A. Mannual for Social Surveys and Food Habits and Consumption in Developing Countries. Pudor Wagenonger. 1985.

TECHNOLOGY OF FOOD PRODUCTS - I

(Cereals, legumes, oilseeds & protein foods)

Full Marks : 100

1. Introduction. 4
 - 1.1 Production of grains, legumes & oilseeds.
 - 1.2 Post-harvest handling of grains, legumes & oilseed.
 - 1.3 Formation of grain seeds.
2. Physical properties of grains, legumes & oilseeds. 8
 - 2.1 Geometrical properties-Shape, size, volume, roundness, sphericity.
 - 2.2 Gravimetric properties-Bulk density, specific gravity, 1000 kernel weight.
3. Structure of Grain. 4
 - 3.1 Structure of wheat, Nutrition distribution, chemical composition.
 - 3.2 Structure of rice, Nutrition distribution, chemical composition.
 - 3.3 Structure of Maize.
4. Wheat Milling. 16
 - 4.1 Varieties, classification, and quality.
 - 4.2 Milling.
 - 4.2.1 Premilling operation-separation & surface, cleaning, conditioning & grading.
 - 4.2.2 Attrition mill, Hammer mill.
 - 4.2.3 Modern flour milling: white flour: gradual reduction process, extraction rate, milling by roller.
5. Wheat flour. 8
 - 5.1 Flour quality, flour strength, gluten determination.

5.2	Flour bleaching & maturation, flour for various uses	
6.	Dough & its properties.	8
6.1	Dough formation and structure, gas retention, water absorption alveograph, farinograph, extensograph.	
7.	Technology baking.	12
7.1	Bread, Biscuits, Cake.	
7.2	Technology of pasta products & Instant noodles.	
8.	Rice.	16
8.1	Varieties, classification.	
8.2	Milling	
8.2.1	Factors affecting the milling yield, and breakage	
8.2.2	Traditional & modern milling system	
	Introduction, development of milling system, Huller & Hullers mills, Sheller & modern milling.	
9.	Parboiling of paddy.	12
9.1	Traditional and modern system of parboiling.	
9.2	Cooking quality of rice, processed food from rice, enrichment & ageing.	
10.	Maize.	6
	Varieties of classification, dry milling of maize, grits of corn flacks.	
11.	Malting.	4
	Malting of barley, sorghum & millets.	
12.	Legumes.	14
	Varieties, structure & chemical composition, amino acid patterns, anti-nutritional & toxic factors in legumes of oilseeds, Processing of legumes, wet methods, dry methods, & modern methods of Dhal milling, cooking of Dhal.	

13. Extraction of oil from oil seed. 6
Production of hydrogenated fat and refined oils uses of oilseeds meal & cakes.
14. Detail of protein solubility: Technology of vegetables protein concentrates & isolates. Functionality of proteins and protein products, protein rich foods preparation, meat analogs and textured protein products, processing methods of infant & textured protein products, processing methods of infant & weaning foods based on protein concentrates & isolates. 10

Practicals:

1. Determination of physico-chemical properties of wheat, rice and coarse grains.
2. Experimental milling of wheat and rice.
3. Experimental baking-bread, biscuits, cakes and pastries.
4. Experimental parboiling of rice, experimental expeller processing of oilseeds, experiments on solvent extraction.
5. Visit to cereal industries.
6. Tofu preparation.
7. Production of protein concentrate & isolates.

Textbooks:

1. N.L.Kent. Terminology of Cereals.
2. S.Bandhopadhyaya & N.C. Roy. Rice Process Technology.
3. K.M. Sahay & K.K. Singh. Unit Operations of Agricultural Processing.
4. P. Pillaiyar. Rice Postproduction manual.

THIRD YEAR

TECHNOLOGY OF FOOD PRODUCTS - II (Fruits & vegetables, Chocolate & sugar confectionary, Tea, Coffee and spices)

Full Marks : 100

Part-A (Fruits & Vegetables):

1. Standards for harvesting, post harvest handling, physiology of fruit ripening, pre-packing methods for prolonging storage life. Physical and chemical treatments to increase post harvest life, types of storage. 10
2. Fruit juices, squash, cordials and nectars, fruit juice concentrate and powder, orange juice, apple juice. 10
3. Preservatives, candies and crystallized fruits. 4
4. Manufacture of pectin, pectin characteristics, manufacture of jam, jelly and marmalades. 10
5. General methods of preparation and utilization of vinegar. 3
6. Tomato products: preparation of tomato puree, tomato ketchup, tomato juice, canning of tomatoes, grading of canned tomatoes. 10
7. Chutneys, sauces and pickles. 3
8. By-product utilization of fruits and vegetables waste. 4
9. Nutritional value of processed fruits and vegetables products. 4
10. Aseptic processing and packaging of fruit juice and beverages. 4

Practicals:

1. Extraction, purification and characterization of pectin.
2. Preparation of squash, fruit juices, cordials & nectars.

3. Preparation of tomato products: (a) tomato juice (b) tomato puree (c) tomato soup (d) chilli sauce (e) tomato ketchup (f) tomato sauce.
4. Preparation of chutneys sauces and pickles.
5. Preparation of preserves, candies and crystallized fruits.
6. Canning of fruits and vegetables.
7. Drying and dehydration and vegetables.
8. Preparation of jams, jellies and marmalades.
9. Examination of canned products.
10. Freezing preservation of fruits & vegetables.
11. Preservation of fruit juices by different methods: (a) physical (b) chemical.

