

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY, LUCKNOW

**STUDY AND EVALUATION SCHEME
B.TECH (FOOD TECHNOLOGY) FOURTH YEAR
[Effective from the Session 2016-17]**

B.Tech. (Food Technology)

Year 4TH Semester-VII

S. No.	Course Code	Subjects	Periods			Evaluation Scheme				Subject Total	Credit
			L	T	P	SESSIONAL EXAM					
						CT	TA	TOTAL	ESE		
THEORY SUBJECTS											
1	NOE071 to 074	Open Elective-I	3	1	0	30	20	50	100	150	4
2	NCH017 to 019	Open Elective from other department	3	1	0	30	20	50	100	150	4
3	NFT701	Food Packaging	3	1	0	30	20	50	100	150	4
4	NFT702	Food Quality & Food Laws	3	1	0	30	20	50	100	150	4
5	NFT011 to 013	Departmental Elective-I	3	1	0	30	20	50	100	150	4
PRACTICALS											
6	NFT751	Food Quality Evaluation Lab	0	0	2	10	10	20	30	50	1
7	NFT752	INDUSTRIAL TRAINING **	0	0	2	--	50	50	--	50	1
8	NFT753	PROJECT	0	0	6	--	100	100	--	100	3
9	NGP701	General Proficiency					50	50		50	
		TOTAL								1000	25

Note: ** Practical Training (4-6 weeks) done after 6th Semester would be evaluated in 7th Semester through Report and Viva voce etc.

Open Elective-I

1. **NOE071:** Entrepreneurship Development
2. **NOE072 :** Quality Management
3. **NOE073:** Operations Research
4. **NOE074:** Introduction to Biotechnology

Open Elective from other department

1. **NCH017:** Bioprocess Engineering Principles
2. **NCH018:** Industrial Safety & Hazard Management
3. **NCH019:** Plant Design & Economics

Departmental Elective-I

1. **NFT011:** Technology of Animal Foods
2. **NFT012:** Frozen Foods & Cold Chain Management
3. **NFT013:** Nutraceuticals & functional Foods

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**STUDY AND EVALUATION SCHEME
B.TECH (FOOD TECHNOLOGY) FOURTH YEAR
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B.Tech (Food Technology)

Year 4TH Semester-VIII

S. No	Course Code	Subjects	Periods			Evaluation Scheme				Subject Total	Credit
						SESSIONAL EXAM					
			L	T	P	CT	TA	TOTAL	ESE		
THEORY SUBJECTS											
1	NOE081 to 084	Open Elective-II from other departments	3	1	0	30	20	50	100	150	4
2	NFT801	Traditional & Fermented Foods	3	1	0	30	20	50	100	150	4
3	NFT021 to 023	Departmental elective-II	3	1	0	30	20	50	100	150	4
4	NFT031 to 033	Departmental elective-III	3	1	0	30	20	50	100	150	4
PRACTICALS											
5	NFT851	SEMINAR	0	0	3	--	100	100	--	100	2
6	NFT852	PROJECT	0	0	12	--	100	100	150	250	7
7	NGP801	General Proficiency						50		50	
		TOTAL	12	4	15					1000	25

Open Elective-II

NOE081-Non Conventional Energy Resources
NOE082-Non Linear Dynamic Systems
NOE083-Product Development
NOE084-Automation & Robotics

Departmental Elective-II

NFT021-Food Processing Waste Management
NFT022-Rheological & Sensory Assessment
NFT023- Food Physics

Departmental Elective-III

NFT031- Food Products & Process Development
NFT032- Speciality Foods
NFT033-Engineered, Texturized & Fabricated Foods

NOE071: ENTREPRENEURSHIP DEVELOPMENT

L: T: P

3: 1: 0

UNIT –I

Entrepreneurship- definition. growth of small scale industries in developing countries and their positions vis-a-vis large industries; role of small scale industries in the national economy; characteristics and types of small scale industries; demand based and resources based ancillaries and sub-control types. 5 Government policy for small scale industry; stages in starting a small scale industry.

UNIT –II

Project identification- assessment of viability, formulation, evaluation, financing, field-study and collection of information, preparation of project report, demand analysis, material balance and output methods, benefit cost analysis, discounted cash flow, internal rate of return and net present value methods.

UNIT –III

Accountancy- Preparation of balance sheets and assessment of economic viability, decision making, expected costs, planning and production control, quality control, marketing, industrial relations, sales and purchases, advertisement, wages and incentive, inventory control, preparation of financial reports, accounts and stores studies.

UNIT –IV

Project Planning and control: The financial functions, cost of capital approach in project planning and control. Economic evaluation, risk analysis, capital expenditures, policies and practices in public enterprises. profit planning and programming, planning cash flow, capital expenditure and operations. control of financial flows, control and communication.

UNIT –V

Laws concerning entrepreneur viz, partnership laws, business ownership, sales and income taxes and workman compensation act. 5 Role of various national and state agencies which render assistance to small scale industries.

