

# **Curricula and Syllabi**

## **B. Tech. Food Engineering Programme**



**Kelappaji College of Agricultural Engineering  
and Technology  
Kerala Agricultural University  
Tavanur, Kerala-679573.**



**CURRICULUM-SEMESTER WISE BREAK UP**

<b>Semester I</b>			
1.	Basc.1101	Communicative English	2+0
2.	Basc.1102	Engineering Mathematics - I	3+0
3.	Basc.1103	Engineering Physics	2+1
4.	Basc.1104	Engineering Chemistry	2+1
5.	Cien.1101	Basic Civil Engineering	2+1
6.	Fdsc.1101	Food Science and Nutrition	2+1
7.	Cien.1102	Engineering Drawing	0+2
8.	Meen.1101	Production Technology	2+1
<b>Total</b>			<b>15+7</b>
<b>Semester II</b>			
1.	Fden.1201	Engineering Properties of Biological Materials	2+1
2.	Fden.1202	Heat and Mass Transfer	1+1
3.	Fdqu.1201	Fundamentals of Biochemistry	2+1
4.	Basc.1205	Engineering Mathematics II	3+0
5.	Basc.1206	Information Technology	1+1
6.	Meen.1202	Machine Drawing	0+1
7.	Elen.1201	Basic Electrical Engineering	2+1
8.	Meen.1203	Engineering Thermodynamics	2+1
9.	Fdqu.1202	General Microbiology	1+1
<b>Total</b>			<b>14+8</b>
<b>Semester III</b>			
1.	Fden.2103	Refrigeration and Cold Storage	1+1
2.	Meen.2104	Boiler and steam Engineering	1+1
3.	Meen.2105	Kinematics of Machinery	2+1
4.	Fdqu.2103	Bio Chemical Engineering	1+1
5.	Basc.2107	Computer Programming	1+1
6.	Fdqu.2104	Biochemistry of Processing and Preservation	1+1
7.	Basc.2108	Engineering Mathematics III	2+1
8.	Fden.2104	Crop Process Engineering	2+1
9.	Cien.3105	Fluid Mechanics	2+1
<b>Total</b>			<b>13+9</b>
<b>Semester IV</b>			
1.	Basc.2209	Numerical Methods for Engineering Applications	1+1
2.	Fdpr.2201	Post Harvest Engineering of Horticultural Crops	2+1
3.	Fden.2205	Food Process Engineering	2+1
4.	Fdsc.2202	Baking and Confectionery Technology	1+1
5.	Fden.2206	Dairy Engineering and Technology	2+1
6.	Fdqu.2205	Food Microbiology	1+1
7.	Cien.2204	Mechanics and Strength of Materials	2+1
8.	Fden.2207	Unit Operations in Food Engineering	2+1

<b>Total 13+8</b>			
<b>Semester V</b>			
1	Meen.3106	Systems Engineering	2+0
2	Fdsc.3103	Entrepreneurship and agribusiness management	2+0
3	Fdsc.3104	Food Safety and Quality Management	1+1
4	Fden.3108	Energy for Food Industries	1+1
5	Fdpr.3102	Meat and Poultry Technology	2+0
6	Fdpr.3103	Oil Chemistry and Technology	2+1
7	Meen.3107	Machine Design	1+1
8	Basc.3110	Statistics	1+1
9	Basc.3111	Economics of Food Processing and Marketing	2+1
10	Cien.3105	Design of Structures	1+1
<b>Total 15+7</b>			
<b>Semester VI</b>			
1	Fdpr.3204	Post Harvest engineering of Plantation Crops	2+1
2	Fdsc.3205	Food Industry Waste Management	2+0
3	Fden.3209	Food Process Equipment Design and Layout	1+1
4	Fden.3210	Computer Aided Drafting of Food Processing Equipments	1+1
5	Elen.3202	Instrumentation and Process Control	2+1
6	Fdsc.3206	Fermentation Technology	1+1
7	Elfe.0001	Elective 1	3+0
8	Semr.3201	Seminar 1	0+1
9	Proj.3201	Project Work	0+2
<b>Total 12+8</b>			
<b>Semester VII</b>			
1.	Fdpr.4105	Food Packaging Technology	2+1
2.	Fdpr.4106	Processing of Marine Products	2+0
3.	Fdpr.4107	Storage and Preservation Technology	1+1
4.	Fdsc.4107	Food Industry Management	2+1
5.	Fdsc.4108	Sanitation and Hygiene in Food Industries	2+0
6.	Basc.4112	Extension Methods and Transfer of Technology	1+1
7.	Elfe.0002	Elective II	3+0
8.	Semr.4102	Seminar II	0+1
9.	Proj.4102	Project Work	0+2

<b>Total 13+7</b>
-------------------

<b>Semester VIII</b>			
1.	Idtl.4201	Industrial Training	0+9
2.	Sist.4201	South India Study Tour	0+1
<b>Total</b>			<b>0+10</b>

The Industrial Training and South India Study Tour have to be offered for 90 days and 15days respectively

### SEMESTERWISE DISTRIBUTION OF COURSES AND CREDITS

Sl.No.	Semester	No. of Courses	Credit Hours
1	I	8	15+7= 22
2	II	9	14+8= 22
3	III	9	13+9= 22
4	IV	8	13+8= 21
5	V	10	15+7= 22
6	VI	9	12+8= 20
7	VII	9	13+7= 20
8	VIII	2	0+10= 10
		<b>64</b>	<b>95+ 64= 159</b>

<b>DEPARTMENTWISE DISTRIBUTION OF COURSES</b>		Page No.	Credit
<b>Department of Food Engineering</b>			
Fden.1201	Unit Operations in Food Engineering	10	2+1
Fden.1202	Heat and Mass Transfer	11	1+1
Fden.2103	Refrigeration and Cold Storage	11	1+1
Fden.2104	Engineering Properties of Biological Materials	12	2+1
Fden.2205	Food Process Engineering	13	2+1
Fden.2206	Dairy Engineering and Technology	15	2+1
Fden.2207	Crop Process Engineering	16	2+1
Fden.3108	Energy for Food Industries	17	1+1
Fden.3209	Food Process Equipment Design and Layout	18	1+1
Fden.3210	Computer Aided Drafting of Food Processing Equipments	19	1+1
<b>Total</b>		<b>15+10</b>	<b>(15.72%)</b>
<b>Department of Food Processing</b>			
Fdpr.2201	Post Harvest Engineering of Horticultural Crops	22	2+1
Fdpr.3102	Meat and Poultry Technology	23	2+0
Fdpr.3102	Oil Chemistry and Technology	24	2+1

Fdpr.3203	Post Harvest Engineering of Plantation Crops	25	2+1
Fdpr.4105	Food Packaging Technology	25	2+1
Fdpr.4106	Processing of Marine Products	26	2+0
Fdpr.4107	Storage and Preservation Technology	27	1+1
<b>Total 13+5(11.32%)</b>			
<b>Department of Food Science</b>			
Fdsc.1101	Food Science and Nutrition	30	2+1
Fdsc.2202	Baking and Confectionery Technology	31	1+1
Fdsc.3103	Entrepreneurship and agribusiness management	32	2+0
Fdsc.3104	Food Safety and Quality Management	32	1+1
Fdsc.3205	Food Industry Waste Management	33	2+0
Fdsc.3206	Fermentation Technology	33	1+1
Fdsc.4107	Food Industry Management	34	2+1
Fdsc.4108	Sanitation and Hygiene in Food Industries	35	2+0
<b>Total 13+5(11.32%)</b>			
<b>Department of Food Quality</b>			
Fdqa.1201	Fundamentals of Biochemistry	38	2+1
Fdqu.1202	General Microbiology	39	1+1
Fdqu.2103	Bio Chemical Engineering	40	1+1
Fdqu.2104	Biochemistry of Processing and Preservation	40	1+1
Fdqu.2205	Food Microbiology	41	1+1
<b>Total 6+5(6.92%)</b>			
<b>Department of Supportive Engineering</b>			
Cien.1101	Basic Civil Engineering	44	2+1
Cien.1102	Engineering Drawing	45	0+2
Meen.1101	Production Technology	46	2+1
Elen.1201	Basic Electrical Engineering	47	2+1
Meen.1202	Machine Drawing	48	0+1
Meen.1202	Engineering Thermodynamics	48	2+1
Cien.2103	Fluid Mechanics	49	2+1
Meen.1203	Boiler and steam Engineering	50	1+1
Cien.2204	Mechanics and Strength of Materials	51	2+1
Meen.2104	Kinematics of Machinery	53	2+1
Cien.3105	Design of Structures	54	1+1
Meen.3106	System Engineering	54	2+0
Meen.3107	Machine Design	55	1+1
Elen.3202	Instrumentation and Process Control	56	2+1
<b>Total 21+14(22.01%)</b>			

<b>Department of Basic Science</b>			
Basc.1101	Communicative English	58	2+0
Basc.1102	Engineering Mathematics - I	58	3+0
Basc.1103	Engineering Physics	59	2+1
Basc.1104	Engineering Chemistry	60	2+1
Basc.1205	Engineering Mathematics II	61	3+0
Basc.1206	Information Technology	61	1+1
Basc.2107	Computer Programming	62	1+1
Basc.2108	Engineering Mathematics III	63	2+1
Basc.2209	Numerical Methods for Engineering Applications	64	1+1
Basc.3110	Statistics	65	1+1
Basc.3111	Economics of Food Processing and Marketing	66	2+1
Basc.4112	Extension Methods and Transfer of Technology	67	1+1
<b>Total 21+9 (18.87%)</b>			
As per the offering Department	Elective I		3+0
	Elective II		3+0
Semr.3201	Seminar I		0+1
Proj.3201	Project Work		0+2
Semr.4102	Seminar II		0+1
Proj.4102	Project Work		0+2
Idtl.4201	Industrial Training		0+9
Sist.4201	South India Study Tour		0+1
<b>Total 6+16(13.84%)</b>			

SI No.	Name of Department	No. of Courses	Credit Hours
1	Department of Food Engineering	10+1*	15+10+3
2	Department of Food Processing	7+1*	13+5+3
3	Department of Food Science	8+1*	13+5+3
4	Department of Food Quality	5	6+5
6	Department of Supportive Engineering	14	21+14
7	Department of Basic Science	12	21+9



## Department of Food Engineering

### LIST OF COURSES

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No.</b>
1	Fden.1201	Unit Operations in Food Engineering	2+1	10
2	Fden.1202	Heat and Mass Transfer	1+1	11
3	Fden.2103	Refrigeration and Cold Storage	1+1	11
4	Fden.2104	Engineering Properties of Biological Materials	2+1	12
5	Fden.2205	Food Process Engineering	2+1	13
6	Fden.2206	Dairy Engineering and Technology	2+1	15
7	Fden.2207	Crop Process Engineering	2+1	16
8	Fden.3108	Energy for Food Industries	1+1	17
9	Fden.3209	Food Process Equipment Design and Layout	1+1	18
10	Fden.3210	Computer Aided Drafting of Food Processing Equipments	1+1	19

## **Fden.1201 UNIT OPERATIONS IN FOOD ENGINEERING (2+1)**

Basic concepts of unit operations- Units of measurements-dimensional analysis. Conservation of mass and energy. Evaporators- single and multiple-effect evaporator-vapour recompression-boiling point elevation-evaporation of heat-sensitive materials-evaporation equipments-simple problems.

Mechanical separation Sedimentation-Gravitational sedimentation-Floatation-sedimentation of particles in gas, settling under combined forces-centrifugal separation--centrifugation Filtration- filtration in relation to food processing. Membrane Technology-methods- types of membranes.

Size reduction-principles--size reduction in liquid foods-equipments. Grinding and cutting-various grinding equipments -cryogenic grinding of spices. Emulsification-preparation of emulsions. Characteristics of mixtures – measurements of mixing –particle mixing-liquid mixing-mixing equipments.

Contact equilibrium - separation processes - concentrations - gas-liquid equilibria, solid-liquid equilibria - equilibrium concentration relationships - operating conditions - equilibrium processes - gas absorption - rate of absorption - stage equilibrium - absorption equipment. . Leaching and Extraction-principles- rate of extraction - super critical fluid extraction. Washing equipments - crystallization - rate of crystal growth - distillation - steam, vacuum and batch distillation - distillation equipments. Irradiation-Extrusion cooking-type of extruders. Microwave and infrared radiation-theory equipments, application and effect on foods.

### **Practical Schedule**

1. Determination of separation efficiency of centrifugal separator
2. Determination of energy requirement in size reduction using the ball mill and hammer mill.
3. Experiments on reverse osmosis
4. Determination of energy requirement in liquid extraction using ghani and press
5. Experiments on Ultra filtration.
6. Determination of separation efficiency of centrifuge.
7. Determination of collection efficiency of cyclone separator.
8. Determination of efficiency of liquid solid separation by filtration.
9. Problems on evaporators
10. Performance evaluation of an extruder
11. Determination of particle size of granular foods by sieve analysis.
12. Performance evaluation of a steam distillation process.
13. Visit to a solvent extraction industry.
14. Visit to a food processing industry.
15. Practical examination.

### **Suggested Reading**

1. Coulson, J.M and J.F. Richardson. 1977. Chemical Engineering. Volume I to V. The Pergamon Press. New York.
2. Earle, R.L. 1985. Unit Operations in Food Processing. Pergamon Press. Oxford. U.K.
3. Henderson, S.M. and R.L. Perry. 1955. Agricultural Process Engineering. John Willey and Sons, New York.