Textbooks:

1. Ryal, A.L. and Pentzer, W.T. Handling, Transportation and Storage of Fruits and Vegetables, 2nd edn, Vol.-2, Fruits and Tree nuts. Avi publishing company, Inc., Westport, Connecticut. 1982.
2. Chan., H.T. (ed) Hand book of Tropical Science. Marcel and Dekker, Inc., New York. 1983.
3. Wills, R.B.H., McGlasson, W.B., Graham, D. and Hall, E.G., Post-harvest an Introduction to the physiology and Handling of Fruits and Vegetables, CBS Publication & Distribution, New Delhi, India. 1996.
4. Siddapa, G.S. & Tandon, G.L., Preservation of Fruits and Vegetables., Indian Council of Agricultural Research, New Delhi. 1998.
5. Ranganna, S. Hand book Analysis and Quality Control for Fruit and Vegetable Products. Tata Mcgraw Hill Publishing Company Limited, New Delhi. 1986.

6. Goose, P.G. & Binsted, R. Tomato Paste and Other Tomato Products, 2nd edn. Food Trade Press Ltd. Longon. 1973.

Part- B (Chocolate & Sugar Confectionary):

1. Major candy types with crystalline & non-crystalline sugar such as rock candy, fondant, cream, gum drops, toffees etc. 11
2. Ingredients for making confectionary, chocolate & related materials. Confectionary manufacturing practices, chemical & allied substances used in confectionary. Use of lecithin in chocolate. Microbiological & other spoilage problems. 11

Practicals:

1. Preparation of caramel, toffee, fondant, fudge, chocolate.
2. Preparation of penut, brittle.
3. Preparation of Rock candy.

Textbooks:

1. Lees, R. & Jackson, E.B. Sugar Confectionery and Chocolate Manufacture. Leonard Hill. 1973.
2. Becketl S.T. (ed) Industrial Chocolate Manufacture and Use. Blackie & Son Ltd. London. 1988.

Part- C (Tea, Coffee and Spices):

1. Tea: History, introduction, world tea production and growing, tea cultivation & production in Nepal, chemical composition of tea. Manufacture of tea, grading and specification, quality & storage of tea. Factors affecting tea quality. 12
2. Green and partially fermented tea. 3

3. Coffee: History, introduction, production statistics, cultivation, chemical composition of coffee, processing technology, agglomeration, packaging & storage, quality control. 12
4. Spices: Ginger, turmeric, chillies, cardamum, large cinnamon, black pepper. 10
 - (a) Production, cultivation & uses.
 - (b) Chemistry and Technology.
 - Special attributes - flavour components.
 - Chemical composition.
 - Processing, drying & storage.
 - Extraction of oleoresin, essential oil. -

Practicals:

1. Crude piperine determination in pepper.
2. Determination of volatile oil content in spices.
3. Volatile oil content in oleoresins.
4. Preparation of spice oleoresins.
5. Scoville heat units of capsicum and red pepper oleoresins.
6. Extraction of essential oils from spices.

Textbooks:

1. Clarke, R.J. and Macrae, R. (eds) Coffee, Vol.-1 Chemistry. Elsevier Applied Science Publisher, London & New York. 1985.
2. Clarke, R.J. & Macrae, R. (eds) Coffee, Vol.- 2 Technology, Elsevier Applied Science Publisher, London & New York. 1985.
3. Sivetz, M. & Desrosier, N.W. Coffee Technology. AVI Publishing company, Inc. Westport, Connecticut. 1979.
4. Verma, A.H. & Sutherland, J.P. Beverages Technology, Chemistry & Microbiology. Chapman & Hall, London. 1994.

TECHNOLOGY OF FOOD PRODUCTS - III

(Meat, Poultry and Fish)

Full Marks: 100

1. Development of livestock and poultry in Nepal. Livestock production, meat production and supply. 3
2. Development of livestock based industry in Nepal. Act and regulations. 2
3. Slaughtering of animals and poultry birds. Preslaughter handling, antemortem inspection, stunning, dressing of cattle, sheep and goat, scalding and dehairing of pig, scalding and defeathering of poultry, evisceration, splitting of carcass, postmortem inspection. 12
4. Muscle structure. 2
5. Chemical composition of meat. Moisture, protein and non-protein nitrogenous compounds, fat, carbohydrate, vitamins and minerals. 2
6. The nutritive value of meat and meat products. 4
7. Meat grading. Beef grading: criteria and methods of grading beef in USA and Europe, beef grades. Pork grading: pork grades, grading criteria, instrumental grading. 6
8. Postmortem changes in meat (muscle). Normal and abnormal (PSE, DFD, cold shortening, thaw rigor) postmortem changes in meat. 3
9. Quality of meat, and factors affecting quality of meat. Colour, odour and taste; tenderness, juiciness quality of meat; intrinsic and extrinsic processing factors affecting quality attributes. 6
10. Methods of meat preservation. Preservation of meat by low temperature (chilling and freezing): Principles of preservation, freezing methods, storage temperature and shelf life.

Preservation of meat by salting and curing: Preservative effect of salt and nitrite, methods of curing, kinetics of curing, chemistry of cured colour development, development of cured aroma, toxicity of nitrite.

Preservation of meat by smoking: Production of smoke from wood, methods of smoke generation, effect of smoking on meat (preservation, colour development, aroma development, texture firming and softening), health aspect of smoked meat.

Preservation of meat by thermal processing, drying and dehydration and irradiation: Principle of preservation. 20

11. Manufacturing technology of meat products.

11.1 Sausage products: types, technology of emulsion type cooked sausage (theory of emulsion development, selection of raw materials and ingredients such as meat, fatty materials, functional ingredients, manufacturing process of sausage), dry sausage (types, selection of raw material and ingredients, process of manufacture).