Recommended Books :

1. Forbat, John, "Entrepreneurship" New Age International.
2. Havinal, Veerbhadrappa, "Management and Entrepreneurship" New Age International
3. Joseph, L. Massod, "Essentials of Management", Prentice Hall of India.

NOE072: QUALITY MANAGEMENT

L: T: P

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UNIT-I

Quality Concepts: Evolution of Quality Control, concept change, TQM Modern concept, Quality concept in design, Review of design, Evolution of proto type. 3 Control on Purchased Product Procurement of various products, evaluation of supplies, capacity verification, Development of sources, procurement procedure. 2 Manufacturing Quality Methods and techniques for manufacture, inspection and control of product, quality in sales and services, guarantee, analysis of claims.

UNIT-II

Quality Management Organization structure and design, quality function, decentralization, designing and fitting, organization for different type products and company, economics of quality value and contribution, quality cost, optimizing quality cost, seduction program. 3 Human Factor in quality (11) Attitude of top management, cooperation of groups, operators attitude, responsibility, causes of apparatus error and corrective methods.

UNIT-III

Control Charts Theory of control charts, measurement range, construction and analysis of R charts, process capability study, use of control charts. 5 Attributes of Control Chart Defects, construction and analysis of charts, improvement by control chart, variable sample size, construction and analysis of C charts.

UNIT -IV

Defects diagnosis and prevention defect study, identification and analysis of defects, correcting measure, factors affecting reliability, MTTF, calculation of reliability, building reliability in the product, evaluation of reliability, interpretation of test results, reliability control, maintainability, zero defects, quality circle.

UNIT –V

ISO-9000 and its concept of Quality Management ISO 9000 series, Taguchi method, JIT in some details.

Text / Reference Books:

1. Lt. Gen. H. Lal, "Total Quality Management", Eastern Limited, 1990.
2. Greg Bounds, "Beyond Total Quality Management", McGraw Hill, 1994.
3. Menon, H.G, "TQM in New Product manufacturing", McGraw Hill 1992.

NOE073: OPERATIONS RESEARCH

L: T: P

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UNIT-I

Introduction: Definition and scope of operations research (OR), OR model, solving the OR model, art of modelling, phases of OR study. Linear Programming: Two variable Linear Programming model and Graphical method of solution, Simplex method, Dual Simplex method, special cases of Linear Programming, duality, sensitivity analysis.

UNIT-II

Transportation Problems: Types of transportation problems, mathematical models , transportation algorithms, Assignment: Allocation and assignment problems and models, processing of job through machines.

UNIT-III

Network Techniques: Shortest path model, minimum spanning Tree Problem, Max-Flow problem and Min-cost problem. Project Management: Phases of project management, guidelines for network construction, CPM and PERT.

UNIT-IV

Theory of Games: Rectangular games, Minimax theorem, graphical solution of 2 x n or m x 2 games, game with mixed strategies, reduction to linear programming model. Quality Systems: Elements of Queuing model, generalized poisson queuing model, single server models.

UNIT-V

Inventory Control: Models of inventory, operation of inventory system, quantity discount. Replacement: Replacement models: Equipments that deteriorate with time, equipments that fail with time.

Recommended Books :

1. Wayne L. Winston, "Operations Research" Thomson Learning, 2003.
2. R. Panneer Seevam, "Operations Research" PHI Learning, 2008.
3. V.K.Khanna, "Total Quality Management" New Age International, 2008.

NOE074: INTRODUCTION TO BIOTECHNOLOGY

L: T: P

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UNIT-I

Introduction: Concept nature and scope of biotechnology. Cell Structure and Function: Eukaryotic and prokaryotic cells, cell wall, membrane organization, cell organelles, Nucleus, Mitochondria, endoplasmic reticulum, chloroplast, viruses and toxins into cells. Cell Division: Mitosis and Meiosis.

UNIT-II

Biomolecules: A brief account of structure of carbohydrates, Lipids and Proteins. Genes: Brief idea about Mendel's laws and chromosomes, nature of genetic materials, DNA and RNA, DNA replication.

UNIT-III

Gene Expression: Central dogma, genetic code, molecular mechanism on mutations, regulations of gene expression, housekeeping genes, differentiation and development mutations and their molecular basic. Genetic Engineering: Introduction, cloning (vectors and enzymes), DNA and genomic libraries, Transgenics, DNA fingerprinting, genomics.

UNIT-IV

Applications of Biotechnology: Bioprocess and fermentation technology, cell culture, Enzyme technology, biological fuel generation, sewage treatment, environmental biotechnology, biotechnology and medicine, biotechnology in agriculture, food and beverage technology, production of biological invention.

UNIT-V

Safety and Ethics: Safety, social, moral and ethic considerations, environmental ethics, bioethics and stem cell research, safety of new biotechnology foods, agro biodiversity and donor policies.

Recommended Books :

1. Smith, "Biotechnology" Cambridge Press.
2. P.K. Gupta, "Elements of Biotechnology" Rastogi
3. H. D. Kumar, "Modern concepts of Biotechnology" Vikas publishing House.