4. McCabe, W.L. and J.C.Smith.1976. Unit Operations of Chemical Engineering. McGraw-Hill. Inc. Kosaido Printing Ltd. Tokyo, Japan.
5. Pande, P.H.1994. Principles of Agricultural processing - A Text Book. Kalyani Publishers, Ludhiana.
6. Sahay, K. M. and K.K.Singh. 1994. Unit operation of Agricultural Processing, Vikas Publishing House Pvt.Ltd., New Delhi.

### **Fden.1202 HEAT AND MASS TRANSFER (1+1)**

Heat transfer mechanism and types. Conduction; Fourier's law, heat transfer through various geometries, steady state uni directional flow, insulation. Convection; natural and forced convection. Radiation; Stefan Boltzmann's law, Krichoff's law and Plank's law. Concepts of black body and grey body. Emissivity; shape factor. Heat exchangers; parallel, counter and cross flow. Logarithmic mean temperature difference. Condensation heat transfer.

Introduction to mass transfer, Fick's law of diffusion, steady state diffusion of gases and liquid through solids, Equimolal diffusion. Convective mass transfer, Analogy between heat, mass and momentum transfer, Application of mass transfer phenomena in food processing.

#### **Practical Schedule**

1. Determination of thermal conductivity by lagged pipe method.
2. Determination of thermal conductivity in a composite wall.
3. Determination of heat transfer coefficient in forced convection.
4. Determination of emissivity of the given test surface.
5. Determination of Stefan-Boltzmann constant in radiation heat transfer.
6. Determination of heat transfer coefficient in a parallel flow heat exchangers.
7. Determination of heat transfer coefficient in a counter flow heat exchangers.
8. Determination of effectiveness of heat transfer in a radiator.
9. Determination of effectiveness of heat transfer in a coiled type heat exchanger.
10. Determination of effectiveness of a condenser.
11. Parallel and Counter flow heat exchangers- Numerical problems on LMTD.
12. Design of heat exchangers- LMTD and NTU methods.
13. Problems on molecular diffusion in gases and liquids, equimolal diffusion, Isothermal evaporation of water into air.
14. Problems on mass transfer through membranes and packaging materials.
15. Practical Examination.

#### **Suggested Reading**

1. Arora, S.C and Domkunderwar, S(1984). A course in Heat & Mass transfer, Dhanpat Rai & Sons, Delhi.
2. Geankoplis, C.J (1997), Transport Process and Unit Operations, Prentice Hall of India, New Delhi.
3. Holman, J.P. (1993), Heat Transfer S.I. Metric Edition, McGraw Hill Ltd., New Delhi.
4. Necati Ozisik (1985). Heat Transfer- A basic approach, International student edition, Mc Graw Hill Book Co. ltd., New Delhi.

5. Treybal, R.E., (1997), Mass Transfer Operation, McGraw Hill Ltd., New Delhi

**Fden.2103 REFRIGERATION AND COLD STORAGE (1+1).**

Principles of refrigeration, second law of thermodynamics applied to refrigeration, carnot cycle, reversed carnot cycle, coefficient of performance, unit of refrigeration. Refrigeration in food industry, types of refrigeration system, mechanical vapour compression, vapour absorption system, components of mechanical refrigeration, refrigerant, desirable properties of ideal refrigerant, Centrifugal and steam jet refrigeration systems, thermoelectric refrigeration systems, vortex tube and other refrigeration systems, ultra low temperature refrigeration, cold storages, insulation material, design of cold storages, defrosting. Thermodynamic properties of moist air, perfect gas relationship for approximate calculation, adiabatic saturation process, wet bulb temperature and its measurement, psychometric chart and its use, elementary psychometric process. Air conditioning – principles- Type and functions of air conditioning, physiological principles in air conditioning, air distribution and duct design methods, fundamentals of design of complete air conditioning systems – humidifiers and dehumidifiers – cooling and calculations, types of air conditioners – applications.

**Practical schedule**

1. Study of vapour compression and vapour absorption systems.
2. Study of Electrolux refrigerator
3. Solving problems on refrigeration on vapour absorption system.
4. Experiments with the refrigeration tutor to study various components of refrigeration.
5. Determination of the coefficient of performance of the refrigeration tutor.
6. Experiment on humidifier for the determination of humidifying and dehumidifying efficiency.
7. Experiments on the cooling efficiency of a domestic refrigerator.
8. Experiments on working details of a cold storage plant and air conditioning unit.
9. Experiments with air conditioning tutor to study various components and its coefficient of performance.
10. Estimation of refrigeration load.
11. Estimation of cooling load for air conditioner.
12. Estimation of humidification and dehumidification load.
13. Design of complete cold storage system.
14. Visit to a cold storage unit and collection of working details.
15. Practical Examination.

**Suggested Reading**

1. Arora,C.P. 1981. Refrigeration and Air Conditioning. Tata-McGraw-Hill Publishing Co., New Delhi.
2. Ballaney, P.L. 1980. Refrigeration and Air conditioning. Khanna Publishers, New Delhi.
3. Jordoan and Prister. 1973. Refrigeration and Air Conditioning. Prentice-Hall of India, New Delhi.
4. Patel,R.C.1970. Refrigeration and Air-conditioning. Acharya Book Depot. Baroda.

5. William, H.S., R.F. Julian, 1986. Air conditioning and Refrigeration. John Wiley & Sons, Inc. London.

### **Fden.2104 ENGINEERING PROPERTIES OF BIOLOGICAL MATERIALS (2+1)**

Physical characteristics of different food grains, fruits and vegetables - shape and size - description of shape and size - volume and density, porosity, surface area - rheology - ASTM standard, terms - physical states of materials - classical ideal material - rheological models and equations - visco elasticity – creep-stress relaxation - Non Newtonian fluid and viscometry - rheological properties - force - deformation, stress - strain, elastic - plastic behaviour.

Contact stresses between bodies - Hertz problems - firmness and hardness - mechanical damage - dead load and impact damage - vibration damage - friction - effect of load, sliding velocity, temperature, water film and surface roughness - friction in agricultural materials - rolling resistance - angle of internal friction, angle of repose - flow of bulk granular materials - aero dynamics of agricultural products - drag coefficients - terminal velocity.

Thermal properties - specific heat, thermal conductivity, thermal diffusivity - methods of determination - steady state and transient heat flow - electrical properties - dielectric loss factor, loss tangent, A.C.conductivity and dielectric constant - method of determination - energy absorption from high-frequency electric field

#### ***Practical Schedule***

1. Determination of length, breadth and thickness of Agril. Materials.
2. Determination of roundness, sphericity and surface area of Agril products.
3. Determination of bulk density, true density and porosity of Agril . products.
4. Determination of textural properties of solid and liquid foods.
5. Determination of coefficient of friction of Agril . products.
6. Determination of Angle of repose of Agril . Products.
7. Determination of lift and drag force of Agril . Products.
8. Determination of terminal velocity of Agril . Products.
9. Determination of hardness, compressive strength and shear of Agril. Products.
10. Determination of Dielectric constant and Dielectric loss factor of Agril . Products.
11. Determination of Dielectric loss factor, loss tangent and conductivity of Agril. Products.
12. Determination of thermal conductivity, specific heat and thermal diffusivity of Agril. Products.
13. Determination of calorific value of Agril. Products
14. Determination of specific heat of solids and liquids by method of mixtures and by Newton's' law of cooling.
15. Practical Examination

#### ***Suggested Reading***

1. Mohsenin, N.N., (1996), Physical Properties of Plant and Animal Materials: Gordon and Breach Publishers, U.K.
2. Mohsenin, N.N., (1996), Thermal Properties of Foods and Agricultural Materials. Gordon and Breach Publishers, U.K.

3. Peleg, M. and Bagelay, E.B., (1983), Physical Properties of Foods : AVI Publishing Co.
4. Rao, M.A. and Rizvi, S.S.H., (1986), Engineering Properties of Foods: Marcel Dekker Inc., New York.

### **Fden.2205 FOOD PROCESS ENGINEERING (2+1)**

Introduction, Scope and importance of food processing-National and international perspective- sensory characteristics and nutritional properties of food- Texture, terms-sensory measurements. Physical and functional properties of raw material- preparation for food processing- Energy conservation- Material and energy balance – Problems.

Processing methods -Heat processing - methods of applying heat to food - sterilization Thermo bacteriology - Blanching and Pasteurization. Low temperature preservation- Freezing, Concentration - Freeze concentration - freezing and storage of frozen products - ohmic heating-.Canning- fermentation- extrusion cooking- hydrostatic pressure cooking-micro wave processing, - dielectric heating of foods , aseptic processing Infra red radiation processing- Concepts and equipment used.

Drying -Moisture content- definition, methods of determination- direct and indirect methods. Equilibrium moisture content- Hysterises effect- Psychrometry- properties of air, water- vapour mixer, problems in psychrometry. Drying-mechanisms-constant rate period and falling rate period- methods and equipment used- factors affecting rate of drying - water activity - classification of dryers - tray, and freeze dryers, osmotic dehydration- foam mat drying

Mixing of solids, pastes and liquids - characteristics of mixtures - blending - emulsification - equipments - liquid, pastes, plastic masses - dry powders - criteria of mixer effectiveness - mixing index. Food conservation operation -Size reduction-Fibrous foods, dry foods and liquid foods. Material handling - types of handling and conveying system for food products and their design- Belt conveyor, screw conveyor, bucket elevator and pneumatic conveyor.

#### **Practical Schedule**

1. Determination of thermal death time.
2. Calculation of process value F, D, Z.
3. Experiments on Sterilization in retorts.
4. Experiments on mixing liquid and solid foods
5. Experiments on tray dryers.
6. Experiments on osmotic drying of fruits
7. Experiments on foam mat drying of liquids
8. Experiments on extrusion cooking
9. Experiments on freezing food materials
- 10 Experiments on freeze dryer,
- 11 Problems on freezing food materials
- 12 Irradiation of fruits and vegetables.
- 13 Microwave and dielectric heating of food products
- 14 Visit to food processing industries..
- 15 Practical examination.

### **Suggested Reading**

1. Arhold Spicer. 1974. Advances in preconcentration and dehydration of Foods. Applied Science Publishers Pvt.Ltd.
2. .Fellows P .1988. Food Processing Technology. Principles and practice. Ellis Horwood International publishers, Chichester, England.
3. Charm, S.E.1971.Fundamentals of Food Engineering. The AVI Publishing Co., Connecticut.
4. Dennis, R. H. and B.Lund.1992. Hand Book of Food Engineering. Marcel Dekker, New York.
5. Dennis, R.H.1971. Food process Engineering, The AVI Publishing Co., Connecticut.
6. Leninger,H.A and W.A.Beverloo. 1975. Food process engineering, The AVI
7. Romeo, T. Toledo (1996). Fundamentals of Food Process Engg. CBS Pub. & Distribution, New Delhi
8. Sivasankar. B. 2002. Food processing and preservation. Prentice Hall of India Pvt. Ltd., New Delhi-110 001.

### **Fden.2206 DAIRY ENGINEERING AND TECHNOLOGY (2+1)**

Dairy development in India. Milk – composition – basic physical and chemical properties, collection





and transportation of milk - milk collection centre - chilling centre - modes of transport - milk reception - clarification - separation - chilling - cans - tankers .

Pasteurization –principles, objectives and methods. LTLT/holding pasteurization-types, advantages and disadvantages. HTST pasteurization-components and functions of HTST pasteurizer, advantages and disadvantages –milk flow diagram-regeneration of heat. UHT pasteurization – vacreation.

Sterilization-Inbottle sterilization, UHT processing, indirect heating systems using plate heat exchangers, Direct heating-Fouling of heat exchangers. Homogenization theory, effect of homogenization of milk-Homogenizer-components valves. Pumps –functions and efficiency of process-operation and maintenance. Types of homogenizers-stages of homogenization-importance.

Centrifugation-clarification-clarifiers and separators-separation efficiency-factors affecting fat percentage in cream-fat loss in skim milk. Construction of separator-components-bactofuge treatment.

Cleaning-basic principles-can washers-cleaning-in-place-centralised and de-centralized CIP systems –cleaning of various equipment- bottle fillers – packaging of milk and milk products - aseptic packaging - corrosion control. Dairy plant design and layout,

Dairy products Butter manufacture –methods-cheese manufacture–methods. Skimmed milk powder Drum dryer-spray dryer-construction, powder recovery systems-agglomeration. Ice – cream manufacture-over-run-types of freezers. Recombined milk - special milks – standardized, toned, reconstituted milks and flavored milks.

### **Practical Schedule**

1. Determination of specific gravity fat percentage and total solids in milk.
2. Study of milking machine
3. Study of Pasteurizers
4. Study of sterilizers
5. Study of homogenizers
6. Study of butter churns
7. Study of cream separator
8. Production of flavored milk
9. Production of yoghurt and paneer
10. Experiments on spray dryer
11. Visit to modern milk processing plant
12. Judging and grading of condensed and dried milk
13. Manufacturing of Ice Cream
14. Manufacturing of Khoa, cottage cheese and Bacteriological estimation of milk products
15. Practical examination

### **Suggested Reading**

1. Ananthakrishnan,C.P and M.N.Sinha.1987. Technology and Engineering of Dairy Plant operations. Laxmi Publications, New Delhi.
2. Arbuckle, W.S.1977. Ice cream. AVI Publishing Co. Westport, Connecticut.