11.2 Cured meats: raw material, manufacturing process.

11.3 Canned meat products: manufacturing technology of canned meat products.

11.4 Dry meat: manufacturing process of different dried meats. 16

12. Packaging, transport and distribution of meat and meat products. 4

13. Analysis of meat and meat products (proximate composition, aw, pH, colour, water holding capacity, tenderness, salt, phosphate, peroxide value, TBA, nitrite, nitrate etc.). 10

14. Meat by-products: production, classification, nutritive value, processing and utilization. 6

15. Egg: Production, structure, chemical composition, nutritive value, spoilage and factors affecting egg quality, grading, methods of preservation, manufacturing technology of egg products such as dried egg and frozen egg. 10
16. Legislative aspects of meat, fish and poultry products. 3
17. Fish: production, catching, transportation, spoilage, methods of preservation (salting, smoking, drying, preservation by chemicals etc.) , manufacturing technology of fish products. 8

Practicals:

1. Slaughtering of pig and buffalo.
2. Meat cutting. Preparation of wholesale & retail cuts.
3. Preparation of R-to-C chicken and its cut up parts.
4. Preparation of sausage, (cooked emulsion type sausage, fresh ground sausage, dry sausage)
5. Preparation of cured meats: ham and bacon.
6. Physicochemical analysis meat & poultry products (proximate composition, pH, water holding capacity, salt, nitrite, nitrate, phosphate, peroxide value, TBA No., aW, Eh, starch etc.).
7. Grading, handling and preservation of egg.
8. Determination of egg quality.
9. Determination of freshness of fish by subjective method and lab tests.
10. Fish preservation by salting, smoking and drying etc. methods.
11. Visit to local poultry, pig and fish farms.
12. Visit to local abattoir.

Textbooks:

1. Gracey, J.F. and Collins, D.S. Meat Hygiene. ELBS. 1992.
2. Kramlich, W.E., Pearson, A.M. and Tauber, F.W. Processed Meats. AVI Publishing Company. 1982.

3. Lawrie, R.A. Meat Science: III ed. Pergamon Press. 1979.
4. Levie, A. Meat Handbook: IV edn. AVI Publishing Company. 1979.
5. Pearson, A.H. and Dutson, T.R. Edible Meat By-products: Advances in Meat. 1988.
6. Research: vol.5. Elsevier Applied Science.
7. Pearson, A.M. and Gillet, T.A. Processed Meats. IInd Edition. CBS. 1997.
8. Price, J.F. and Schweigert, B.S. The Science of meat and Meat Products. II edn. 1971.
9. Sharma, B.D. Meat and Meat Products Technology. Jaypee Brothers Ltd. 1999.
10. Subba, D. Textbook of Meat Technology. 2001.
11. Subba, D. Practical Book of Meat, Poultry and Fish Technology. RONAST. 2001.

Reference books:

- Anonymous Proceedings of FAO seminar on meat development and low cost preservation methods in Asia and Pacific. October 24-28, 1990. Bangkok, Thailand. 1990.
- Anonymous Guidelines for Slaughtering, Meat cutting and further processing. FAO Animal Production and Health Paper 91. FAO, Rome. 1991.
- Anonymous Meat and Meat Products in Human Nutrition in Developing Countries. FAO Food and Nutrition Paper 53. FAO, Rome. 1992.
- Anonymous Statistical Information in Nepalese Agriculture 1998/99. His Majesty's Government, Ministry of Agriculture, Agricultural Statistics Division, Singha Durbar, Kathmandu, Nepal, 1998/99.
- Anonymous Marketing of Meat and Meat Products. Third Livestock Development Project. Department of Livestock Services, Ministry of Agriculture, HMG Nepal. 1999.

BIOCHEMICAL ENGINEERING

Full Marks: 100

1. Introduction: Interaction of biochemistry, microbiology, chemical engineering with biochemical engineering. 4
2. Mass transfer: Introduction to transport phenomenon, different types of mass transfer in processes. Mass transfer phenomena in microbial systems, mass transfer in foods, diffusion, membrane transport, dialysis, nutrient uptake rate of microorganisms, dissolved oxygen concentration measurements, volumetric oxygen transfer coefficient measurements inside a fermenter. 10
3. Kinetics: Enzyme kinetics, microbial growth kinetics including basic growth equation from various aspects i.e. from cell no increase & from incremental increase in the population over a small growth time. Microbial death kinetics. 8
4. Aeration and agitation in fermenter: Formation of separate gas bubbles, ascending velocity of gas bubbles, mechanical agitation of a gassed newtonian fluid, decrease in power requirement during agitation, oxygen requirement, measurement of absorption co-efficient, bubble aeration with mechanical agitaion, correlation between volumetric oxygen transfer co-efficient (KLA) and operating variables in the fermenter. 12
5. Sterilization: Different methods of sterilization for destruction of microorganisms, air filtration through fibrous bed, significances of different types of filter beds, mechanism of collection of microorganisms and characteristics of collection efficiency, limitations of different types of filter beds. 2

6. Media sterilization: Dry heat sterilization, sterilizer design criteria, Bigelow's Bio theory, batch sterilization process, continuous sterilization process, basic relation responsible for the loss of nutrient value in the food. 2
7. Fermenter design: Basis of design, design of its component parts, design of different types of fermenter, conception of several types of biochemical reactors. 10
8. Instrumentation and process control during fermentation: Control of various physical & chemical process parameters, uses of suitable sensor control operation, computer control. 6
9. Continuous fermentation. 4
10. Enzyme engineering: Enzyme production processes, enzyme isolation techniques, different methods of enzyme purification, immobilized enzyme technology, methods of immobilization, separation of one optical variety from its racemic modification by the use of immobilized enzyme, different uses of immobilized enzymes in industry. 10
11. Basic principle and application of genetic engineering. 7
12. Scale up in fermentation: Scale up on the basis of power unit volume of liquid, scale up on equal mixing time basis, scale up on equal shear basis. 3
13. Product recovery, purification. 8
14. Waste-water engineering: Fundamental of biological waste treatment, concept of biological oxygen demand or biochemical oxygen demand (BOD) and chemical oxygen demand (COD) & their co-relations, treatment techniques of discharged industrial wastes, conception about effluent treatment plants & its utility, waste treatment of effluent coming from food industry. 16

Practicals:

1. Introduction, layout of fermentation technology pilot plant.
2. Follow-up of bacterial growth in batch cultures.
3. Heat inactivation of enzymes, calculation of rate constant, thermal death rate etc.
4. Thermal death time of bacteria.
5. Mass transfer across membrane, permeability coefficient, uptake of solute in biological systems.
6. KLA measurement by dynamic method, effect of air flow rate and rpm.
7. Biochemical oxygen demand measurement.
8. Chemical oxygen demand measurement.
9. 200 liter fermenter operation, instrumentation etc.