NCH017: BIOPROCESS ENGINEERING PRINCIPLES

(3:1:0)

Unit 1

Introduction, engineering calculations, presentation and analysis of data, material balance, energy balance.

Unit 2

Fluids in motion, viscosity, rheological properties of fermentation broth, mixing equipment, scale-up for mixing systems, heat transfer equipments in bioprocess, heat transfer coefficients for stirred vessel, cooling-coil length in fermenter design, molecular diffusion, O₂ uptake in cell cultures, oxygen transfer in fermenters, measurement of dissolved oxygen concentrations.

Unit 3

Filtration, Centrifugation, Cell disruption, Adsorption, Application of Chromatography in bioprocess.

Unit 4

Basic reaction theory, reaction kinetics for biological systems, zero-order, first order and M-M kinetics, cell growth kinetics, kinetics of cell death, concentration gradients and reaction rates in solid catalysts, reaction rates for free and immobilized enzyme, internal O₂ transfer to immobilized cells.

Unit 5

Bioreactor configurations, practical considerations for bioreactor construction, monitoring and control of bioreactors, operations in bioreactor (Enzyme reaction and cell culture).

Text Books

1. Doran P. M., "Bioprocess Engineering Principles" 2nd Ed., Elsevier (2013)

NCH018: INDUSTRIAL SAFETY & HAZARD MANAGEMENT (3:1:0)

Unit 1

Industrial safety, Industrial hygiene and safety aspects related to toxicity, noise, pressure, temperature, vibrations, radiation etc. Explosions including dust, vapor, cloud and mist explosion.

Unit 2

Elements of safety, safety aspects related to site, plant layout, process development and design stages, identification of hazards and its estimation, risk, risk analysis and assessment methods; fault free method, event free method, scope of risk assessment, controlling toxic chemicals and flammable materials.

Unit 3

Toxic substances and degree of toxicity, its estimation, their entry routes into human system, their doses and responses, control techniques for toxic substances exposure, use of respirators, ventilation systems.

Unit 4

Prevention of losses, pressure relief, provision for firefighting, release of hazardous materials from tanks, pipes through holes and cracks, relief systems: types and location of reliefs.

Unit 5

Handling, transportation and storage of flammable liquids, gases, and toxic materials and wastes, regulation and legislation, government role, risk management routines, emergency preparedness, disaster planning and management.

Books

1. Sanders R.E. "Chemical Process Safety" 3rd Ed., Elsevier, 2007.
2. D. A. Crowl and J.F. Louvar-Chemical Process Safety (Fundamentals with Applications), Prentice Hall (1990)
3. H.H. Fawcett and W.S. Wood – Safety and Accident prevention in Chemical Operations, 2nd Edition, John Wiley & Sons, New York, 1982.
4. Coulson & Richardson's Chemical Engineering-Vol.6, R.K. Sinnott, Butterworth-Heinemann Ltd., 1996.
5. Sanjoy Banerjee, Industrial Hazards & Plant Safety, Taylor & Francis Group

NCH019: PLANT DESIGN AND ECONOMICS

L : T: P

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UNIT- I

Process Development:Process selection, study of alternative processes, pilot plant, Scale up methods, Flow sheet preparation, sketching techniques, Equipment numbering, Stream designation, Material and energy balances.

Plant Design:Design basis ,Process selection -Selection of equipment, specification and design of equipment's, material of construction, Plant location, Plant layout and installation, Safety, Start up, Shutdown and Operating guidelines. [8]

UNIT- II

Cost Engineering:Time value of money and equivalence, Interest, cost comparisons by present worth, Annual equivalent cost and capitalised cost methods, Uniform gradient and series. Depreciation, Taxes and Insurances Nature of depreciation, Methods of determining depreciation, depreciation rates in current Indian situation, Types of taxes and insurance, Cost comparison after taxes. [8]

UNIT- III

Cost Estimation:Types of cost estimation, capital investment cost, fixed capital cost, working capital cost, start-up costs, process equipment cost estimation, cost index, Equipment costs due to inflation, Battery limit investments, estimation of plant cost, Estimation of total product cost, Manufacturing cost, General expenses. [8]

Profitability

Criteria of profitability, Payout period, Return on investment, Present value, Cash flow analysis, Alternative investment analysis, Sensitive analysis in project profitability. [8]

UNIT- IV

Economic Optimization and Optimum Design:Nature of optimization, Uni-variable and multivariable systems, Analytical, graphical and incremental methods of solution, LaGrange multiplier method, Linear programming and dynamic programming establishing optimum conditions, Break even chart for production schedule, Optimum production rates in plant operation, Optimum conditions in batch, cyclic and semicyclic operation, Sensitivity and response analysis. [8]

UNIT- V

Optimization of Different Process Equipment:Viz., transportation systems, heat exchangers, evaporators, mass transfer equipments and reactors. Determination of height and diameter of different process equipments at conditions of optimum cost .Pinch Technology analysis. Preparation of techno-economic feasibility report. [8]

Recommended Books:

- 1.Peters M., Timmerhaus K. & Ronald W., Plant Design & Economics for Chemical Engineers, McGraw Hill
- 2.James R Couper, Process Engg. Economics (Chemical Industries) CRC Press
3. Aries & Newton, Chemical Engg. Cost Estimation, McGraw Hill

NFT701 : FOOD PACKAGING

L : T: P

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UNIT-I

Basic Concepts: Concept of packaging, Functions of a Food Package, Package development factors and Food package development. Aseptic Packaging. Newer trends.