3. De Sukumar, "Outlines of Dairy Technology", Oxford University Press, New Delhi, 1999.
4. Farrall.A.W., "Engineering for Dairy and Food Products", John Wiley and Sons, New York, 1995 Hall, C.W and T.J. Hedrick. 1971. Drying of milk and milk products. AVI Publishing Co., West Port, Connecticut.
5. Hall, C.W and T.J. Hedrick. 1971. Drying of milk and milk products. AVI Publishing Co., West Port, Connecticut.
6. Kessler, H.G.1981. Food Engineering and Dairy Technology. Verlag A.Kessler, Freising.
7. Lampert, L.M.1970. Modern Dairy Products. Eurasia Publishing House, New Delhi.
8. Rangappa, K.S and K.T.Achaya.1974. Indian Dairy Products. Asia Publishing House, Bombay
9. Robinson, R.K.1986. Modern Dairy Technology Vol.I Advances in Milk processing. Elsevier Applied Science Publishes, London.
10. Tufail Ahmed, "Dairy Plant Engineering and Management", CBS Publishers and Distributors, New Delhi, 2001.

### **Fden.2207 CROP PROCESS ENGINEERING (2+1)**

Post harvest losses in field crops - optimum stage of harvest - properties of grains-physical, electrical, frictional, optical and optical properties-moisture content - measurement - direct and indirect methods - moisture meters - equilibrium moisture content-Psychrometry - properties of air - water vapour mixture - processing operations - threshing, grain drying - principles - thin layer drying - constant and falling rate of drying - deep bed drying - grain dryers

Cleaning and grading - principles - types - air screen cleaner, cylinder separator, spiral separator, magnetic separator, colour sorter, inclined belt separator - efficiency of separation - performance index .Shelling and decortication - principles of operation - maize sheller and groundnut decorticator

Size reduction – principles of comminution – characteristics – particle size distribution – energy and power requirements – crushing efficiency – Rittinger’s, Bond’s and Kick’s laws for crushing – size reduction equipment – Jaw crushing, gyratory crusher, crushing rolls, hammer mills, attrition mills and ball mills..

Rice processing - parboiling of paddy - dehusking of paddy - rice polishers - constructional details and adjustments - layout of modern rice mills processed products from rice - traditional and improved methods - processes and equipments – by products utilization from rice mill -material handling - types - belt conveyor, screw conveyor and bucket elevators.

Wheat milling – types – tempering, break and reduction roll, purifiers and sifters, flour blending-- by-products of wheat milling – semolina, wheat gum, grits, suji and bran. corn milling – wet milling, dry milling, high fructose corn syrup, corn starch- oats processing- Extruded products .

Soybean processing – products – soy sauce – Tofu / Bean curd, break fast cereals. Processing of sorghum, ragi, barley– processed products.

Types of legumes and pulses – chemical composition, pretreatments of pulses – commercial methods of dehulling – dry and wet grinding of pulses – machinery used for dhal milling – roasting and parching of pulses – processed products of pulses.

### **Practical Schedule**

1. Determination of moisture content using moisture meters and comparing with oven method
2. Performance evaluation of cleaner/winnower.
3. Performance evaluation of air-screen machine for grading of various seeds.
4. Performance evaluation of specific gravity separator and cylinder separator.
5. Experiment on parboiling of paddy.
6. Experiment on laboratory model fluidised bed drier.
7. Experiment on thin layer dryer set up to determine drying characteristics
8. Testing of Engleburg huller and centrifugal dehusker for dehusking and polishing of rice.
9. Experiment on rubber roll sheller and polisher.
10. Layout preparation of modern rice mills.
11. Experiment on pulse milling.
12. Evaluation of bucket elevator, belt conveyor and screw conveyor.
13. Study of size reduction equipments – ball mill, hammer mill, attrition mill.
14. .Visit to modern rice mill/ wheat flour mill
15. Practical examination.

### **Suggested Reading**

1. Araullo, E.V. (1980). Rice – Post Harvest Technology
2. Chakravety, A, (1995).Post Harvest Technology of cereals, pulses and oil seeds, Oxford and IBH Pub. Co., Calcutta
3. Fellows.P.(1993)., Food Processing Technology, Principles & Practice, Ellis Horwood, USA
4. Mc Cabe W.Land Smith J.C.(1990). Unit operation in Chemical Engg. – Mc Graw Hill, Tokyo.
5. Pande P.H. (1994). Principles of Agricultural processing. A text book. Kalyani Publishers, Ludhiana.
6. Sahay, K.M. and Singh K.K., (1994). Unit Operation of Agricultural processing, Vikas Publishing House Pvt. Ltd., New Delhi.
7. Mohsenin, N. N. (1996). Physical Properties of Plant & Animal Materials, Gordon & Breach Publishers Inc., U.K

### **Fden.3108 ENERGY FOR FOOD INDUSTRIES (1+1)**

Energy basic concepts - energy sources - renewable and non renewable - statistics of world and Indian energy scenario - food industry, energy auditing - Management of energy sources - efficiency and utilisation - solar energy - drying of agricultural food products - water heating - solar distillation - power generation through photovoltaic system - fuel efficiency and performance of furnaces. Biomass gasification - application in food industry. Heat energy recovery and waste heat utilization - energy from

vegetable and municipal solid waste - Wind energy for pumping and electrical power generation.

### **Practical Schedule**

1. Energy equivalent of different agricultural inputs and outputs and problems on energy conversions.
2. Estimation of solar time, sun-path diagram-estimation of average solar radiation.
3. Determination of thermal efficiency of natural convection solar cabinet dryer for fruits.
4. Determination of thermal efficiency of forced convection solar dryer for grains.
5. Evaluation of the performance of a solar water heater and solar still.
6. Performance evaluation of solar cookers.
7. Incineration of solid wastes – design.
8. Performance evaluation of biomass gas stove.
9. Performance evaluation of furnaces.
10. Evaluation of rice husk gasifier.
11. Visit to a rice mill and estimation of energy inflow-outflow and economics.
12. Estimation of energy inflow-outflow and economics of a fruit processing industry.
13. Visit to an oil mill and estimation of inflow-outflow and economics.
14. Visit to a tea industry and estimation of energy inflow -outflow and economics.
15. Practical examination

### **Suggested Reading**

1. Chawla, O.P.1986. Advances in Biogas technology, Publications and information Division, ICAR, New Delhi.
2. David Pimentel and W.Hall.1984. Food and Energy Resources. Academic Press. New York.
3. Murgai,M.P. and Ram Chandra.1990. Progress in Energy Auditing and Conservation - Boiler Operations. Wiley Eastern Ltd. Newyork.
4. Rai,G.D. 1994. Non- conventional sources of energy. Khanna Publishers, New Delhi.
5. Rai, G.D.1993. Solar Energy utilisation. Khanna Publishers, New Delhi

## **Fden.3209 FOOD PROCESS EQUIPMENT DESIGN AND PLANT LAYOUT (1+1)**

Application of Engineering Principles to design and selection of food processing equipments - materials of construction - design of pressure vessels - storage tanks, sterilizers, processing vats, homogenizers - Design of coolers, heat exchangers, flavour treating equipments - Design of evaporators, evaporating systems - spray dryers, roller dryers, freezers - Design of equipments for pulping, crushing, juice extraction, extrusion - Equipments for packing of food - optimization of design - scale up in food processing Plant location, location theory and models-plant site selection-estimation of series- peak and critical load-Economic plant size-plant layout objectives-classical and practical layout. Development and presentation of the layout-preparation of machinery layout for fruit, vegetables and meat-size reduction machinery layout-size reducing mills-types of machinery for separation of products by size shape and colour. Evaporation plant layout-single, multiple, vacuum and film evaporators-types and concepts, drying plant layout-

drying process, drier types, selection of driers. Bake oven and frying plant-types, concepts and layout. Filling closing and labeling plant layout. Organization and trends in plant layout – sample layout, installation procedure for food processing plant.

#### **Practical Schedule**

1. Design and Drawing of bucket elevator and belt conveyor
2. Design and drawing of screw conveyor and pneumatic conveyor
3. Design and drawing of continuous flow dryer
4. Design and drawing of batch dryer
5. Design and drawing of a cleaner and a grader
6. Design and drawing of a parboiling tank.
7. Design and drawing of a shelling equipment
8. Design and drawing of grinding mill
9. Design and drawing of a oil expeller
10. Drawing of the layout of a modern rice mill
11. Computer assisted design of dryer
12. Study of Process Control Systems and drawing of Process & Product flow layouts for a fruit Canning Industry.
13. Study of Process Control Systems and drawing of Process & Product flow layouts for a dairy plant.
14. Study of Process Control Systems and drawing of Process & Product flow layouts of a food processing plant
15. Practical examination.

#### **Suggested Reading**

1. Brounsel and Young(1993), Process Equipment Design.
2. James,M.More.1976. Plant Layout and Design. MacMillian Publishing Co., New York.
3. Geankoplis,C.J.(1997). Transport processes and Unit operations, Prentice Hall of IndiaPublication, New Delhi
4. Farrall, A.W. 1963. Engineering for dairy and food products. John Wiley and Sons, New York.
5. Hall, C.W and T.J. Hedrick. 1971. Drying of milk and milk Products. AVI Publishing Co., West Port, Connecticut
6. Jowitt, R.(Ed.), 1980. Hygienic Design and Operation of Food Plant. Ellis Horwood, Chichester.
7. Leniger and Beverloo. 1975. Food process Engineering. Reidal Publishing Co. Holland.
8. Perry, R.H and C.H.Chilton.1973. Chemical Engineering Hand Book. McGraw Hill, Tokyo.
9. Slade,F.H.1967. Food processing plant. Leonardhill Books, London.
10. Spotts, M.F. (1991) Design of Machine Elements, Prentice Hall of India, New Delhi

### **Fden.3210 COMPUTER AIDED DRAFTING OF FOOD PROCESSING EQUIPMENTS (1+1).**

Introduction-CAD and drafting-hardware and software- input and output devices-drawing editor-setting up the drawings- scales, units and limits-layers, colours and line types-snap, grid and pick commands-drawing entities- line, pline, circle, ellipse, polygons-editing-fill, erase, move, blocks, fillet, extend, trim, modify-text and dimensions-3D drawings-transforming 2D to 3D- drawing output-design and drafting of food processing equipment-shaft, hoppers, bins, pulleys-preparation of production drawings. Auto CAD

### **Practical Schedule**

1. Understanding hardwares and softwares of CAD.
2. Working with menu and files.
3. Working with snap,grid and pick commands.
4. Working with creation of layers, changing colours and linetypes.
5. Drawing lines, circles , ellipse and arc
6. Editing the drawings-copy and rotate.
7. Modifying the drawings-mirror, fillet and chamfer.
8. Modifying the drawings-extend, stretch and trim commands.
9. Hatching the drawings and filling with patterns.
10. Working with measure, divide, block and insert commands.
11. Working with text and dimensions.
12. Positioning the drawing, working with 3D objects and transforming 2D to 3D drawings.
13. Drafting of components like shafts and pulleys
14. Drafting of components like bins and hoppers.
15. Practical examination.

### **Suggested Reading**

1. Berghauer W Tom W. and Schlieve L Paul.1989. Illustrated AutoCAD - Release 10, BPB Publications, B-14,Connaught Place, New Delhi- 1.
2. Burchard Bill and Pitzer David.1999. Inside AutoCAD 2000. Techmedia, New Delhi -2.
3. Grabowski Ralph. 1992. Learn AutoCAD in a day. First Indian edition, BPB Publications, B-14,Connaught place, New Delhi-
4. Katz Geneviere, 1991. Teach Yourself AutoCAD- Release 11. First Indian Edition, BPB Publications, B-14,Connaught place,New Delhi- 1.
5. Raker Daniel and Harbert Rice, 1987. Inside AutoCAD, First Edition, BPB Publications, B-14,Connaught place,New Delhi -1
6. Rakker, D and Rice,H. 1999. Inside AUTOCAD, Release 12. Prentice Hall of India Ltd., New Delhi-1.

**Department of Food Processing**

**LIST OF COURSES**

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No.</b>
1	Fdpr.2201	Post Harvest Engineering of Horticultural Crops	2+1	22
2	Fdpr.3102	Meat and Poultry Technology	2+0	23
3	Fdpr.3103	Oil Chemistry and Technology	2+1	24
4	Fdpr.3204	Post Harvest Engineering of Plantation Crops	2+1	25
5	Fdpr.4105	Food Packaging Technology	2+1	25
6	Fdpr.4106	Processing of Marine Products	2+0	26
7	Fdpr.4107	Storage and Preservation Technology	1+1	27

## **Fdpr.2201 POST HARVEST ENGINEERING OF HORTICULTURAL CROPS (2+1)**

Status-Importance – and constituents of fruits and vegetables- Post harvest losses in fruits and vegetables – factors influencing losses- Enzymatic and textural changes during ripening.

Engineering properties of horticultural crops. – Chemical composition and nutritional aspects – structural features. Post harvest physiology – Importance, Maturity – criteria for physiological Maturity – Post harvest changes in biochemical constituents of fruits and vegetables – loss of nutritive value. Environmental factor affecting Post Harvest deterioration- Environmental factor – stress – high and low temperature stress, Gas stress, Water stress – Mechanical injury – effect on fruits and vegetables. Plant hormone – role – importance. Respiration – effects – methods to measure respiration, Transpiration.

Harvesting- pre-cooling - cleaning- washing and grading. Handling-storage-refrigerated- Modified and Controlled atmosphere storage-Recommended storage conditions of fruits, vegetables and flowers.