Textbooks:

1. Stanbury. Principle of Fermentation Technology.
2. Henry C. Vogel Noyes. Fermentation & Biochemical Engineering hand book. Publication.
3. James E. Bailey, David F. Ollis. Biochemical Engineering Fundamental. Mcgraw Hill book Company.
4. Christie J. Geanleoplis. Transfer process & unit operation 3rd edition, Prentice hall of India Ltd. New Delhi.
5. I bea & Humprey Biochemical Engineering Fundamentals.
6. D. Patranabis, Principles of Industrial Instrumentation. Tata Mcgraw publishing company Ltd. New Delhi.

INDUSTRIAL MICROBIOLOGY

Full Marks: 100

1. Industrial importance of microbiology. 6
2. General techniquis of selection, treatment, strain development, preservation of industrially important microorganisms. 10
3. Screening of industrially important microorganisms. 6
4. The production of industrial alcohol by fermentation and process & technology of ethyl alcohol fermentation. 4
5. Process & technology of brewing. 8
6. Process & technology of wine preparation. 10
7. The distillation industries. 4
8. Vitamin production by yeast and yeast like micro-organisms. viz., riboflavin. 4
9. Yeast enzyme and minor products: invertase, lactase. 6
10. Fermented food products: Miso, tempeh, soya sauce, natto, sauerkraut. 10
11. Microbial production of aminoacids: (a) Tryptophan (b) Lysine (c) Glutamic acid. 6
12. Microbial production of therapeutic compounds: (a) Penicillins (b) Tetracyclines (c) Streptomycin. 8
13. Microbial synthesis of fats, protein & polysaccharides. 8
14. Microbiological assay of nutrients. 6
15. Microbial flavors & fragrances: (a) Diacetyl (b) Lactones (c) butyric acid. 4
16. Production of single cell proteins. 2
17. Microbial production of organic acids: (a) Citric acid (b) Gluconic acid. 4
18. General study of biofertilizers.

Practicals:

1. Antibiotic assay.
2. Penicillin fermentation.
3. Amylase growth precipitation, estimation and application.
4. Citric acid fermentation, analysis and recovery.
5. Fermented beverages, preparation of wines & *jand*, and their quality tests.
6. Study of the traditional fermented food preparation & production of wine, alcohol and suggestion for process modification.
7. *Preparation and quality as well as quantity production of ethyl alcohol in the laboratory.*
8. Determination of productivity efficiency and yield of ethanol in batch fermentation.
9. Hydrometric and pyknometric determination of alcohol in alcoholic beverages.
10. Screening of fermentative molds and saccharifying molds from *murcha* cake and *murcha* plants.
11. Lab preparation of *murcha* cake.
12. Solid-state fermentation for analysis production.
13. Production of immobilized yeast cells.
14. Lab design of continuous culture for ethanol production.
15. Mold fermentation for enzyme production.
16. Continuous culture for alcohol production.
17. Screening of fermentative yeasts from *murcha* cake and *murcha* plants.

Textbooks:

1. Moo Young, M. Comprehensive Biotechnology, vol.-3, Pergamon press. 1985.
2. Prescott and Dunn. Industrial Microbiology, 4th edn, CBS publishers and distributions, Delhi.
3. Peppler, J.H. Microbioal technology. Reinhold publishing corporation. 1977.
4. Singha, B.D. Biotechnology, Kalyani Publishers, India. 1998.

Reference books:

1. Smith, J.E. Biotechnology, 3rd edn. Cambridge University press. 1986.
2. Patel, A.H. Industrial Microbiology, Macmillan India limited. 1986.
3. Dubey, R.C. A textbook of Biotechnology, 3rd edn, S. Chand and company, India. 2000.
4. Dasva, E.J. Microbial Technology in the developing world oxford university Press, NY. 1987.
5. Aneja KR. Experiments in microbiology, plant pathology and tissue culture, 2nd edn, wishwa prakashan, India. 1996.
6. Chan ECS, Pelczar MJ Jr, Kreia NR. Laboratory exercise in microbiology, 6th edn, MC Graw- Hill Inc 1993.

FOOD QUALITY CONTROL & ANALYSIS

Full Marks: 100

1. Introduction to the concept of food quality control. 2
2. Quality and its function, quality assurance in food industries & functions of quality control organization. 4
3. Quality attributes of foods: 6
 - (a) Size and shape (b) Colour & gloss (c) Texture-visual & objective attributes (d) Aroma of foods - introductory ideas.
4. Anthropology of food psychology. 2
5. Introduction- sensory evaluation of foods and beverages. 3
6. Toxicological and legislative aspects of food additives. 3
7. Water contamination in the food industries, water supplies, water purification, types of impurities, water analysis, method of removal of their waste disposals. 3
8. Extraneous matters in foods and their methods of detection and removal. 3
9. Good Laboratory Practice. 2
10. Laboratory layout and design, operation and maintenance of different types of laboratory. 3
11. Role of Q.C. chemist in food establishments. 3
12. Hazard analysis and critical control points. 3
13. Food contamination and adulteration, quality control under different stages of food processing. Quality assurance and sampling technique. 5
14. Food standards- formulation. 2
15. Food control system in Nepal. 3
16. Introduction to agricultural practices in Nepal and food control system. 2