UNIT -II

Cellulosic and Polymeric packaging materials and forms: Food grade polymeric packaging materials, Rigid plastic packages. Films: Oriented, Co-extruded, Laminates and Metallised; Cellophane, Olefins, Polyamides, Polyesters, PVC, PVDC, PVA, Inomers, Copolymers, Polycarbonates, Phenoxy, Acrylic and Polyurethane. Their mechanical sealing and barrier properties.

UNIT -III

Glass and Metal containers: Glass: Composition, Properties, Bottle making and Closures for glass containers. Metal: Bulk containers, Tin-plate containers, Tin free steel containers, Aluminum containers, Latest development in metal cans and protective lacquers.

UNIT -IV

Food product characteristics and package requirement, Selection of materials, Forms, Machinery and methods for fresh produce (Fruits, Vegetables, Egg, Meat and Fish), Edible oils and Fats, Spice and spice products, Processed products (Fruit & Vegetable, Cereal & Pulse, Dairy, Confectionary & Snacks, Meat & Marine products).

UNIT -V

Package printing, Packaging Laws and Regulations, Evaluation of food packaging materials and package performance.

Recommended Books :

M. Mahadeviah and R.V. Gowramma Food Packaging Materials
S. Saclarow and R.C. Griffin Principles of Food Packaging
Trends in Food Science & Technology Proceedings of IFCON-1988

NFT702 FOOD QUALITY AND FOOD LAWS

L : T: P

3 : 1 : 0

UNIT -I

Ways of describing of Food Quality, Quality control and Quality Assurance functions. Total Quality Control (TQC) and the role of management/TQM.. Statistical quality control. Quality costs., Analysis and Interpretation of sensory scores. Application of sensory evaluation in Quality Management of foods.

UNIT -II

Instrumental measurements of sensory attribute of foods: Appearance, color, volume, density and specific gravity, Rheological and textural characteristics . Texture profile analysis. Correlation between instrumental and Sensory analysis of food quality attributes.

UNIT -III

Nutritional Quality of foods and its assessments: Food proteins (Digestibility, Biological value, NPU, PER), Modifications of foods constituents due to processing and storage and their nutritional implications.

UNIT -IV

Food standards and Specifications: Compulsory and voluntary trade and Company standards. Consumer, company, In-process and finished product specifications. Relevant Food laws: PFA, FPO, SWMA, MPO, AgMark, and BIS Standards.

UNIT -V

FSSAI: Definitions, Provisions and standards. Penalty Provisions. Comparison with other International Standards.

Recommended Books :

J.M.DeMan Rheology and Texture in Food Quality
Y.Pomeranz Food Analysis : Theory and practice IS: 6273 (Part-1&Part-2)
M.A. Amerine Principles of Sensory Analysis of Food ; FSSAI Act.

NFT011: TECHNOLOGY OF ANIMAL FOODS

L : T: P

3 : 1 : 0

UNIT -I

Ante-mortem examination of meat animals, Scientific slaughtering; Meat cuts and portions of meat, Post mortem changes in meat; Conversion of muscle to meat; Colour of meat; composition and nutritional value, Meat microbiology and safety.

UNIT -II

Meat processing- curing and smoking; Fermented meat products (sausages and sauces); Frozen meat & meat storage. Beef Mutton, Pork Sausages and other meat products.

UNIT -III

Poultry processing, Canning of poultry products. Structure, composition and Nutritional and Functional characteristics of Egg. Causes of deterioration of quality of egg, Preservation and Processing of Egg. Manufacturing of egg white, Egg yolk and Whole Egg solids/powder.

UNIT -IV

Classification of fresh water fish and marine fish; Commercial handling, storage and transport of raw fish. Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of fish. Methods of processing and preservation of fish- Canning, Freezing, Drying, Smoking and Curing. Fish products – fish meal, fish protein concentrate, fish liver oil, fish sauce and surimi; Fish processing industries in India.

UNIT -V

Meat plant hygiene – GMP and HACCP. By-products from meat industries and their utilization; Meat industries in India. Production of chitin, chitosan; Production of non-food items from fish processing wastes. Byproduct Utilization – commercial processing of lecithin and other egg solids, Utilization of egg-derived products as food ingredients; Fertilizer from shells.

Recommended Books :

ountney Poultry Products Technology
Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
Developments in Meat Science – I & II, Lawrie R; Applied Science Pub. Ltd.
Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.