Principles of processing and preservation: blanching-canning-bottling-freezing- Refrigeration- Cold storage – cooling load calculation – evaporation cooling – types . Drying and dehydration– importance – pretreatments before drying – drying curve – shrinkage, case hardening – Thermo plasticity – chemical changes during drying. Types of dryer – tray, drum, spray, pneumatic, fluidized bed dryer, and foam mat drying. Irradiation-surface coatings-chemical dips-preservatives-water activity-preparation of juice, jam, jelly & pickle

Processing of important fruits and vegetables-banana, mango, pineapple, tomato and mushrooms. Packing and transportation of fruits, vegetables and flowers

Process flow charts for processing plants-basic principles-Design, control and maintenance of storage structures- Ethylene evolution during storage – methods to prevent ethylene production – physiological loss of weight – methods of storage – pests, insects, rodents, fungi – their nature, occurrence and control. Modern techniques of infestation control. Application of quality control techniques.

### **Practical Schedule**

1. Determination of fruit firmness, cutting strength of fruit and vegetables
2. Modified Atmosphere Storage of Fruits and Vegetables
3. Fluidized bed drying of Fruits and Vegetables
4. Lye peeling and determination of total acidity of fruits
5. Drying characteristics of fruits and vegetables using Convective dryer
6. Moisture content determination of fruits and Vegetables
7. Pretreatments on Fruits and Vegetables
8. Osmo-vac dehydration and Osmo-air drying of fruits
9. Preparation of fruit juice, Jam, jelly and RTS
10. Study of pineapple peeler
11. Design of cold storage
12. Preparation of crystalline and glazed candies.
13. Problems on concentration and water activity.



14. Visit to fruit and vegetable processing plant and report writing.
15. Practical examination.

#### **Suggested Reading**

1. David Arthey and Collin Dennis (1991). *Vegetable Processing*, Blackie Publication, New York.
2. Girdhari Lal, G.S. Siddappa & G.L. Tandon (1995). *Preservation of Fruits and Vegetables*, ICAR, New Delhi.
3. Kader, A.A., R.F. Kasmire, M.S. Reid, N.E. Sommer & J.E. Thompson (1985). *Post Harvest Technology of Horticultural Crops*, Cooperative Extension University of California, Division of Agriculture and Natural Resources.
4. Luh, B.S. and Woodroof J.G. (1988). *Commercial Vegetable Processing*, AVI Publication, New York.
5. Somogyi, L.P., D.M. Barrett, Y.H. Hui (1996). *Processing of Fruits: Science & Technology (Vol.II) – Major Processed Products*, Technomic Publishing Co. Inc., Lancaster, USA.
6. Somogyi, L.P., H.S. Ramaswamy & Y.H. Hui (1996). *Processing of Fruits: Science and Technology (Vol.I) – Biology, Principles and Applications*, Technomic Publishing Co. Inc., Lancaster, USA.
7. Srivastava, R.P. and Sanjeev Kumar (1998). *Fruits and Vegetable Preservation – Principles and Practices*, International Book Distributing Co., Lucknow.
8. Thomson, A.K. (1996). *Post-harvest Technology of Fruits and Vegetables*, Blackwell Science Publication.

### **Fdpr.3102 MEAT AND POULTRY TECHNOLOGY (2+0)**

Introduction to Meat Processing-Structures and composition-Grading and inspection slaughtering-methods. Ageing of meat-softening-Artificial Tenderizing-Mechanical means. Suspension of Carcass-Different types of cuts-curing of meat-fundamentals of curing-methods of curing. Processing steps-grinding-mixing-chopping-emulsifying-stuffing-linking and tying-smoking and cooking-chilling-freezing-canning-peeling and packaging. products and by-product utilization; poultry processing-transport and receiving – slaughtering-bleeding-scalding-Defeathering –singeing –washing-pinning-transfer to evisceration room –neck slitting and removal of feet-removal of lungs and examination –chilling –draining and weighing –cutting-tenderization-packaging and storage. Preservation of poultry meat. –refrigeration, freezing. Curing, smoking, dehydration, canning, irradiation-microwave heating, chemical additives and antibiotics, poultry products-and by products utilization; egg processing, preservation, shell eggs, immersion in liquid, oil treatment – gas, thermo processing, refrigeration, pickling, liquid eggs, freezing, drying, processing of eggs-collection, grading, cleaning, packaging and transport, by products utilization.

#### **Suggested Reading**

1. Gracey, J. F., D.S. Collins and R.J. Huey. (1999). *Meat Hygiene* (10 ed.). W.B. Saunders Co. Ltd.
2. Kinsman, D.M., A.W. Kotula and B.C. Breidenstein. (1994). *Muscle foods, Meat, poultry and seafood technology*. Chapman and Hall, Newyork.

3. Mountney, G.H. and C.R. Parkhurst. (2001). *Poultry Products Technology* (1 Indian ed.). VIVA Books Pvvvt. Ltd.
4. Narahari, D., V. Sndarasu and M. Ahmed. (2005). *Food safety and quality control of poultry products*. Laboratory Manual. Department of poultry Science, Madras Veterinary College, Chennai-7
5. Ockerman, H.W and C.L. Hansen. (1988). *Animal By-product Processing*. Ellis Horwood Ltd., Enland.
6. Pearson, A.M. and T.A. Gillet. (1997). *Processed Meats* (1 Indian ed.). CBS Publishers and Distributors, New Delhi.

### **Fdpr.3103 OIL CHEMISTRY AND TECHNOLOGY (2+1)**

Lipids, oils and fats-occurrence and distribution in nature, Physical properties of fat and oil. Colour, Odour, consistency, chemical composition of fat and oil –iodine value-saponification value-Melting point-free fatty acids. Physical and chemical reaction-hydrolysis, hydrogenation, oxidation polymerization, esterification, halogenation, isomerization, Enzymatic and chemical spoilage-rancidification and their control.Milling of oil seeds and other oil bearing materials-concept of oil extraction-ghanies, Industrial production of oil Production of oil-rendering-pressing-cold pressing and hot pressing-solvent extraction methods-milling-extraction-removal and recovery of solvent form miscella. Leaching-system of leaching-single stage, multi stage co-current and multi stage counter current. Leaching equipment-stationary bed and moving bed type-Liquid extraction-extraction equipments-mixer settler, spray and packed extraction towers. Pulse colour and centrifugal extractors.Super critical fluid extraction-phase equilibric Extraction of oleoresius and essential oils from spices and aromatic plants.Refining-filtration, winterization, deodorization and packaging.Hydrogenation of unsaturated fats and oils-chemistry process conditions and techniques.Butter substitutes, solid oil, shortenings and oils of special use-inter esterification.Nutritional aspects of oils and fats-metabolism of fats-Analytical methods of oils and fats-specification and standards.

#### **Practical Schedule**

1. Extraction of oil using a soxhelet apparatus.
2. Determination of saponification value.
3. Determination of idone number
4. Determination of acid number.
5. Testing of rancidity in fats
6. Testing of rancidity in oil samples.
7. Study of a mini oil expeller.
8. Study of a hydraulic press.
9. Extraction of essential oils from aromatic plants.
10. Analysis of flavour components using gas chromatogram.
11. Extraction of oleoresin from spices.
12. Studies on reaction during oil frying.
13. Visit to an oil extraction plant.
14. Visit to a solvent extraction plant.
- 15 Practical Examination

### **Suggested Reading**

1. Harry Lawson (1994). Food Oils and Fats-Technology Utilization and Nutrition. Chapman and Hill, 29 West, 35<sup>th</sup> Street, New York.
2. Mc Cobe, W.L. and J.C. Smith (1990). Unit Operation of Chemical Engineering. McGraw Hill Inc., Tokyo, Japan.
3. Pande P.H. (1994). Principles of Agricultural Processing-A Text Book. Kalyani Publishers, Ludhiana.
4. Thomas Dekin, M. (1997). Text Book of Biochemistry. Wiley Liss. John Wiley & Sons Inc. Publication, New York.

### **Fdpr.3204 POST HARVEST ENGINEERING OF PLANTATION CROPS (2+1)**

Status of production, Processing and Utilization, Domestic and international demand of plantation crops, Processing of plantation crops: Tea, coffee, cocoa, coconut, arecanut, rubber, cashew nut and oil palm; including the processes and equipments. By-product utilization. Processing of spices and condiments: Pepper, cardamom, clove, ginger, vanilla, turmeric and chillies. Processing of aromatic and medicinal plants like lemon grass, citronella grass, palmarosa, lemon mint, celery, vetivel, cinchona, kacholam, asgand and dill. Extraction of oleoresins and essential oils from aromatic plants and spices. Packaging and Storage of processed plantation products. Technologies for product diversification and by product utilization.

### **Practical Schedule**

1. Performance evaluation of coconut dehusker
2. Production and evaluation of activated carbon from coconut shell
3. Production and evaluation of particle board from coirpith
4. Study of a colloid mill
5. Performance evaluation of a cashew nut sheller.
6. Determination of moisture content of spices- Dean stark apparatus
7. Extraction of essential oil and oleoresin from spices and aromatic plants – clevenger apparatus and soxhlet apparatus
8. Performance evaluation of a pepper thresher.
9. Performance evaluation of a pepper grader
10. Performance evaluation of a white pepper decorticator
11. Visit to a solvent extraction industry and determination of solvent recovery
12. Visit to various processing industries –tea, coffee and cashew
13. Visit to a rubber processing unit
14. Visit to an oil palm processing unit.
15. Practical Examination.

### **Suggested Reading**

1. Kumar N. , Abdul Khadeer , Rangaswami P. Irulappan I.(1995), Introduction to Spices , Plantation crops, Medicinal and aromatic Plants; IBH Publishing Co. Pvt. Ltd. New Delhi.
2. Mulky, M.J., Sharma V.S. (1995). Tea, Culture, Processing and Marketing., IBH Publishing Co. Pvt. Ltd., New Delhi.
3. Pruthi J.S.(1993). Major Spices in India – Crop Management and Post Harvest Technology, Publication and Information division –I.C.A.R. New Delhi.

4. Purseglove J.W. , Brown E.G. , Green C.L. , Robbins S.R.J.(1981). Spices Vol. I & II; Long man Scientific and Technical,. New York

### **Fdpr.4105 FOOD PACKING TECHNOLOGY (2+1)**

Factors affecting shelf life of food material during storage; spoilage mechanism during storage; definition, requirement, importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system. Different types of packaging materials used. Different forms of packaging, metal container, glass container, plastic container, paper boards, flexible films, shrink packaging, vacuum & gas packaging, aseptic packaging. Packaging requirement & their selection for the raw & processed foods. Lamination and sealing techniques. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities, Package testing, Printing, labeling and lamination. Economics of packaging; performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements; disposal and recycle of packaging waste.

#### **Practical Schedule**

1. Determination of tensile strength and compressive strength of packaging material
2. Testing of bottle - measurement, resistance to thermal shock
3. Testing of papers -. Bursting and Tearing strength
4. Vacuum packaging of agricultural produces
5. Testing of plastics - thickness.
6. Testing of plastics – impact strength.
7. To perform grease-resistance test in plastic pouches
8. Determination of water vapour transmission rate
9. Testing of chemical resistance of packaging materials
10. Determination of drop test of food package
11. Modified Atmospheric package
12. Retort pouching.
13. Visit to a packaging industry.
14. Visit to a food industry and study the packaging practice.
15. Practical examination.

#### **Suggested Reading**

1. Paine (1998). Food Packaging, AVI Publishing Co.
2. Gordon and Roberston, Food Packaging, AVI Pub. Co.
3. Saccron & Graffin. Food Packaging, AVI Pub. Co.
4. Crosby (2000). Food Packaging Material, Applied Science Publishers.
5. Mathlonthi, M. Food Packaging and Preservation- Theory and Practice, Elsevier Applied Science
6. Gopakumar, K (1998). Fish Packaging Technology- Materials and Methods, Concept Pub. Co., New Delhi

### **Fdpr.4106 PROCESSING OF MARINE PRODUCTS (2+0)**

Introduction to fish processing, Chilling of fish-methods and equipment for chilling; icing- quality of ice, ice-making; refrigerated or chilled sea water, chilling rate; spoilage of fish during chilled storage; use of chemicals and radiations to extend storage life.

Freezing of fish- fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate and freezing time; methods of freezing, preparation of commercially important fish and shell fish for freezing, freezing and frozen storage of fish, shell fish and other food products.

Canning- thermal processing- heat resistance of micro organisms-survivor curve-TDT curve. Retort pouch packing-principles and techniques-HTST process and aseptic packing –principles and techniques.

Fish products and byproducts- introduction to various products and byproducts from fish. Preservation by drying-principle significance of water activity method, equipments, solar dryers, mechanical dryers. Processing steps, equipment. Salting –principle-wet and dry salting methods-quality of salt-spoilage changes and control measures. Smoking-methods, equipments-pickling/ marinating-principle of preservation, various products and their preparation. Fermented fish products-fish sauces, fish pastes etc. Fish oil and Liver oil- extraction methods, miscellaneous products such as fish leather, shark fin rays, gelatin, fish glue etc.

#### **Suggested Reading**

1. Gopakumar K. (ED), (2002), Fish processing Technology, ICAR, New Delhi.
2. Venugopal V. (2006), Sea food processing, Narendra Publishing Co., New Delhi.
3. Hersom A. C. and Hulland E. D. (1980), Canned foods, Thermal Processing and Micro biology
4. Hall G. M. (ED), (1997), Fish processing Technology, Blacky academic and professional, London.
5. Kulilove P. I., (1978), Production of meal oil and protein-vitamin preparations in the fishing industry, Amerind publishing co. Pvt. Ltd., New Delhi.
6. Suzuki, Taneko, (1981), Fish and krill protein,; processing technology, applied science publishers ltd. London.
7. Govindan T. K. (1985), Fish processing technology, oxford and IBH publishing co. pvt. Ltd, New Delhi.