17. Food laws development and enforcement, inspection, grading and certification of food. 3
18. A study of international food regulations. Functions of Codex Alimentarius Commission. 3
19. Terminologies and concept of Good Manufacturing Practice (GMP) and Generally Recognized as Safe (GRAS). 3
20. Import and export quality control rules and regulations, inspection and sampling at sea port and dry port. 2
21. ISO 9000 series. 2
22. Introduction to TQM. 2
23. Statistical quality control-quality control chart, exercises applying inference tests. 5
24. Strengthening of QC network in context of WTO. 2
25. Feed acts and regulations. 2
26. Statistical quality control- modern trends in food science. 5
27. Errors & accuracy in analysis of food materials, sampling & preparation of samples for analysis. 2
28. Proximate analysis of food products i.e. estimation of moisture, ash, carbohydrate, crude fibre, crude protein, crude fat. 4
29. Occurrence, toxic effects and test of hazardous contaminants-heavy metals, pesticide and drug residues, microbial toxins and adulterants such as aflatoxin maxicana. 4
30. Study of the methods of determination of additives like sulfur dioxide, benzoic acid, formaldehyde, boric acid, lactic acid and saccharin, cyclamate, dulcin etc. 4
31. Study of the methods of determination of trace metals like tin, lead, arsenic. 3

32. Test of radioactivity on foods. 2
33. Analytical methods applied in dairy products like milk, milk powder, ice cream, butter, cheese, milk cream, chocolates etc.
34. Analysis of food stuffs with reference to the standards of quality fixed for jam, jelly, canned fruits & vegetables, pickles, squash, vinegar, rice, wheat. 5

Practicals:

1. Proximate analysis of wheat, bran, biscuit, milk.
2. Extraction, separation & identification of water & oil soluble food colors.
3. Detection or estimation of trace metals: Iron, tin, copper, lead, arsenic (depending on the facilities available).
4. Estimation of food additives like SO_2 , benzoic acid, formaldehyde, boric acid, saccharin, dulcion, cyclamate, lactic acid.
5. Analysis of food stuffs with reference to the standards of quality fixed for jam, jelly, canned fruits & vegetable, milk, ice cream, biscuits, flour, pickles, cheese, *dahi*, meat products.
6. Checking of water contamination & extraneous matters in food.
7. Sensory evaluation of foods.
8. Test of adulteration: Baudouin test, Halphen test, Holde test, Hexabromide test, Metaril yellow, Starch in milk, Agremone oil test.
9. Mini column chromatography (e.g. for argemone oil test)
10. Chromatographic separation of free amino acids by TLC.
11. Two-dimensional paper chromatography.
12. Complete analysis of table salt.

13. Determination of glucose by enzymatic method.
14. Determination of Cholesterol.
15. Determination of Vit. C.
16. Statistical analysis using different software, e.g. office add-ins, GENSTAT, etc.
17. Paper chromatography, ascending, one by two-dimensional.
18. Water analysis: physicochemical and bacteriological.
19. Stability of fats and fatty foods by AOM.
20. Determination of glucose by glucose oxidase method.

Textbooks:

1. Ranganna, S. Hand book of analysis of and quality control of fruit and vegetable products. 2nd edn. Tata McGraw-Hill pub. New Delhi. 1996.
2. Sadasivam, S. and A. Manikam. Biochemical Methods in Agricultural Sciences. India. 1992.
3. Plummer, D.T. An introduction to practical biochemistry, 3rd edn. Tata Mc-Graw-Hill Pub. India. 1987.
4. AOAC. Official Methods of analysis of the association of official analytical chemists. 13th edn. Washington D.C. 1980.
5. Egan, H., R.S. Kirk and R. Sawyer. Pearson's chemical analysis of foods 8th edn. Churchill livingstones, New York. 1981.
6. S.M. Herschdoerfer. Quality control in the Food Industry vol. 1,2,3.
7. Jerry Banks. Principle of Quality control. Wiley Johan Weley and Son, New York.

FOURTH YEAR

STORAGE AND PACKAGING TECHNOLOGY

Full Marks : (50+50)

A. *Storage Technology*

1. Introduction to the storage of food materials.
2. Transport & handling of food materials (Fresh fruits & vegetable, grain & oilseeds).
3. Food losses & damages during storage:
 - (a) Types of storage loss.
 - (b) Loss assessment and estimation- an approach to more efficient storage.
 - (c) Factors responsible for food losses during storage & their prevention.
4. Definition & measurement of physical factors affecting stored grain:
 - (a) Mechanical & thermal properties of grain.
 - (b) Moisture migration in grain.
 - (c) Grain quality.
5. Grain sampling: Theoretical basis of grain sampling, sampling devices, their applications, analysis of grain sample.
6. Inspection procedures: grain, grain stores & handling equipment, milling premises.
7. Entomology and mycology of stored grain stores & handling equipment, milling premises.
8. Biology of stored product insects, food performance & specificity, infestation quality & quantity.
9. Stored product insects: processed food.

10. Rodents & their control:
Rodents- identification, biology & economic importance.
Chemical & physical control of rodents.
11. Storage structures- principles of grain storage, types of storage, selecting of design of storage building, physical, chemical, biological storage structure & handling equipment.
12. Control measures.
 - A. *Non-chemical control methods:*
 - a) Aeration principles.
 - b) Grain & seed drying.
 - c) Modified atmosphere, hermetic storage and CA storage.
 - d) Refrigeration storage.
 - e) Irradiation.
 - B. Chemical control method:
Fumigants & their application, principle of fumigation & properties of fumigants. Effects of fumigants on stored grains. Estimation & detection of fumigants. Fumigant application methods & dosage. Fumigating devices and their operation.
13. Use of insecticides: Properties, general principles, preparation and application, pesticide residues & their significance, pesticides resistance in stored product insect, methods of detecting pesticide resistance in storage pests; type, active principle and application of natural insecticides.
14. Good storage practices, warehouse management, maintenance.