NFT012: FROZEN FOODS AND COLD CHAIN MANAGEMENT

L : T: P

3 : 1 : 0

UNIT -I

Fundamentals of freezing: Glass transition in frozen foods and biomaterial, microbiology of frozen foods, thermo-physical properties of frozen foods, Freezing load and freezing time calculations, Innovation in freezing process

UNIT -II

Facilities for the cold chain: freezing methods and equipment, cold store design and maintenance, transportation of frozen foods, retail display equipment and management, household refrigerators and freezers, monitoring and control of the cold chain.

UNIT -III

Quality and Safety of Frozen Foods: Quality and Safety of frozen meat and meat product, Quality and safety of frozen poultry and poultry products, Safety and quality fish, Shellfish and related products, Quality and safety of frozen vegetables, fruits, dairy products, ready meads , bakery products, Eggs and eggs products.

UNIT -IV

Monitoring and measuring techniques for quality and safety: Chemical measurements, sensory analysis of frozen foods, Food borne illnesses and detection of pathogenic microorganisms, self life prediction of frozen foods.

UNIT -V

Packaging of frozen foods: Introduction to frozen food packaging, plastic packaging of frozen foods, paper and card packaging of frozen foods, Packaging of frozen foods with other materials, Packaging machinery.

Recommended Books :

1. P.G.Smith, Introduction to Food Process Engineering, Springer.
2. O.R.Fennema : Principles of Food Science, AVI Publications
3. Mallett, C.P., Frozen Food Technology, Springer
4. Da-Wen Sun, Handbook of Frozen Food Processing and Packaging, Second Edition

NFT013: NUTRACEUTICAL & FUNCTIONAL FOODS

L : T: P

3 : 1 : 0

UNIT -I

Defining nutraceuticals and functional foods, Nature, type and scope. Nutraceuticals and functional foods applications and their health benefits, classification based on chemical and biochemical nature with suitable and relevant descriptions.

UNIT -II

Nutraceuticals for specific situation such as cancer ,heart diseases, stress, Osteoartehritis, hypertension etc. Antioxidants and other phytochemicals, isoflavones, lycopenes, their role in nuraceuticals and functional foods, dietary fibers and complex carbohydrates as functional food ingredients.

UNIT -III

Protein as a functional food ingredients, Probiotic foods and their functional role ,Herbs as functional foods, health promoting activity of common herbs. Cerals products as functional foods- Oats, Wheat bran, rice bran etc.

UNIT -IV

Functional vegetable products, oil seeds and sea foods. Coffee, tea and other beverages as functional foods/ drinks and their protective effects. Effects of processing and storage and interaction of various environmental factors on the potentials of such foods.

UNIT -V

Marketing and regulatory issues for functional foods and nutraceuticals
Recent developments and advances in the area of nutraceuticals and functional foods.

Recommended Books :

1. Robert E.C. Wildman, Robert Wildman, Taylor C. Wallace, Handbook of Nutraceuticals and Functional Foods, Second Edition ,CRC Press
2. Robert E.C. Wildman, Denis M. Medeiros, Advanced Human Nutrition, CRC Press
3. Shubhangini A. Joshi Nutrition and Dietetics, Tata McGraw-Hill Education, 2010

NFT751: FOOD QUALITY EVALUATION LAB

L : T: P
O : O: 2

1. Sensitivity tests (Threshold/Dilution) to measure individual ability for sensory analysis.
- 2-3. Difference tests to evaluate qualitative and quantitative differences and/or preference between test products.
- 4-5. Assessment of quality of wheat flour (Water Absorption Power, Gluten Content, and Sedimentation Value etc.).
6. Evaluation of quality of Bakery Products: Bread, Biscuits, Cakes etc.
- 7-8. Evaluation of quality of Dairy Products: Over run and fat content in Ice-cream, Specific gravity of Milks etc.
- 9-10. Assessment of quality of Fruit & Vegetable Products: Tomato Products, Jam, Jelly, Marmalades, Squashes& Cordials, Canned Products.
- 11-12. Assessment of Quality of Beverages: Tea & Coffee, Carbonated and RTS Beverages.

Recommended Books:

1. BIS Specifications Morris B. Jacobs The Chemical Analysis of Foods & Food Products
2. S. Ranganna Hand Book of Analysis and Quality Control for Fruit & Vegetable Products
3. Official Method of Analysis of AOAC

NFT752: INDUSTRIAL TRAINING

L : T: P
O : O: 2

The student(s) will be required to undertake training in the food industry after III B.Tech.VI semester for a specified period and submit its report after completion for evaluation and viva-voce in the VII semester of his studies .

NFT753: PROJECT

L : T: P
O: O: 6

The student (s) will be required to search literature pertaining to design of an equipment / processing of a food commodity / production of food product, comprehend it and prepare a report for assessment.

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NOE081: NON-CONVENTIONAL ENERGY RESOURCES

L :T :P

3 :1 :0

UNIT-I

Introduction: Various non-conventional energy resources- Introduction, availability, classification, relative merits and demerits. 3 Solar Cells: Theory of solar cells. solar cell materials, solar cell array, solar cell power plant, limitations.

UNIT-II

Solar Thermal Energy: Solar radiation, flat plate collectors and their materials, applications and performance, focussing of collectors and their materials, applications and performance; solar thermal power plants, thermal energy storage for solar heating and cooling, limitations.