#### **Fdpr.4107 STORAGE AND PRESERVATION TECHNOLOGY (1+1)**

Spoilage mechanisms of perishables and durable commodities - traditional methods of storage of food grains - factors affecting storage, types of storages – bag and bulk storage, storage structure, storage losses - estimation - storage of grains in large bins – grain dust - characteristics and preservation - modified atmosphere storage of grains - facilities, construction, operation and maintenance.

Storage of fruits and vegetables – ITK for storage - storage under ambient conditions, low temperature storage, evaporative cooling, irradiation methods - controlled atmosphere storage – concept and methods – storage of processed fruits and vegetables.

#### **Practical Schedule**

1. Assessment of storage loss in food grain storage
2. Assessment of storage loss in fruits and vegetables.

3. Experiments and design with storage bins – plywood bin
4. Experiments with storage bins – plastic silo
5. Experiments with open field bag storage
6. Experiments on biogas fumigation of food grains
7. Experiments on rat proof godowns and design.
8. Assessment of losses in the stored fruit products in Tins and cans
9. Experiments on modified atmosphere storage of cereals and pulses
10. Assessment of qualities of fruits and vegetables during storage
11. Experiments on cold storage of fruits and vegetables.
12. Experiments on cold storage of evaporative cooling zero energy of fruits and vegetables.
13. Experiments on cold storage of Controlled atmosphere storage of fruits.
14. Visit to FCI godown
15. Practical examination

### **Suggested Reading**

1. Ooraikul, B and Stiles, M. E (1992). Modified atmosphere Packaging of Food, Ellis Horwood Publication, New York
2. Vijaya Raghavan, S (1994). Grain Storage Engg. & Technology, Batra Book Service, New Delhi
3. Desrosier, W. Worman and James N. Desrosier. 1987. The Technology of Food Preservation. CBS, Publishers & Distributors, New Delhi.
4. Multon, J.L., Reimbert A.M., Marsh D., and Eyd A.J., 1989. Preservation and storage of grains, seeds and their byproducts. CBS Publishers and Distributors, Delhi.
5. Shejbal, J.(ed).1980. Controlled atmosphere storage of grains. Elsevier scientific publishing Co., London.
6. Srivastava, R.P. and Sanjeev Kumar. 1998. Fruit and vegetable preservation. International Book Distributing Co., Lucknow.

## Department of Food Science

### LIST OF COURSES

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No</b>
1	Fdsc.1101	Food Science and Nutrition	2+1	30
2	Fdsc.2202	Baking and Confectionery Technology	1+1	31
3	Fdsc.3103	Entrepreneurship and agribusiness management	2+0	32
4	Fdsc.3104	Food Safety and Quality Management	1+1	32
5	Fdsc.3205	Food Industry Waste Management	2+0	33
6	Fdsc.3206	Fermentation Technology	1+1	33
7	Fdsc.4107	Food Industry Management	2+1	34
8	Fdsc.4108	Sanitation and Hygiene in Food Industries	2+0	35

## **Fdsc.1101 FOOD SCIENCE AND NUTRITION (2+1)**

Food- functions and groups. Food science- objectives and applications- methods of cooking- nutrient losses during cooking. Cooking qualities of cereals, pulses and vegetables. Colloids-emulsion, foams, sol and gel- classification, physical properties and fermentation. Denaturation, gelatinization, crystallization, Parboiling of rice. Enzymatic and non- enzymatic browning-prevention. Classification and Dietary requirements-minerals classification and role-food colours and flavours- food additives-classification and purpose-role of thickeners, sweeteners, stabilizers, emulsifiers, leaveners, colours, flavouring agents, preservatives- examples. Vitamins-classification and deficiency diseases. Nutrition- definition. Concepts of mal nutrition and under nutrition. Balanced diets- recommended dietary allowances (RDA) for various age groups. Energy value of foods, energy requirements of the body estimation. Water balance, nutritional deficiency disorders .Food laws and standards: food packaging; quality control in food industry.

### **Practical Schedule**

1. Determination of acidity.
2. Determination of vitamin (Vit C).
3. Determination of sugars (reducing and total).
4. Determination of crude fibre.
5. Testing of rancidity in fats and oils.
6. Detection of adulterants in foods.
7. Extraction of oil and estimation of oil content.
8. Study on foam formation and its stability
9. Cooking quality tests - cereals and vegetables
10. Cooking quality tests – pulses
11. Studies on enzymatic browning of fruits and vegetables.
12. Estimation of diet requirements for adults.
13. Study on denaturation of proteins (egg and milk).
14. Study on Indian balanced diets and their energy value.
- 15 Practical Examination

### **Suggested Reading**

1. Potter ,N.N. and Joseph,H.Hotchkiss . 1996. Food Science. CBS Publishers and distributors, New Delhi.
2. Swaminathan.M. 1999. Food Science, Chemistry and experimental foods. The Bangalore Printing and Publishing Co.Ltd., Bangalore – 560 018.
3. Shanuntalamanay,N. and M.Sadaksharaswamy. 1996. Food facts and principles. New Age International Publishers, Chennai.
4. Srilakshmi,B. 2001. Food Science. New Age International Publishers, Chennai.
5. Raheena Begum. 2001. A Text book of foods, nutrition and Dietetics. Sterling Publishers Private Ltd.
6. Swaminathan.M. 1999. Hand book of Food and Nutrition. The Bangalore Printing and Publishing Co.Ltd., Bangalore – 560 018.



## **Fdsc.2202 BAKING AND CONFECTIONARY TECHNOLOGY (1+1)**

Introduction-Status of bakery and confectionary industries in India – Raw materials for bakery products – flour, sugar, shortening agent, yeast, salt. FPA specification of raw materials. Wheat – varieties – qualities for baking – quality grading system for wheat – wheat milling, refined wheat flour, aging. Technology of baking - dough rheology -- preparation of breads, biscuits, crackers, cakes, buns, pizza-extruded products- pasta food likes macaroni, noodles and spaghetti.Types of confectionery goods - processing of raw materials - machinery required for manufacture of toffees, chocolates, fruit drops, candies, marshmallows, bars, chewing gums and special confectionery goods - colour, flavor and texture in confectionery.

Quality control and sanitation-Quality control of baking items – standards and regulations – hygienic conditions required in bakery and confectionary units.

### **Practical Schedule**

1. Dough characteristics - determination of gluten.
2. Farinographic and Extensographic studies.
3. Baking of bread - different methods and types of breads.
4. Bun and bread rolls.
5. Types of cakes - baking and quality analysis.
6. Biscuit and Cookies different types.
7. Flaky pastry - types and uses.
8. Danish pastry.
9. Types of pie.
10. Identification of types of confectioneries, sugar cookery, manufacture of toffee.
11. Manufacture of chocolate, toffee, fruit drops, fruit toffees, candies and preservers.
12. Baked confectioneries, marsh mallow and jujeps, bars, chewing gums and special confectionery goods.
13. Familiarization of BIS standards for confectionery regulations and specifications, packaging materials
14. Visit to bakery unit
15. Practical examination.

### **Suggested Reading**

1. Bernard,W.M.1989. Chocolate, Cocoa and confectionery, Science and Technology, 3rd Edn., AVI Book Published by VAN Nostrand Reinhold, New York.
2. Deman,J.M., P.U. Voisey, V.F .Rasper and D.W. Stanley. 1976. Rheology and Texture in Food Quality, AVI Publishing Company, INC, Westport.
3. Lee.R. and E.B.Jackson. 1973. Sugar Confectionery and Chocolate manufacture, Leonard Hill Books, International Text book Company Ltd., Britain.
4. Manfie, “Chocolate, Cocoa and Confectionery Science &Technology (3<sup>rd</sup> edition) Advance Books, Jaipur.
5. Matz, “Bakery Technology and Engineering”, Elsevier, Tokyo.
6. Yeshajahu, P. and S.A.Shellen Berger. 1971. Bread Science and Technology. AVI

Publishing Company, INC, Westport.

### **Fdsc.3103 ENTREPRENEURSHIP AND AGRIBUSINESS MANAGEMENT (2+0)**

Basic management concepts, personal, production material, financing and marketing managements. Problem solving and innovation, industrial and business law. Entrepreneurial motivation.

Environmental analysis, project selection, project appraisal, modification/finalization of projects, collaboration, preparation for launching, trial run and test marketing. Mini Project Report Writing.

Management of agribusiness project and enterprise. Management of agribusiness trade in WTO environment. Agriculture and food policy. Rural environment and institution.

Marketing of Agricultural input and marketing of Agricultural product. Market research for agri business.

Commodity trading and forecasting for agribusiness. Retail and supply chain management, Management of cooperation.

#### **Suggested Reading**

1. Michael E Newman(1994),Agribusiness Management and Entrepreneurship, Vero Media Inc.
2. R.D Agarwal(1993). Organization & Management. Tata –McGraw Hill Publishing Company Ltd
3. S.K Basu, K.C Shahu,& N.K Datta(1993). Work Organization & Management. Oxford&IBH Publishing Company Ltd

### **Fdsc.3104 FOOD SAFETY AND QUALITY MANAGEMENT (1+1)**

Introduction to food safety and quality, quality attributes of food in the production chain, Factors affecting quality, quality management activities with respect to safe food chain. Biological, chemical, physical and miscellaneous hazards- Types and means of contamination.

Concept of quality assurance systems and food safety, Principles of quality assurance, TQM, SSOP, GMP, ISO, Codex Alimentarius, HACCP.

Risk management process and food safety, risk assessment, risk communication and principles of enterprise risk management. Traceability in food supply chains, relationship between quality systems and traceability in food chains, traceability systems. Consumer perception of food safety, ethics in food safety, organic food production and safety.

#### **Practical Schedule**

- 1 Design and implementation ofHACCP system for fruit processing plants.
2. Design and implementation ofHACCP system for milk processing plants
3. Design and implementation ofHACCP system for meat processing plants
- 4 Design and implementation ofHACCP system for fish processing plants.
5. Design and implementation ofHACCP system for cereals and pulses processing plants.

6. Microbial analysis of food.
- 7 Detection and identification of microbial load.
8. Quantification of microbial load.
- 9 Analysis of chemical hazards
10. Quality evaluation of food products Part I
11. Quality evaluation of food products Part II
12. Presentation of various case studies related to food safety Part I
13. Visit to food processing industries for HACCP verification.
14. Visit to spice processing industries for HACCP verification
15. Practical Examination.

#### **Suggested Reading**

1. Dean, J.W. and J.R.Evans, (1994). Total Quality. West Publishing company, New York.
2. Frazier, W.C and D.C. Westhoff. (1978). Food microbiology. Tata Mc Graw Hill Publishing Co. Ltd. New Delhi. 540pp.
3. Hobbs. B.C and R.J. Gilbert. (1982). Food Poisoning and food hygiene., The English Language Book Society and Edward Arnold Publishers Ltd., London.
4. Luning, P.A, W.J.Marcelis and W.M.F. Jongen, (2002). Food quality management: A technomanagerial approach, Wageningen press, ISBN 9074134815, Wageningen, The Netherlands, 323 pp.
5. Luning. P.A., F. Devlieghere and R. Verhe, (2007). Safety in the agri- food chain, Wageningen academic publishers.

### **Fdsc.3205 FOOD INDUSTRY WASTE MANAGEMENT (2+0)**

Different sources of wastes from food industries and their availability in India-nature of different waste - Waste utilisation from rice mill - Thermal and biotechnological uses of rice husk - pyrolysis and gasification of rice husk - cement preparation and different thermal applications - utilisation of rice bran - stabilization - defatted bran utilization Processes for Waste utilization from fruit and vegetable industries- Distillation for production of alcohol - oil extraction from waste - waste management in sugar mills - citric acid production from fruit waste.Waste from tuber crops - effluent safe disposal-effluent treatment plant- waste recycling plant - feasibility report for food industries using food waste and by products.

Fish industry by products and waste utilisation - meat and poultry waste recycling Waste from tuber crops - effluent safe disposal- effluent treatment plant- waste recycling plant - feasibility report for food industries using food waste and by products By products of wheat milling – germs and bran – by products of pulse milling – husk, germs and broken. Coconut processing – by- product utilization – fuel briquette .

#### **Suggested Reading**

1. A. Chakravarthy & De, "Agricultural Waste and By Product Utilisation".
2. Bor S. Luli (ed), "Rice Production and Utilisation"
3. E. Beagle, "Rice Husk Conversion to Energy"
4. P. N. Chereminoff & A.C Morresi, 1976, "Energy from Solid Wastes"

## **Fdsc.3206 FERMENTATION TECHNOLOGY (1+1)**

Introduction of fermentation process – History and development of fermentation industry – benefit of fermentation – nutritive value of fermented foods– Selection of industrial important microorganism -production of single cell protein. Media for industrial fermentation – Medium Composition – Energy, CO<sub>2</sub>, nitrogen and other growth factors, buffering and foam agents.– microbial biomass – microbial enzymes – microbial metabolites - recombinant products .Microbial growth kinetics – batch – continuous and fed batch cultures – application of fed batch culture - use of fed batch culture.

Fermentation types- Ethonolic fermentation – mixed alcoholic and acid fermentation – Lactic acid fermentationSterilization – Principles, sterilization of fermentation media, fermenter – in-batch parts – agitator, impellers, aerator, baffles, process control, function and maintenance of various parts of fermentor. Recovery and purifications of food products – filtration – batch and continuous types – fermentor accessories. Technology of fermented food products- Traditional fermented foods – Curd, yoghurt, dhokla, miso, shrikand, cheese, butter milk, dosa. Modern fermented products – Wine, beer, brandy, vinegar, baker's yeast, sauerkrauts, sausages, fermentation of milk, meat, fruits and vegetables.