15. Farm level storage and storage structures in Nepal and possible ways of improvement.

Practicals:

A. Storage Technology:

1. Infestation evaluation, precautions, causes & control.
2. Godown sanitation.
3. Handling of equipment.
4. Fumigation technique- balooning techniques.
5. Grading & inspection of grain- analysis of pesticide residues.
6. Storage study of dehydrated products.
7. Visit to warehouse, rural storage structure.
8. Factory visit in Dharan & Biratnagar.

Textbooks:

1. B.K. Bala. Drying and Storage of Cereal Grains. Oxford and IBH Pub. Co. P Ltd, New Delhi 1997.
2. Carl W. Hall P.E. Drying and Storage of Agricultural Crops. AVI Pub. Co. Inc., Westport, Connecticut.
3. D.W. Hall. Handling and Storage of Food Grains in the Tropical and Subtropical. Oxford IBH P. Co. New Delhi.
4. Fred J. Baur. Insect Management for Food Storage and Processing. The American Association of Cereal Chemists Inc., St. Paul Minnesota 55121, 2097 USA..

B. Packaging Technology

16. Introduction to packaging:

Evolution of packaging as a science, technology-
package functions & design considerations, packaging
operations & hazards distribution.

17. Principles of packaging- mechanical damage, physical, and biochemical, biological and microbiological hazards. 4
18. Principles in the development of protective packaging: Deteriorative changes in food stuffs and packaging methods adopted to retard them. The shelf-life of packaged food stuffs- prediction and estimation, methods to extend shelf life. 4
19. Packaging materials, properties and identification: Paper and paper board, regenerated cellulose films. plastic films, aluminum foils and laminations. 12
20. Food packages: Bags, pouches and wrap, folding cartons, set-up boxes and liquid-tight paper board containers, aluminium, tin and composite cans, collapsible metal and plastic tubes, glass containers, molded plastic containers, traditional packages. 6
21. Types of closures and lids. 2
22. Special packaging methods: Vacuum and gas packaging, shrink packaging. 2
23. Shipping containers: Wooden box and crates, plywood and wire- bound boxes, basko corrugated and solid fiber board containers, textile and paper sack, miscellaneous containers. 4
24. Properties of food (physical, thermal, mechanical, electrical, biological) and packaging requirement of fresh products (fruit and vegetable, meat, poultry, seafood), fats and oils, dairy products, cereals, pulses, spice, dry products. 8

25. Product package compatibility: Toxicity, tainting and corrosion. Protection against insects by packaging. Industrial packaging outline - material handling, cushioning; palletizing; stacking and containerization. 4
26. Evaluation of packaging materials and package performance. 4
27. Package standards and regulations. 2
28. Packaging specifications and quality control. 2
29. Marketing and economics: An idea of disposal of wastes package materials. 4

Practicals:

1. Testing of paper - moisture content, thickness, grease resistance, brightness, opacity, chloride test, pH, alkali staining, wax covering.
2. Determination of basis weight, water absorptiveness, ink adhesion of paper and paper board.
3. Testing of bottle - Dimension measurement, resistance to thermal shock.
4. Identification of plastic films.
5. Chemical resistance of plastic films.
6. Shrink packaging of poultry.

Textbooks:

1. A.S. Athalye. Plastics in Packaging. Tata Mcgraw. 1992.
2. Hanlon. Hand Book of Package Engineering.
3. Crosby. Food Packaging Materials. NT Appl/Sc. 1981.
4. Frank A Paine. A hand book of Food Packaging. Leonand Hall. 1983.

OPERATION RESEARCH & FOOD PLANT MANAGEMENT

Full Marks : 100

PART 1: Operation Research:

(a) Historical Development, Definition and Future Scope. (b) Techniques/methodology frequently used, case studies. (c) Role of Research in Industry and Administration. (d) Selection & evaluation of problems and projects in industrial research. (e) The role of models in OR- the need to strike a balance between simplicity & complexity. (f) Network analysis: PERT & CPM (g) Linear Programming: Assumption, Simplex method. (h) queuing models: Concept, Basic structure, Classification, Mathematical formulation, Monte Carlo simulation of queuing, Industrial applications. 20

PART 2: Food Plant Management:

Section A: Financial Management Aspects:

1. Financial Management: Concept, Definition, Purpose of investment, Types of capital: Fixed & Working Capital, Source of Finance: Internal and External Sources, Reserve & Surplus, Financial Accounting & Book Keeping, The Journal & Ledger, Financial Statements, Balance Sheets, Profit & loss a/c, Financial Ratios. The Time Preference for Money, Compound Value, Value of an Annuity Due. 7
2. Inventory Control: Nature of inventories, Need to hold inventories, Objectives of inventory management,

- Techniques of Inventory Management, Functions of inventories, Inventory models, ABC analysis. 4
3. Cost-Volume-Profit Analysis: Introduction, Assumption in B-E Analysis, Calculation of Break-even-point, Limitation, Advantage and Application of B-E Analysis. 4
4. Industrial Budgeting and Cost Analysis: Concept, budget control, Budget, Budget preparation, Introduced Budget, Capital Budgeting Decisions: Nature of Investment decisions, Investment evaluation criteria (Traditional and Modern Methods), Problems in cost reduction, cost reduction technology, modern tools for cost reduction. 6
5. Industrial Costing: Introduction, cost, Accounting: Necessity and Importance of cost control, Elements of Cost, Process cost & Cost of Production. 3
6. Analysis of Risk & Forecasting. 2

Section B: Production Management Aspects:

7. Product Design & development: Product Design, Design & product costs, Factors determining the design of a product, Characteristic of a good product Design, New food product Development, Product Life Cycle, Necessity of Product Development, Product Life Cycle, Necessity of Product Development, Tools for product Development. 6
8. Production Planning and Control: Objectives, Components of PPC, Steps in Production Planning and