UNIT-III

Geothermal Energy: Resources of geothermal energy, thermodynamics of geo-thermal energy conversion-electrical conversion, non-electrical conversion, environmental considerations. 4 Magneto-hydrodynamics (MHD): Principle of working of MHD Power plant, performance and limitations. 2 Fuel Cells: Principle of working of various types of fuel cells and their working, performance and limitations.

UNIT-IV

Thermo-electrical and thermionic Conversions: Principle of working, performance and limitations. 2 Wind Energy: Wind power and its sources, site selection, criterion, momentum theory, classification of rotors, concentrations and augments, wind characteristics. performance and limitations of energy conversion systems.

UNIT-V

Bio-mass: Availability of bio-mass and its conversion theory. 2 Ocean Thermal Energy Conversion (OTEC): Availability, theory and working principle, performance and limitations. Wave and Tidal Wave: Principle of working, performance and limitations. Waste Recycling Plants.

Recommended Books :

1. Raja et al, "Introduction to Non-Conventional Energy Resources" Scitech Publications.
2. John Twideu and Tony Weir, "Renewal Energy Resources" BSP Publications, 2006.
3. M.V.R. Koteswara Rao, " Energy Resources: Conventional & Non-Conventional " BSP Publications, 2006.
4. D.S. Chauhan, "Non-conventional Energy Resources" New Age International.

NOE082: NON-LINEAR DYNAMIC SYSTEMS

L :T: P

3 :1 :0

UNIT-I

Dynamic systems: Concept of dynamic systems, importance of non-linearity, nonlinear dynamics of flows (in 1, 2, and 3 dimensions) and Maps (1 and 2 dimensions) in phase space, Equilibrium, Periodicity. Picard's theorem, Peano's theorem, boundedness of solutions, omega limit points of bounded trajectories.

UNIT-II

STABILITY-I: Stability via Lyapunov's indirect method, converse Lyapunov functions, sublevel sets of Lyapunow functions, Lasalle's invariance principle.

UNIT-III

Stability-II Lyapunov's direct method, converse Lyapunov's theorems, Brokett's theorem, applications to control system, stable manifold theorem, centre manifold theorem, normal form theory and applications to nonlinear systems.

UNIT-IV

Bifurcation: Elementary Bifurcation theory, catastrophe, strange attractor, fractals, fractal geometry and fractal dimension.

UNIT-V

Chaos: Deterministic Chaos, routes to chaos (period doubling, quasiperiodicity, intermittency, universality, renormalization); Measurement of Chaos (Poincare section, Lyapunov index, entropy); control of chaos.

Recommended Books :

1. D.K. Arrowsmith and C.M. Place, "An Introduction to Dynamical Systems" Cambridge University press, London, 1990.
2. K.T. Alligood, T.D. Sauer, and J.A Yorke, "CHAOS: An Introduction to Dynamical System" Springer Verlag, 1997.
3. H.K. Khalis, "Nonlinear Systems" Prentice Hall, 1996.
4. R. R. Mohler, "Non linear systems, Vol-I: Dynamics and Control" Prentice Hall, 1991.
5. J.M. T. Thomson and H.B. Stewart, "Nonlinear Dynamics and Chaos" John Wiley & Sons, 1986.
6. Stanislaw H. Zak, "Systems and control" Oxford University Press, 2003.

NOE083: PRODUCT DEVELOPMENT

L :T :P

3: 1: 0

UNIT-1

Concept of Product, definition and scope. Design definitions, old and new design methods, design by evolution, examples such as evolution of sewing M/C, bicycle, safety razor etc., need based developments, technology based developments physical reliability & economic feasibility of design concepts.

UNIT –II

Morphology of design, divergent, transformation and convergent phases of product design, identification of need, Analysis of need. Design criteria; functional, aesthetics, ergonomics, form, shape, size, colour. Mental blocks, Removal blocs, Ideation techniques, Creativity, Check list.

UNIT –III

Transformations, Brainstorming & Syntetics, Morphological techniques. Utility Concept, Utility Value, Utility Index, Decision making under Multiple Criteria. Economic aspects, Fixed and variable costs, Break-even analysis.

UNIT-IV

Reliability considerations, Bath tub curve, Reliability of systems in series and parallel, Failure rate, MTTF and MTBF, Optimum spares from Reliability considerations. Design of display and controls, Man-machine interface, Compatibility of displays and controls. Ergonomic aspects, Anthropometric data and its importance in design. Application of Computers in Product development & design.

UNIT-V

Existing techniques, such as work-study, SQC etc. for improving method & quality of product. Innovation versus Invention. Technological Forecasting. Use of Standards for Design.

Recommended Books :

1. A.K. Chitab& R.C. Gupta "Product design & Manufacturing" – Prentice Hall (EE)
2. R.P. Crewford, "The Technology of creation Thinking" Prentice Hall.
3. C.D. Cain, "Product Design & Decision" Bussiness Books.