### **Practical Schedule**

1. Fermenters – sterilization of substrates – operations
2. Inoculation techniques for biomass production
3. Role of yeast and bacteria in food fermentation
4. Organic acid production by fungal fermentation
5. Solid state fermentation – mushroom production
6. Liquid fermentation – submerged – SCP
7. Development of efficient strains by mutagenesis – physical agents.
8. Development of efficient strains by mutagenesis – chemical agents
9. Effect of pH on fermentation process
10. Effect of temperature and moisture on fermentation process
11. Effect of additives on fermentation process
12. Product recovery by filtration single cell protein
13. Sauerkraut fermentation
14. Malt fermentation
15. Practical Examination

### **Suggested Reading**

1. Pederson, C.S. 1971. Microbiology of food fermentations, AVI Publishing Co., Inc. Westport, Conn.
2. King, R.D. and P.S.J. Cheetham. 1986. Food Biotechnology. Elsevier Applied Science, New York.
3. Brock, T.D. 1990. Biotechnology. A text book of Industrial microbiology. Sin Auer Associates, Inc. Sunderland, M.A., USA.
4. Stanbury, P.F., Allan Whitaker and S.J. Hall. 1997. Principles of fermentation technology. Aditya Books (P) Ltd., New Delhi.
5. Patel, A.H. 1996. Industrial microbiology. Macmillan India Ltd., New Delhi.

## **Fdsc.4107 FOOD INDUSTRY MANAGEMENT (2+1)**

Definition and classification of food industries - characteristics - labour efficiency - wages and incentives - decision making and production management - production planning - production control - job production - batch, mass production - production and process charts time and motion study. Materials management - inventory control - types of inventory - ABC analysis - VED analysis - economic order quantity (EOQ), plant location - factors - plant layout - types - advantages. Quality control and inspection - acceptance sampling - optimization technique - network analysis - PERT and CPM Financial management - determination of capital needs - break even analysis - manpower management - industrial relations and labour welfare - marketing management - product mix - advertising - Market research. Management control and information systems in agro-food processing units - responsibility centre's - design of management information systems social responsibility of business.

### **Practical Schedule**

1. Prepare organisation structure for an agro - based industrial concern.
2. Analyse, with the help of suitable examples, the various advertising media.
3. As the head of a business corporation, how would you finance the purchase of new equipments ? Consider the various alternatives that are open to you ?
4. What points would you bear in mind while devising the capital structure of a proposed agro - based food industrial concern ?
5. "Profit sharing has been recommended as a panacea for the current industrial ills in India" – Do you agree ?
6. Prepare a project report of an agro - based industrial concern.
7. Recommend a system of wage payment which may stimulate productivity and improve labour management relations.
8. What would be the social responsibility of management in an agro - based food processing unit ?
9. Do you think that the existing Government policies are adequate for the healthy growth of the agro - based food - processing industry in India ?
10. 10. What stems you should follow when you are appointed as a sales manager of a agro - based food processing company ?
11. Give an account of the production planning process of an agro - based food processing industry taking into consideration of the different systems of production.
12. Describe the different methods that you can take for ensuring workers' participation in management.
13. "Non - financial incentives are as strong motivators as financial ones." – Critically examine this statement and bring out the role of financial and non - financial motivators.
14. Visit to agro food processing industry.
15. Practical examination.

### **Suggested Reading**

1. Joseph. G. Monkas.(1981). Operations management- Theory and problems, Mc Graw Hill Book Company, New Delhi.
2. Khanna, O.P.(1995). Industrial Engineering and Management. Dhanpath Rai & Sons, New Delhi.

3. Richard A. Jhonson, T. William, Newel & Rager C. Vergin, (1975). Operations Management- A system concept, Houghton Mifflon Company, Boston.

### **Fdsc.4108 SANITATION AND HYGIENE IN FOOD INDUSTRIES (2+0)**

Introduction – Sanitation – need for sanitation – laws and regulations – sanitation performance standards- safe handling – cross contamination – cleaning and cleaners – Materials for good sanitation. Good Manufacturing Practice. Management and Sanitation, ISO 9000, ISO 14000. Microorganisms and their relationship to Sanitation. Food Plant Design and Construction; Air Sanitation; Equipment for Effective Sanitation, Water and environment, Sanitation procedures. Types of sanitizers. Waste Product( Disposal ). Personal Hygiene; Cleaning, Sanitizing Pest Control; Packaging Sanitation, Food Storage Sanitation; Food Transport Sanitation

#### **Suggested Reading**

1. Marriott, Norman G. and Gravani, Robert B. 2006. Principles of Food Sanitation. An ASPEN publication, Food Science Text series.
2. Marriott, Norman G. Essentials of Food Sanitation, Food Science Text series.
3. Lelieveld, H.L.M., Mostert, M.A., Holah, J., White, Beverley (Ed.). Hygiene in Food Processing, Woodhead Publishing in Food Science and Technology.

**Department of Food Quality**

**LIST OF COURSES**

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No</b>
1	Fdqu.1201	Fundamentals of Biochemistry	2+1	38
2	Fdqu.1202	General Microbiology	1+1	39
3	Fdqu.2103	Bio Chemical Engineering	1+1	40
4	Fdqu.2104	Biochemistry of Processing and Preservation	1+1	40
5	Fdqu.2205	Food Microbiology	1+1	41

## **Fdqu.1201 FUNDAMENTALS OF BIOCHEMISTRY (2+1)**

Chemistry of bio molecules: carbohydrates- classification, structure, physical and chemical properties of monosaccharides, disaccharides, oligosaccharides and polysaccharides. Pectins, seed gums, sea weeds and algal polysaccharides. Amino acids-chemistry, structure and properties. Protein- classification based on solubility and functional properties. Structure of proteins- primary, secondary, tertiary and quaternary. Nutritional quality of proteins- egg, milk and meat. Lipids-classification, structure and properties. Fatty acids, classification, chemistry and properties.

Enzymes-classification, structure and biological importance: co-enzymes and co-factors. Activators and inhibitors of enzymes; enzymes kinetics; factors affecting enzyme action and mechanism of enzyme action; active site. Industrial applications of enzymes. Immobilized enzymes, enzyme technology.

Metabolism- glycolysis; TCA cycle, cellular respiration- lipid metabolism-lipases and phospholipases. Fatty acid metabolism- beta oxidation. Metabolism of proteins- proteolytic enzymes. Metabolic inter relationship.

### **Practical Schedule**

1. Qualitative tests for monosaccharide.
2. Qualitative tests for disaccharide.
3. Qualitative tests for polysaccharide.
4. Qualitative tests for amino acids
5. Qualitative tests for proteins.
6. Estimation of sucrose and starch
7. Estimation of amylase.
8. Estimation of protein.
9. Isolation of an enzyme and its assay.
10. Determination of pH.
11. Assay of lipase.
12. Electrophoresis of amino acids.
13. Separation of amino acids by ascending and descending paper chromatography.
14. Separation of amino acids by circular paper chromatography.
15. Practical examination

### **Suggested Reading**



1. Bailey, J.E. and D.F.Ollis.1977. Biochemical Engineering Fundamentals. McGraw-Hill Book Co., Singapore.
2. Blakebrough, N.1967.Biochemical and Biological Engineering Science. Vol I Academic Press, Newyork.
3. Klotz. I.M. 1967. Energy changes in biochemical reactions. Academic press. Newyork.
4. Mukhiyonov. I.P.1977. Calculation of chemical technological processes, M.I.R. Publishers, Moscow.
5. Stanburry, P.F. and A. Whitaker.1984. Principles of fermentation technology. Pergamon Press, New York.

### **Fdqu.1202 GENERAL MICROBIOLOGY (1+1)**

Development and scope of Microbiology – History of Microbiology - Spontaneous generation theory – Germ theory of diseases – Contributions by Anton van Leeuwenhoek, Louis Pasteur, John Tyndall, Robert Koch, Joseph Lister, Winogradsky, Beijerinck, Alexander Fleming and Waksman - Characterisation classification and Identification of Microorganisms. Microscopy – Resolving Power – Numerical aperture, magnification, Types of Microscopes – Light microscope, Dark field, phase contrast, U.V. Microscope, Electron microscope (Scanning – Transmission type).

Structure and organization of microbial cell - Prokaryotes - Eukaryotes - Morphology and fine structure of different microorganisms. Methods of isolation and purification - pure culture technique- preparation of media - types of nutritional media - Staining techniques - Simple, differential and structural staining - preservation of the microbial culture.

Nutritional types- Growth curve - continuous culture, synchronous culture - chemostat - Energy production by aerobes, anaerobes, photosynthetic organisms - Biosynthesis of proteins (enzymes) and other macro molecules. Classification of micro-organisms - General principle and outline of classification in bacteria, fungi and algae. Viruses and bacteriophages - chemical nature - Life cycle - Lytic and Lysogenic types - importance.

Microbial genetics – mutation- induction of mutation - conjugation, transformation, transduction - heterokaryoses - parasexuality - General mechanism of gene transfer techniques in genetic engineering. Principles of immunology - Antigen and antibody reaction - Development of vaccines - Microbial products and industrial application of microorganisms

#### **Practical Schedule**

1. Study and experiments with different microscopes.
2. Measurement of microorganisms.
3. Simple staining and Gram staining.
4. Sterilization techniques and equipments.
5. Preparation of culture media.
6. Isolation of microorganisms and Enumeration.

7. Growth of bacteria - Colorimetric method - Plating method.
8. Purification of bacteria.
9. Purification of fungi.
10. Study of physiological characteristics of bacteria.
11. Study of Bacteria - Morphology.
12. Study on the bacterial mutation.
13. Viruses - bacteriophages - plaque formation.
14. Industrial use of microorganism.
15. Practical examination.

#### **Suggested Reading**

1. Pelczar, M.J., E.C.S.Chan and N.R.Krieg. 1988. Microbiology. McGraw-Hill New York.
2. Powar, C.B. and H.F.Daginawala. 1989. General Microbiology. Vol. I and II. Himalaya Publishing House, New Delhi.
3. Rangaswami, G and D.J.Bagyaraj. 1992. Agricultural Microbiology. Asia publishing House, New Delhi.
4. Stanier, R.Y., J.Ingtaham, M.C.Wheelis. and P.R.Painter. 1986. The Microbial world. Prentice Hall, England. New Jersey.
5. Tauro, P, K.K. Kapoor and K.S.Yadav. 1989. An Introduction to microbiology. Wiley Publications, New Delhi.

### **Fdqu.2103 BIOCHEMICAL ENGINEERING (1+1)**

Introduction – microbial and enzyme reaction - kinetics – Michaelis- Menten Kinetics, activation energy - mass balance and principles of stoichiometry – oxygen requirement - fermenters – aeration and agitation in fermenters - mass transfer and absorption coefficient - sterilization – fermenter design and operation – productivity – product recovery - instrumentation – fermenters in food processing industries

#### **Practical Schedule**

1. Reaction rate determination.
2. Evaluation of parameters in the Michaelis Menten Equation.
3. Evaluation of parameters by - Line weaver burk plot.
4. Determination of growth rate of micro organisms.
5. Determination of doubling-time
6. Experiment in fermenter.
7. Oxygen requirement determination - transfer rate.
8. Instrumentation and control in Fermenter.
9. Experiments on aeration- bubble.
10. Experiments on mechanical agitators.
11. Experiments on centrifuge.
12. Experiments on filtration Techniques.
13. Design of fermenter.
14. Visit to a Food Industry / distillery unit.
15. Practical examination.

#### **Suggested Reading**

1. Bailey, J.E. and D.F.Ollis.1977. Biochemical Engineering Fundamentals. McGraw-Hill Book Co., Singapore.
2. Blakebrough, N.1967.Biochemical and Biological Engineering Science. Vol I Academic Press, Newyork.
3. Klotz. I.M. 1967. Energy changes in biochemical reactions. Academic press. Newyork.
4. Mukhiyonov. I.P.1977. Calculation of chemical technological processes, M.I.R. Publishers, Moscow.
5. Stanburry, P.F. and A. Whitaker.1984. Principles of fermentation technology. Pergamon Press, New York.

### **Fdqu.2104 BIOCHEMISTRY OF PROCESSING AND PRESERVATION(1+1)**

Chemistry of cooking- biochemical changes in carbohydrates, proteins and lipids during cooking; caramellization of sugars, browning and Maillard reactions. Loss of nutrients and prevention of loss during cooking.

Food storage- biochemical changes during storage of food grains, fruits and vegetables. Cold storage and freezing of foods- factors affecting quality of foods and biochemical changes.

Food preservation- biochemical changes during preservation of foods; and mechanism of action. Biochemical changes during processing of foods- pickling, malting etc. Biotechnology in food processing and preservation. Instrumental biochemistry:chromatography, electrophoresis, spectro photometry.

#### **Practical Schedule**

1. Isolation of protein from milk and egg.
2. Hydrolysis of starch by amylase.
3. Assay of amylase.
4. Hydrolysis of protein by trypsin.
5. Studies on packaging of foods.
6. Studies on microwave cooking.
7. Cold storage and freezing of foods.
8. Assay of protease.
9. Estimation of peroxide value.
10. Estimation of alcohol by GC.
11. Isolation of starch from tapioca.
12. Assay of Polyphenol oxidase
13. Freeze Drying of foods
14. Determination of moisture content by different methods
15. Practical Examination

#### **Suggested Reading**

1. Belitz.W.Grosch.1986.Food Chemistry, Springer Verley Berlin Heidelberg, New York
2. Daid S robinson,1987.Food Biochemistry and Nutritive Value.Longman Group,U.K
3. Leslie Hat,F and Harry Johnstone Fisher,1971.Modern Food Analysis,Spinger-Cerlag,New York.