- Control, Importance of Production Planning &/or control, Differences between pp & PC. 6
9. Plant Location: Introduction, Importance, dynamic nature of plant location, localization of Plants, factors of Plant Location, Location Analysis. 3
 10. Plant Layout: Meaning, Definition, Objectives, Advantages, Types, Techniques of Plant Layout, Features of a Good Layout, Factors Relevant for the choice of layout, Building for a plant.
 11. Productivity: Concept, Measures, Importance of Productivity, Factors affecting productivity, Techniques to improve Productivity, Measurement of Productivity. 2
 12. Industrial Standardization of the products. 2
 13. Coordination of sales, Production and Quality control Department. 2
 14. Quality Control: Quality control & Product Quality, Factors Controlling Quality, growth of Quality Control, Objectives of SQC, Statistical Techniques, Control charts, Use of Control charts & types, Theory of control charts, Control charts for Variables, Control chart for Fraction defectives (p-chart) & its example. 6

Section C: Industrial Management Aspects:

15. Manpower Management: Recruitment & selection, Training, Promotions & transfer, Job evaluation, Wage & Salary administration, Wage Incentive Plans, Motivation: Concept, theory of motivation, process of Motivation. 8

16. Industrial Ownership: Concept, Types of Ownership, Sole proprietorship, Partnership Organization: Features of Partnership, types of partners, Limited Partnership, Deed, Registration of firms, Mutual rights & Obligation, dissolution, Evaluation, Joint stock Company. 10
17. Management Functions: Planning, Organizing, Directing, Controlling, Co-ordination and Decision-Making. 6
18. Management by Objectives (MBO): Concept, Definition, Objectives, Steps in Setting up MBO, Advantage and Limitations of MBO. 2
19. Purchasing, Manufacturing and Internal Finance and Office Services. 5
20. Organization: Concept, Organization functions, Principle of Organizational structure, Types of Organization, Characteristics of Organization executives. 4

Section D: Marketing Management Aspects:

Concepts of Marketing, Definition, Principles and Functions of Marketing, Marketing Management & its functions, Marketing Research, sales Forecasting, The Marketing mix, Advertising, Sales promotion, Channels of Distribution, Product packaging, Pricing. 10

Section E: Miscellaneous

- a. Role of government regulatory agencies in establishing food industries. 2
- b. Concept of mixed economy. 2

Practicals:

1. Preparation of a report after the spot studies in a given factory.
2. Market survey of different food products existing in the market.
3. Exercise in CPV, Inventory Control, Capital Budgeting etc.
4. Exercise in Industrial Costing-Based on seasonal local food materials.
5. Exercises on plant layout and Location.
6. Study of the problems of an industry and solution of the problem.
7. Exercises on Quality Control.

Textbooks:

1. Khanna, O.P. Industrial Engineering and Management. Dhanapat Rai & Sons, Delhi. 1999.
2. Dalela, S & Ali, M. A Text Book of Industrial Engineering and Management systems. Standard Publishers Distributors, Delhi. 1985.
3. Bhusan, Y.K. Fundamental of Business Organization & Management, Sultan Chand & Sons, New Delhi. 1996.
4. Goel, S.B. Production/Operations management (For Engineering, Management & Commerce Students), Pragati Prakashan, Meerut, India. 1988.
5. Pandey, I.M. Financial management, Vikas Publishing House Pvt. Ltd. 1998.
6. Ahuja, K.K. Personnel Management, Kalyani Publishers. 1992.
7. Arora, M.N. Cost Accounting-Principles & Practice, Vikas Publishing House Pvt. Ltd. 1993.
8. Ahuja, K.K. Management & Organizaion, CBS Publishers & Distributors 1993.

DAIRY TECHNOLOGY

Full Marks : 100

1. *General Aspects of Milk:* General introduction, History of Dairy Industry in Nepal, Definition of milk, Proximate Composition of Milk, Major and Minor Constituents, Differences between milk produced from different herds. Biosynthesis and Secretion of Milk. Factors affecting the Composition of Milk. 5
2. *Physico-chemical aspects of Milk: Physico-chemical properties of Milk:* Color, Flavor, Specific Gravity, Specific Heat Capacity, Freezing point, Boiling point, Acidity (Natural & Developed) & pH, Surface Tension, Viscosity, Redox-Potential, Action of Milk on Metals. *Milk Components:* Water: Free, Bound and Crystallized water. *Carbohydrates:* Chemical Properties of Lactose, Physicochemical aspects of lactose, Lactic acid fermentation. *Lipids:* Composition, Some properties, Autooxidation, Crystallization. *Proteins:* Chemistry of proteins, Serum proteins, Casein & Its Precipitation. *Enzymes:* Enzyme activity, some milk enzymes, Inactivation. *Salts:* Composition & distribution among the phase properties of salt solution, Colloidal Calcium Phosphate, Changes in salts. *Other Components:* Natural Components, Contaminants, Radio nuclides, Flavor Components. *Pigments:* Carotenoids, Riboflavin etc. *Colloidal Particles of Milk:* Fat globules: Properties, Emulsion Stability, Interaction with air bubbles, Creaming, Lipolysis. *Casein Miscelles:* Description, Changes, Colloidal Stability. *Physical Properties:* Optical Properties, Viscosity. *Whey Proteins:* Definition, Composition, Manufacture of Whey Milk Powder. 26