NOE084: AUTOMATION AND ROBOTICS

L :T: P

3 :1 :0

UNIT 1.

Introduction: Definition, Classification of Robots, geometric classification and control classification.

UNIT 2.

Robot Elements: Drive system, control system, sensors, end effectors, gripper actuators and gripper design.

UNIT 3.

Robot Coordinate Systems and Manipulator Kinematics: Robot co-ordinate system representation, transformation, homogenous transform and its inverse, relating the robot to its world. Manipulators Kinematics, parameters of links and joints, kinematic chains, dynamics of kinematic chains, trajectory planning and control, advanced techniques of kinematics and dynamics of mechanical systems, parallel actuated and closed loop manipulators.

UNIT 4.

Robot Control: Fundamental principles, classification, position, path velocity and force control systems, computed torque control, adaptive control, Seroo system for robot control, and introduction to robot vision.

UNIT 5.

Robot Programming: Level of robot programming, language based programming, task level programming, robot programming synthesis, robot programming for welding, machine tools, material handing, assembly operations, collision free motionplanning.

UNIT 6.

Applications: Application of robot in welding, machine tools, material handling, assembly operations parts sorting and parts inspection.

Recommended Books :

1. Coifet Chirroza, "An Introduction to Robot Technology" KoganPage.
2. Y. Koren "Robotics for Engineers" McGraw Hill.
3. K. S. Fu, R.C. Gonzalez Y& CSG Lee, "Robotics" McGraw Hill.

NFT801 :TRADITIONAL AND FERMENTED FOODS

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UNIT -I

Indian traditional sweet, savory and snack food products: Sweetmeats, Namkins, Papads Idli and Dosa.

UNIT -II

Preparation and Maintenance of Bacterial, Yeast and Mold cultures for food fermentations. Lactic acid bacteria-activities and health-promoting effects. Mushrooms: Cultivation and preservation.

UNIT -III

Fermented Dairy Products: Cheeses, Curd and Yoghurt, Butter milk and the fermented milks. Spoilages and defects of fermented dairy products and their control. Fermented meat and fish products.

UNIT -IV

Fermentative Production of Beer, Wines, Cider and Vinegar. Fermented Vegetables (Pickles).

UNIT -V

Production of Baker's Yeast, Microbial Proteins and fats, Food enzymes, and Food additives. Oriental fermented foods.

Recommended Books :

1. K.H. Steinkrus Handbook of Indigenous Fermented Foods
2. Sukumar De Outlines of Dairy Technology
3. Prescott & Dunn Industrial Microbiology
4. L.E. Casida Industrial Microbiology

NFT021: FOOD PROCESSING WASTE MANAGEMENT

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UNIT -I

Basic considerations: Standards for emission or discharge of environmental pollutants from food processing Industries as per the updated provision of Environment (Protection) Act, 1986. Elements of importance in the efficient management of food processing wastes.

UNIT -II

Characterization and utilization of by-products from Cereal Pulses, Oilseeds, Fruits and vegetables, Plantation products, Fermented foods, Milk, Fish, Meat, Egg and poultry processing industries.

UNIT -III

Characterization of food Industry effluents, Physical and chemical parameters, Oxygen demands and their interrelationships, Residues (solids), Fats, Oils and grease, Forms of Nitrogen, Sulphur and Phosphorus, Anions and cations, Surfactants, Colour, Odour, Taste, Toxicity. Unit concept of treatment of food industry effluent, Screening, Sedimentation Flootation as pre - and primary reactants.

UNIT -IV

Biological oxidations: Objects, Organisms, Reactions, Oxygen requirements, Aeration devices Systems: Lagoons, Activated sludge process, Oxidation ditches, Rotating biological contactors and their Variations and advanced modifications.

UNIT -V

Advanced wastewater treatment systems. Physical separations, Micro-strainers, Filters, Ultra filtration and reverse osmosis. Physico-chemical separations: activated carbon adsorption, Ion-exchange electro-dialysis and magnetic separation. Chemical oxidations and treatment Coagulation and flocculation. Disinfection. Handling disposal of sludge.

Recommended Books :

J.H. Green Food Processing Waste Management ; Environment (Protection) Act 1986
AFST(I) & CFTRI Proceedings of the Symposium on By-products From food Industries: Utilization and Disposal

NFT022: RHEOLOGICAL AND SENSORY ANALYSIS OF FOODS

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UNIT -I

Mechanical properties of foods. Mechanical models to visualize behaviour of foods. Basic and applied rheological considerations and their application to foods.

UNIT -II

Food Microstructure and its study by light, Scanning and Transmission Electron microscopy. Implications of micro-structure in determining mechanical and sensory characteristics of foods.

UNIT -III

Requirement of test systems for measuring food texture. Types of texture Instrument and their operating mechanisms, Calibration, Performance of test and measurements of test parameters. Interpretation of test results.

UNIT -IV

Textural properties of fruits & vegetables; Dough, Pasta and Baked products; dairy products; Meat; Fat and fat products; and their instrumental Measurements.