4. Sadasivam,S and A.Manickam,1996, Biochemical methods for Agricultural Sciences,New Age International Publishers.

### **Fdqu.2205 FOOD MICROBIOLOGY (1+1)**

Importance of microorganisms in food – primary sources of microorganisms in food – Intrinsic and extrinsic parameters of food affecting microbial growth – Types of microorganisms in foods like meats, poultry, seafood, vegetables, dairy products, fruits and vegetables. Parameters affecting the growth of microorganisms

Microbial spoilage in foods- Assessing microbial load in foods –. Spoilage of foods – principles and types of spoilage – microbial spoilage of different types of foods, - spoilage of fruits and vegetables, fresh and processed meats, poultry, sea foods, cereals, flour, dough, bakery products dairy products, fermented foods and canned foods.

Food preservation – principles – Factors affecting preservation – Food preservation using temperature – low temperature food preservation – characteristics of psychrotrophs – high temperature food preservation – characteristics of thermophiles – preservation of foods by drying chemicals and radiation – limitations – commercial application. Microorganisms as food – single cell protein – bacteria, fungi, yeast, algae – production techniques.

Food sanitation – indicators of food safety – Coliform bacteria. Food borne infections and food poisoning – botulism – salmonellosis – gastroenteritis. Food borne pathogens – *Clostridium perfringens*, *Vibrio*, *Campylobacter*. Food processing plant sanitation – microbiological standards and guidelines – microbial quality control and food laws.

#### **Practical Schedule**

1. Food Sampling Techniques and Preparation of Sample for Microbial Analysis
2. Enumeration of Microorganisms in food by Aerobic Plate Count Method
3. Enumeration of yeast and Molds in Foods by Direct Plating Technique
4. Enumeration of Microorganisms in food by MPN methods
5. Assessing the microbial quality of milk by Dye reduction method
6. Examination of microbial spoilage in Canned Foods
7. Identification of food pathogens in canned foods, tetra packed foods.
8. Isolation and identification of *Bacillus cereus* in food
9. Isolation and identification of *Clostridium perfringens* in food
10. Isolation and identification of Coliforms and *E.coli* in food
11. Isolation and identification of *Salmonella* in food
12. Estimation of toxin production in foods by molds
13. Production techniques of single cell protein - bacteria and. Algae
14. Experiments on effect of pH and water activity on microbial growth.
15. Practical Examination.

#### **Suggested Reading**

1. Banwart, G.J. Basic Food Microbiology. Van No Strand Reinhold Publishers, New York.

2. Frazier, W.C. and Westhoff, 1983. Food Microbiology. Tata McGraw Hill Publishing Co. Ltd., New Delhi.
3. Gould, G.W. 1996. New methods of food preservation. Blackie Academic & Professional, Madras.
4. Jay, J.M. 1996. Modern Food Microbiology. CBS Publishers & Distributors, New Delhi.
5. King R.D. and P.S.J. Cheetham, 1986. Food Biotechnology Elsevier Applied Science, New York.

### **Department of Supportive Engineering**

#### **LIST OF COURSES**

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No</b>
1	Cien.1101	Basic Civil Engineering	2+1	44
2	Cien.1102	Engineering Drawing	0+2	45
3	Meen.1101	Production Technology	2+1	46

4	Elen.1201	Basic Electrical Engineering	2+1	47
5	Meen.1202	Machine Drawing	0+1	48
6	Meen.1203	Engineering Thermodynamics	2+1	48
7	Cien.2103	Fluid Mechanics	2+1	49
8	Meen.2104	Boiler and steam Engineering	1+1	50
9	Cien.2204	Mechanics and Strength of Materials	2+1	51
10	Meen.2205	Kinematics of Machinery	2+1	53
11	Cien.3105	Design of Structures	1+1	54
12	Meen.3106	System Engineering	2+0	54
13	Meen.3107	Machine Design	1+1	55
14	Elen.3202	Instrumentation and Process Control	2+1	56

### **Cien.1101 BASIC CIVIL ENGINEERING (2+1)**

Materials and Buildings-Introduction- Materials- Brick, stone, cement, steel, concrete-properties-uses – factor of safety.Buildings- classification-components-substructure-super structure- types, functions and requirements-capacity

Surveying- Principles and basic concepts, objectives and uses of surveying, classification and methods of surveying. Chain surveying- principles, steps involved in chain survey- instruments used, ranging, offsets, booking of field notes, traversing and plotting. Compass Surveying- prismatic and Surveyor’s compass, bearing, Whole circle and quadrantal system, local attraction- traversing and plotting. Plane table Surveying- Instruments and accessories, methods- radiation and intersection.Levelling- definition-types of levels, bench marks- principles in leveling, booking the readings, reduction of levels- collimation system and Rise and Fall system. Temporary adjustmentsTheodolite Survey- parts of theodolite, adjustments, measurement of angles, Tachometry- Stadia method and Tangential method- calculation of distances and reduced levels. Area and volume computation.

Water Supply and Sewage Disposal- Water Supply- sources- standards of drinking water- analysis of water- physical, chemical and bacteriological test. water processing- sedimentation, coagulation, filtration, disinfection, water distribution systems-methods Water pollution and its control- types of water pollution and preservative measures Introduction of Sanitary Engineering- sewage – Estimation of quality- characteristics- treatment- sludge disposal. Septic tanks- functions and components

### **Practical Schedule**

1. Study of instruments used in chain surveying and area computation by cross staff survey.
2. Chain traversing, locating buildings, plotting.
3. Study of instruments and measurements of bearings.
4. Area computation by compass.
5. Compass traversing- closing error and correction.
6. Study of plane table and area computation by radiation and intersection methods.
7. Levelling- Temporary adjustments and calculation of reduced levels of points.
8. Differential levelling.
9. Study of theodolite- measurement of angles.
10. Theodolite traversing.
11. Calculation of heights and distances by stadia tacheometry
12. Calculation of heights and distance by Stadia Tacheometry for inclined sights.
13. Calculation of heights and distances by tangential tacheometry
14. Visit to water treatment plants.
15. Practical Examination

### **Suggested Reading**

1. Basak,2002. Surveying and leveling, Tata McGraw-Hill company.
2. Garg S. K. (1992) Environmental Engineering (Vol I) Khanna Publishers, Delhi.
3. Kanetkar,T.P and Kulkarni,SV,2004. Surveying and leveling, Part I&II.Poona Vidyathri Griha Prakashan,Poona.
4. Metcalf and Eddy (1997) Waste Water Engineering-Treatment, Disposal, reuse, Tata McGraw Hill Publishing Co. Ltd. New Delhi.
5. Punmia, B. C. and Ashok Kumar Jain, Surveying Vol I & II, Laxmi Publication.
6. Rangwala S. C. (1992) Water supply and Sanitary Engineering, Charotar Publishing House, Anand
7. Rangwala, S.C. (1997)Engineering Materials, Charotar Publishing House, Anand
8. Rangwala, S.C. Surveying and Levelling Charotar Publishing House, Anand
9. Sharma, S.K. (1990) Building Construction, S. Chand & Co., Delhi.
10. Surendra Singh, 1996. Building Materials, Vikas Publishing Company, New Delhi

## **Cien.1102 ENGINEERING DRAWING (0+2)**

Introduction - lines – lettering and dimensioning – Construction and use of scales, construction of geometrical figures, conic sections- parabola, hyperbola and ellipse. Principles of projections - projects of points, straight lines, planes and solids - isometric projections - sections of solids - development of surface – intersection of solids, perspective projection.

### **Practical Schedule**

1. Introduction - graphic language - definitions - projections – classification,. Drawing instruments and their uses. Lines - types - thickness and shade of lines.
2. Lettering - single - stroke letters - gothic letters - dimensioning
3. Scales and their construction
4. Geometrical figures.
5. Conic sections –parabola, hyperbola and ellipse
6. Projection - orthographic projection views - planes of projection, Quadrants - first angle projection - reference line, Projections of points -points in different quadrants.
7. Projections of straight lines - parallel to and contained by one or both the planes.
8. Perpendicular to a plane-inclined to one plane, parallel to the other.
9. Line inclined to both the planes - contained by a plane, perpendicular to both the planes.
10. True length of a line and its inclinations with the reference planes - Traces of a line.
11. Projections of planes - traces of planes - perpendicular planes - oblique planes.
12. Projections of planes, parallel to one plane - perpendicular to both the planes.
13. Projections of planes - perpendicular to one, and inclined to the other.
14. Projection of solids-polyhedra.
15. Solids of revolution - solid in simple position.
16. Axis perpendicular to a plane - axis parallel to both planes.
17. Axis parallel to one plane and inclined to the other.
18. Axis inclined to both the planes - Prism.
19. Axis inclined to both the planes - Pyramid.
20. Isometric projection - isometric axes, lines and planes.
21. Isometric scale-Isometric projection of planes - prisms.
22. Pyramids - cylinders - cones - spheres.
23. Section of solids - section of planes - sections - true shape of sections.
24. Sections of prisms and pyramids.
25. Section of cones and cylinders.
26. Development of surfaces - development of cubes - prisms.
27. Development of cylinders - pyramids-cones-spheres.
28. Intersections - line of intersection - intersection of prism and prism - cylinder and cylinder - cylinder and prism.
29. Perspective projection.
30. Practical Examination.

### **Suggested Reading**

1. Anil kumar, K. N., 2005, Engineering Graphics,Adhyuth Narayan Publishers, Kottayam
2. Bhatt, N.D. 1982. Engineering Drawing. Charotar Publishers, Anand, India.
3. Parkinson, A.C. and J.H. Currie first year Engineering Drawing. Wheelers Publishers,Allahabad, India.

### **Meen.1102 PRODUCTION TECHNOLOGY (2+1)**

Fundamentals of metals and alloys – structure and formation of grains – Iron-carbon equilibrium diagram. Properties of metals. Ferrous metals and alloys. Introduction to Non Ferrous metals and alloys – manufacturing processes and properties. Heat treatment



of steels – purpose and method of heat treatment. Mechanical working of metals – Hot and cold working processes.

Smithy and forging – types – tools and machines used for forging. Welding process – types of welding – welding joints – defects in welds – weld symbols. Introduction to Brazing and soldering

Wood and its structures – seasoning – methods of seasoning – wood working processes involved in Carpentry – wood working tools and machines – Carpentry joints.

Pattern making and foundry – pattern materials – pattern making tools – types of pattern and allowances – moulding tools and equipment – moulding sand – moulding processes. Bench work and fitting – process involved in fitting – tools used. Introduction to lathe – principal parts – types – basic operations.

Drilling machine – principal parts – types – basic operations. Shaper, Planner – principal parts – types – basic operations. Grinding – kinds of grinding machines. Milling machines – types – principal parts – Introduction to basic operations.

Sheet Metal Work-Introduction, equipments, tools and accessories, Sheet Metal working process – various types, applications, advantages / disadvantages.

### **Practical Schedule**

1. Identification of carpentry and fitting tools and accessories.
2. Exercise in planning of wooden block and practice in making halving joint
3. Fitting practice - making 'L' joints
4. Fitting practice - making square joints
5. Identification of smithy tools and accessories - Making a "S" hook
6. Working with foundry sand, conditioning and tempering of green sand - tools and accessories
7. Moulding practice with single piece and split patterns
8. Welding practice - Striking an arc - practice in running beads
9. Edge preparation for butt joint - making butt joint
10. Gas welding set and accessories - gas welding practice
11. Study of lathe - tools - centering practice
12. Plain turning & step turning exercise on lathe
13. Drilling and boring exercise on lathe
14. Thread cutting exercise on lathe
15. Sheet Metal working process- Fabrication of a small cabinet, Rectangular Hopper, etc.,
16. Practical examination

### **Suggested Reading**

1. Hajra Chowdry, S.K.1986. Elements of Workshop Technology, Vol.I. Manufacturing Process. Asian Book Co., New Delhi.
2. Hajra Chowdry, S.K.1986. Elements of Workshop Technology, Vol.II. Manufacturing Process. Asian Book Co., New Delhi.
3. Khanna, O.P. 1990. A text book on welding technology. Dhanpat Rai., New Delhi.
4. Makienko, N.I. 1983. Fitting practice. Mir Publ., Moscow.

## **Elen.1201 BASIC ELECTRICAL ENGINEERING (2+1)**

Electrical Engineering -Basic electrical quantities - specific resistance - temperature coefficient. D.C. circuits - Kirchoff's laws - Net work theorems - Thevenin, superposition theorem - Net work transformation. Magnetic circuit-inductance. Self and mutual law of electromagnetic induction.

Single phase A.C. circuits and basics - RMS and average quantities - vectorial representation of AC - A.C. series, parallel and series, parallel circuits. Three phase A.C. circuits - star and Delta for generation and load-power factor - power and energy measurement-load estimation in the processing industry - metering types and merits - wiring - accessories for wiring - preparation of wiring plan - execution and bill of cost - lighting in plants - equipments and working principles. Heating - types of heaters Electrical tariff and safety.

Electronics - Electronic components and devices-Passive components – Resisters, Inductors and Capacitors and their types. Semiconductor- Energy band diagram – Intrinsic and Extrinsic semiconductors – PN junction diodes and Zener diodes – characteristics.Rectifiers - Half wave and full wave rectifier – capacitive filter – wave forms – ripple factor – regulation characteristics.Transistors - PNP and NPN transistors – theory of operation – Transistor configurations – characteristics – comparison. Special semiconductor devices - FET – SCR – LED – V I characteristics – applications.