3. *Milk Microbiology: General Aspects*, Milk as a substrate for bacteria. Undesirable Micro-organisms: Spoilage microorganisms, Pathogenic Microorganisms, sources of Contamination (microorganisms present in the udder, contamination during and after milking. Hygienic Measures: Protection of the consumer against pathogenic microorganisms Measures against spoilage microorganisms. 10
4. *Milk Processing: General Aspects*: (i) Introduction (ii) Quality Assurance: Concepts, HACCP, Quality assurance of raw milk. Milk Storage & Transport (i) Milk Collection & Reception (ii) Milk Storage (iii) Transport of milk in the Dairy. Filtration & Clarification: Cloth & Wire Filters, Centrifugal Clarifier, Membrane Filtration Processes. Standardizing. Heat Treatment: Changes caused by heating, Heating Intensity, Inactivation of Enzymes. Method of Heating, Centrifugation: Bactofugation Homogenization: Objectives, Operation of the Homogenizer, Two Stage Homogenizer, Factor affecting the fat globule size surface layers, Stability, Homogenization Clusters, Other effects of Homogenization, Creaming. 16
5. *Milk for Liquid Consumption*: (i) Pasteurized milk: Manufacture, Shelf life, Use of Micro filtration. (ii) Sterilized Milk: Description, Methods of Manufacture, Shelf life. (iii) Flavor (iv) Nutritive value. 5
6. *Cream Products*: (i) Sterilized cream: Manufacture, Heat stability, Stability in coffee, Clustering. (ii) Whipping Cream: Desirable Properties, Manufacture, the whipping Process. 4

7. *Ice-cream*: Manufacture, Physical structure: Formation & Stability, Role of various components in ice cream, Over-run, Common defects & their removal. 6
8. *Concentrated Milks*: (i) Evaporated Milk: Description, Manufacture, Organoleptic Properties, Heat Stability, Creaming, Age Thickening & Gelation. (ii) Sweetened Condensed Milk: Description, Manufacture, Microbial Spoilage, Chemical Deterioration, Lactose crystals. 6
9. *Milk powder*: Objectives, Manufacture, Hygienic aspects (Bacteria in the original milk, Growth during manufacture, sampling & checking), physical properties, Ease of Dispersing, Instant milk Power. Influence of Process variables on product properties: Flavor, WPN index, Insolubility, Specific Volume, Free flowingness, Free Fat Content, Dispersibility, Stability. Deterioration, Other Types of Milk Powder, Reconstituted Products. 6
10. *Butter*: (i) Description & Manufacture: Description of types, Manufacturing Scheme, The Churning Process, Working. (ii) Structure & Properties: Microstructure, Consistency, Cold Storage defects. (iii) Culture Butter from sweet cream (iv) High-fat products: Anhydrous milk fat, Recombined Butter, Butter products with a low fat content. 6
11. *Ghee*: Description and Manufacture, comparison of different methods, defects & removal.
12. *Fermented Milks*: (a) General Aspects: Preservation, nutritive value (b) Various types: Types of fermentation, fat content, Concentration of the milk, withdrawal of whey, Milk of various animal species.

13. *Yogurt*: The Yogurt bacteria, Manufacture of set & stirred yogurt, Physical properties, Flavor defects & shelf life. 6
14. *Cheese*: Basic principles of cheese making, classification of cheese, chemical composition of different varieties of cheese, Varieties found in Nepal, manufacturing process of hard and soft varieties of cheese, Cheese milk, additives to cheese milk, curd treatment, moulding, salting, cheese ripening, cleaning and packaging, grading of cheese, Cheese faults and their removal, Processed and spread cheese. 12
15. *Dairy Plant Sanitation & Hygiene*: 6
Sanitation of Dairy plants and milk handling equipments, importance of cleaning and sanitation, cleaning, sanitizing and care of can / bottle washers, conveyors & bottle fillers. CIP attached to the dairy plants, Centralized & Decentralized CIP system. used in Dairy Industry. Common washing detergents and sanitizers, cleaning and sanitizing procedure.
16. *Organization in Dairy*: (i) Organizational chart of Small, medium and large-scale dairy industry. (ii) Costing & Cost Control in Dairy. 4

Practicals:

1. Study the milk processing equipments in nearby milk and cheese industries.
2. Study the Milk Sampling techniques.
3. Platform Testing of Milk Physical Tests: Sediment, Organoleptic, Lactometer, Clot- On-Boiling (COB), Alcohol Test, Specific Gravity, Freezing point, SNF/TS. Chemical Tests: Acidity, Water, Fat, Protein, Lactose.
4. Cream Separation and estimate the efficiency of Cream Separator.
5. Preparation of ice cream and evaluation of its quality.

6. Preparation of Butter by Sweet & Ripened Cream.
7. Preparation of Ghee.
8. Preparation of Yogurt.
9. Preparation of Sweets such as Kalakand, Rasbari etc.
10. Preparation of Condensed Milk, Cheese.
11. MBRT, DMC & SPC test of milk and milk products.

Textbooks:

1. Walstra, P. Geurts, T.J. Noomen, A. Jellema, A and Van Boekel M.A.J.S. DAIRY TECHNOLOGY Principles of Milk Properties & Processes, Marcel Dekker, Inc. 1999.
2. Scott, R. Cheese Making Practice, Elsevier, 1985.
3. Fox, P.F. Cheese Elsevier, 1987.
4. Webb, B.H., Johnson, A.H. and Alford, J.A. Fundamentals of Dairy Chemistry. CBS publishers and Distributors, New Delhi.
5. Nobel, P.W. Fundamentals of dairy chemistry. CBS Publication 1988.
6. Henry, V. Antherton, J.A. Chemistry and Testing of Dairy Products. Newlander. 1987.
7. M.P. Mathur, D.D.Roy and P. Dinakar. Text Book of Dairy Chemistry. ICAR, New Delhi. 1999.
8. C.H. Eckles, W.B.Combs and H Macy, Milk and milk products. TMH Edition. 1986.
9. E. Waagner, Nielsen and Jens A. Ullum. Dairy Technology. Vol. 1 & 2, Danish Turnkey Dairies Ltd. 1989.
10. S.De. Outline of dairy technology. 1996.
11. Dairy processing handbook. Tetrapak, sweden. 1995.
12. W.S. Arbuckle, AVI. Ice cream. 1984.
13. A.W. Farall, Wiley Engineering for dairy and food products. Eastern University Edition, New Delhi. 1967.
14. W.J. Harper and C.W. Hall. Dairy technology and engineering. AVI Publishing Co. INC. 1976.