UNIT -V

Rheology of chocolate, Textural characteristics of food emulsions, Functions of emulsifiers in relation to food texture, Sensory measurement of food texture and texture profile.

Recommended Books :

J.M. de Man Rheology and Texture in Food quality

NFT023: FOOD PHYSICS

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UNIT I-PHYSICAL PROPERTIES

Engineering properties - importance and applications in the crop process equipment design. Physical characteristics – shape, size, volume, bulk density, particle density, porosity, Surface area. Frictional characteristics- angle of repose, co-efficient of friction - determination.

UNIT II-RHEOLOGICAL PROPERTIES

Rheology - definition - various types of materials - Hook's law – classic ideal material. Stress – strain - density relationship. Rheological models – Maxwell model, Kelvin model, Four elements Burger's model.

UNIT III- TEXTURAL PROPERTIES

Texture of food materials - subjective and objective methods - Imitative and Empirical tests . Texture Profile Analysis. Interpretation of results.

UNIT IV-THERMAL PROPERTIES

Thermal properties - specific heat - determination - methods for solids and powders. Determination of thermal conductivity - steady state and unsteady state methods. Thermal diffusivity - determination - relationship among specific heat, thermal conductivity, bulk density and thermal diffusivity - effect of moisture content on thermal properties.

UNIT V-ELECTRICAL AND AERODYNAMIC PROPERTIES

Electrical properties - resistance, capacitance - uses - Dielectric loss factor - method of determination. A.C. conductivity and dielectric constant – determination - Q meter. Effect of moisture content on electrical properties - energy absorption from high frequency electric field.

Recommended Books :

1. Mohesenin. N.N, "*Thermal properties of Foods and Agricultural Materials*". Gordon and Breach Science Publishers, New York 1980.
2. Mohesenin. N.N, "*Physical properties of Plant and Animal Materials*". Gordon and Breach Science Publishers, New York 1980.
3. Rao, M.A and S.S.H.Rizvi (Eds) "*Engineering Properties of Foods*". Marcel Dekker Inc. New York 1986.

NFT031: FOOD PRODUCT AND PROCESS DEVELOPMENT

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UNIT -I

Innovation and product development concept. Generation of ideas. Desk Research. Screening/ appraisal of initial ideas.

UNIT -II

Detailed study of product, process and market, Planning and developmental activities and evaluating them.

UNIT -III

Development of prototype product and its testing for acceptance.

UNIT -IV

Development of process and planning for production trials. Planning the test market. Actual production trials and test marketing. Evaluation of test results.

UNIT -V

Launching of the product. Advertising and marketing plans. Suggestions for improving success.

Recommended Books :

Chicago: Arlington Food Product Development

NFT032 : SPECIALITY FOODS

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UNIT -I

Infant and baby foods, Adolescent / Teen-age foods, Geriatric foods, Foods for pregnant ladies and nursing mothers. Functional foods and Probiotics.

UNIT -II

Foods / Diets in metabolic disorders and disturbances.

UNIT -III

Foods and Diets recommended and restricted in Gastrointestinal disorders; Fever and Infection; Liver, gallbladder and pancreatic disturbances.

UNIT -IV

Foods and Diets recommended and restricted in blood, circulatory and Cardiac diseases; urinary and Musculoskeletal diseases. Allergies.

UNIT -V

Beneficial Effects of Spices, gamma-linolenic acid, Spirulina, antioxidants and other food constituents. New Developments.

Recommended Books :

Benzamin T. Burton Human Nutrition
Shubhangini A. Joshi Nutrition and Dietetics, Tata McGraw-Hill Education, 2010
B. Srilakshmi Dietetics
AFST(I) & CFTRI Proceedings of IFCON

NFT033 : ENGINEERED, TEXTURIZED & FABRICATED FOODS

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UNIT I

Extruders. Single Screw & Multiple Screw Extruders. Extrusion process. Extrusion cooking. Physical & Chemical Changes during Extrusion Process.

UNIT II

Textured vegetable protein products. Puffing Gun ,Puffed Products. Meat Analogues., Imitation Paneer

UNIT III

Fabricated RTS Beverages, Bakery Products, Margarine, Peanut Butter, Imitation Milks Designer Lipids etc.

UNIT IV

Weaning Foods/ Baby Foods. Therapeutic Foods . Geriatric Foods.

UNIT V

Technology and manufacture of Macaroni, Pasta, Noodles, Vermicelli etc

Recommended Books :

1. Zeki Berk, Food Process Engineering and Technology, Academic Press
2. Shubhangini A. Joshi Nutrition and Dietetics, Tata McGraw-Hill Education, 2010
3. S.A.Matz, Cereal Technology, CBS Publishers

NFT851 SEMINAR

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The student (s) will be required to prepare a detailed Seminar report on the topic (s) assigned to them along with an MS Power Point Presentation. The Seminar shall be delivered in the class followed by Queries.

NFT852 PROJECT

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The student (s) will be required to prepare a detailed project report on fabrication of an equipment / establishment of a plant for processing of a food commodity for production of food product(s) with complete lay-out and economic analysis for assessment.