Digital Electronics-Digital Fundamentals-Number system-Boolean Theorems-DeMorgan's Theorems Logic gates – Implementation of Boolean Expression using Gates. Integrated Circuits: IC fabrication – Monolithic Technique.

#### **Practical Schedule**

1. Computation of electrical energy for an appliance by using energy meter
2. Determination of power factor of a load.
3. Special use indicating circuit-wiring for safety and protection
4. Determination of characteristics of 3-phase induction motor
5. Disassembly and study of single and three phase motors
6. Determination of electrical load for a plant/installation
7. Verification of Kirchoff's law
8. Determination of impedance and power factor in RLC circuits.
9. Half wave rectifier and full wave rectifier
10. Capacity filter
11. Studies on transistor characteristics
12. Studies on Diode characteristics
13. Study of different gates.
14. Verification of De Morgan's theorem.
15. Practical examination

#### **Suggested Reading**

1. Ghosh, M.L.1992. Electrical trade theory. Tata McGraw Hill
2. Samuel, L. Oppenheimer.1984. Fundamentals of electrical circuits. Prentice Hall inc.
3. Theraja.1994. A text book of electrical technology. S. Chand and co.
4. Uppal, S.L.1992. Electrical power. Khanna publishers.

### **Meen.1202 MACHINE DRAWING (0+1)**

Free hand sketching in machine drawing-Machine components, detailed: assembly manufacturing drawing. Forms of screw threads-BSW, square, metric, representations of threads Bolts studs, screws, nuts-hexagonal and square headed. Different types of keys-Sunk tape key, hollow saddle key, flat saddle key. Cotter joints, sleeve joints. Shaft couplings box or muff coupling. Coupling-flanged coupling. Shaft bearing-Journal bearing, solid bearing, bush bearing. Method of fixing pulleys-belt pulleys, V belt pulleys, stepped pulleys or speed cones.

#### **Practical Schedule.**

1. Free hand sketching in machine drawing-Machine components, detailed, assembly and manufacturing drawing.
2. Forms of screw threads-BSW, square, metric, representations of threads
3. Bolts studs, screws, nuts-hexagonal and square headed.
4. Different types of keys-Sunk tape key, hollow saddle key, flat saddle key.
5. Cotter-joints
6. Sleeve joints
7. Shaft coupling box or muff coupling.
8. Flanged coupling.
9. Shaft bearing Journal bearing
10. Solid bearing
11. Bushed bearing
12. Method of fixing pulley-Belt pulley.
13. V-Belt pulleys
14. Stepped pulleys or speed cones.
- 15 Practical Examinations.

#### **Suggested Readings**

1. Bhat N.D.(1986).Machine Drawing.Charotar Publishinh Home,Anand.
2. Bhat N.D.(1985). Elementary Engineering Drawing. Charotar Publishinh Home,Anand
3. Varghese P.I and John K.C.(1996) Machine Drawing. Jet Publishings,Viyyur.
4. Varghese P.I and John K.C.(1996). Engineering Graphics (Part 1&II) Jet Publishings,Viyyur.

### **Meen.1203 ENGINEERING THERMODYNAMICS (2+1)**

Thermodynamics - microscopic and macroscopic point of view - Systems, properties, process, path, cycle - Units - pressure, temperature - Zeroth law - work, power, heat and internal energy. First law - closed system, flow work, steady flow system, work done - Non-flow process. Ideal gas - gas laws, Equation of state, characteristic and universal gas constant, internal energy and enthalpy, specific heats, relation between  $C_p$  and  $C_v$ . Ideal gas processes - Isometric, Isobaric, Isothermal, , Isentropic, polytropic processes.

Second law of thermodynamics - various statements, equivalence of Kelvin, Plank, Clausius statements - Reversibility - irreversibility, reversible cycle - Carnot cycle and theorem - Kelvin temperature scale. Entropy - Clausius theorem, Clausius inequality, entropy and irreversibility, T-S diagram, entropy changes during processes. Air standard cycles - Otto, Diesel, Dual, Stirling, Erricson cycle.

Reciprocating air compressors - single and two stage - thermal and volumetric efficiency – Inter cooling - Entropy change in compression

Properties of steam - phase change under constant pressure- P-V-T on phase change - critical point and its parameters - Properties of steam - Wet and superheated - steam tables and their use.

### **Practical Schedule**

1. Problems on properties of system.
2. Problems on conversion of pressure and temperature units.
3. Problems on work, power, heat and internal energy.
4. Problems on heat and work in non - flow quasi static processes.
5. Problems based on first law of thermodynamics.
6. Problems on ideal gas and processes.
7. Problems based on second law of thermodynamics, reversible cycles.
8. Problems on entropy
9. Problems on entropy.
10. Problems on reciprocating compressors.
11. Problems on reciprocating compressors
12. Problems on steam and processes on steam.
13. Problems on steam and processes on steam
14. Problems on steam and processes on steam
15. Practical examination

### **Suggested reading**

1. Ballaney, P.L. 1991. Thermal engineering, Khanna Publishers.
2. Brij Lal and Subramaniam, N. 1994. Heat and thermodynamics, S.Chand and Co.
3. Khurmi, R.S. 1992. Engineering thermodynamics, S.Chand & Co.
4. Kothandaraman, et al. 1992. A course in thermodynamics and heat engines, Dhanpat Rai and Sons, Delhi.
5. Mathur, M.L. and Sharma, R.P. 1992. A course in internal combustion engines, Dhanpat Rai and Sons, Delhi.
6. Nag, P.K. 1992. Engineering thermodynamics, Tata McGraw-Hill Publishing Co.
7. Paul W.Gill. 1967. Internal combustion engines, Oxford and IBH Pub. Co.
8. Rao, Y.V.C. 1993. An introduction to thermodynamics, Wiley Eastern.

### **Cien.3105 FLUID MECHANICS (2+1)**

Nature of fluids: incompressible and compressible, hydrostatic equilibrium, manometers, potential flow, the velocity field, laminar flow, Newtonian and non-Newtonian fluids, Newton's-law of viscosity, turbulence, Reynolds number and transition from laminar to turbulent flow, Eddy viscosity, boundary layer, flow in boundary layers, laminar and turbulent flow in boundary layers, boundary-layer formation in straight tubes

Kinematics of flow-Streamlines and stream tubes, equation of continuity, Bernoulli equation, pump work in Bernoulli equation. Flow of incompressible fluids in conduits and thin layers: friction factor, relationships between skin-friction parameters, average velocity for laminar flow of Newtonian fluids, Hagen-Poiseuille equation, hydraulically

smooth pipe, Von Karman equation, roughness parameter, friction-factor chart, equivalent diameter, form friction losses in Bernoulli equation, couette flow.

Drag, drag coefficients, drag coefficients of typical shapes, Ergun equation, terminal settling velocity, free and hindered settlings, Stokes' law, Newton's law, criterion for settling regime, fluidization, conditions for fluidization, minimum fluidization velocity.

Flow measurements-Orifice and venturimeter, Pitot tube and other types of meters

Transportation of fluids-pipe fittings and valves, Pumps-types, design criteria.

### **Practical Schedule**

1. Computations on differential pressures, with 'U' tube and inverted 'U' tube manometers.
2. Experiment on Bernoulli's Theorem.
3. Determination of friction coefficient in metallic and plastic pipe.
4. Experiment on Buoyancy.
5. Pressure loss in pipe bends.
6. Flow measurement through Venturimeter and Orificemeter..
7. Flow measurement by trajectory of jets.
8. Performance evaluation of multistage pump.
9. Performance evaluation of centrifugal pump - coupled and monoblock.
10. Performance evaluation of jet pump and. submersible pump.
11. Performance evaluation of turbine pump.
12. Performance evaluation of reciprocating pump.
13. Performance evaluation of oil pump.
14. Performance evaluation of hydraulic ram.
15. Practical examination

### **Suggested Reading**

1. Coulson J.M., Richardson J.F., Backhurst J.R. and Harker J.M., "Coulson & Richardson's Chemical Engineering", Vol. I, 6<sup>th</sup> Edn., Butter worth Heinemann, Oxford, 1999.
2. Earle. E.L. (1985) Unit Operations in Food Processing. Pergamon Press, Oxford, U.K.
3. Jagadish Lal. 1984. Hydraulic Machines. Metropolitan Book House, Delhi.
4. Lewit. 1982. Hydraulics. ELBS, London.
5. Massay, B.S.1980. Mechanics of fluids. ELBS, London.
6. Mc Cabe, W.C and J.C Smith (1990). Unit Operation of Chemical Engineering. 5<sup>th</sup> Edn., McGraw Hill Inc., Tokyo, Japan
7. Michael, A.M and S.D.Khepar.1989. Water well and pump engineering. Tata McGraw Hill Co., New Delhi.
8. Modi, P.N and Seth. 1986. Hydraulics and Hydraulic machines. Standard Book House, New Delhi.
9. Noel de Nevers, "Fluid Mechanical for chemical Engineers", 2<sup>nd</sup> Edn., McGraw Hill International Editions, 1991.
10. Yuan, S.W. 1969. Fundamentals of Fluid Mech. Prentice Hall Printers, New Delhi.

Fuel and combustion -Introduction – classification – solid, liquid and gaseous fuel – theory of combustion – calorific value. Bomb calorimeter – Determination of minimum air requirement for combustion – gas analysis. Properties of steam Introduction – steam formation – Thermodynamic properties of steam – Sensible heat, latent heat, dryness fraction, wet fraction – superheated steam – steam table, expansion of steam.

Chimney design Introduction – Classification of draught – natural, forced, artificial, induced draught-draught losses – advances of mechanical draught- determination of height and diameter of chimney – condition of maximum discharge – efficiency of chimney.

Boilers Introduction – classification of boilers – Cochran boiler, Lancaster boiler, locomotive boiler, vertical and horizontal return tube boilers, velox boiler – working principle. Merits and demerits of fire tube and water tube boilers. Fitting safety and maintenance-Selection of size of steam pipes – layout of pipe lines – Energy audit of steam boilers – economy of heat utilization – boiler codes – Indian boiler regulation act – safety in steam plant maintenance.

### **Practical Schedule**

1. Problems on determination of stoichiometric Air requirement of fuels – Gravimetric Analysis of products of combustion.
2. Problems on determination of stoichiometric Air requirement – volumetric analysis of products of combustion.
3. Problems on combustion of fuels – conversion of Mass to Volumetric Analysis and vice versa
4. Problems on determination of calorific value of solid,liquid and gaseous fuels.
5. Problems on properties of steam.
6. Problems on changes in enthalpy and entropy of steam under process conditions.
7. Study of Industrial Boiler
8. Determination of Flue Gas composition using Orsat Apparatus
9. Volumetric and Gravimetric analyses of products of combustion based on Orsat Analysis.
10. Study of Bomb Calorimeter.
11. Study of Cochran, Lancashire, Cornish and Lamont boilers.
12. Study of vertical tube, Velox and locomotive boilers.
13. Study on Boiler Mounting and Accessories.
14. Problems on determination of performance efficiency of boilers
15. Practical examination.

### **Suggested Reading**

1. Ballaney, P.L. 1991. Thermal engineering. Khanna publishers.
2. Brij Lal and N. Subramaniam.1994. Heat and thermodynamics. S.Chand and Co.
3. Indian Boiler Regulation Codes.
4. Khurmi, R.S. 1992. Engineering thermodynamics. S.Chand and Co.
5. Nag,P.K. 1992. Engineering thermodynamics. Tata McGraw-Hill Pub.Co.
6. Rao, Y.V.C. 1993. An introduction to thermodynamics. Wiley Eastern.
7. Vasandani, V.P. and Kumari, D.S. 1972. Heat Engineering, Metropolitan Book Co. Pvt .Ltd.
8. Murgai,MP. And Ram Chandra 1990. Boiler Operations, Wiley Eastern Ltd.

## **Cien.2204 MECHANICS AND STRENGTH OF MATERIALS (2+1)**

Statics: Basic concepts - Force systems - Resultant of forces - Moment and its applications, parallel force - Couples - Free body diagram and equilibrium of forces - Centre of gravity of plane figures - Moment of Inertia of a plane figures - Friction of bodies on inclined planes, ladder friction, wedge friction and screw jack friction; Structural Mechanics: Analysis of perfect frames - Method of joints and method of sections - Statically determinate frames. Analysis of perfect frames by graphical method. Virtual work and its applications. Simple stresses and strains - Basic concepts - stresses on inclined planes - Mohr's circle - Principal stresses and strains; Dynamics: Motion

under variable acceleration. Angular motion. Projectile motion and motion along a circular path; Relative velocity and its applications; Laws of motion and its applications; D'Alembert's principle and its applications; Motion of connected bodies, motion of a lift

Collision of elastic bodies; Work, power and energy - application to bodies on inclined plane.

Elasticity - stresses and strains - elastic limit - elastic constants - lateral strain composite sections - temperature stresses - volumetric strain in a body - Resilience and strain energy; Analysis of statically determinate beams- shear force and bending diagrams, Bending and shearing stresses in beams -slope and deflection of beam method. Combined bending and direct stresses - columns and struts - Euler's - empirical formulae for loads on columns; Stresses in thin cylindrical theory shells Torsion of shafts and springs

### **Practical Schedule**

1. Shear force and bending moment diagrams for simply supported cantilever beam and for overhanging beam
2. Bending test on a timber specimen
3. Tension test on a MS rod
4. Preparation of concrete cubes for determination of characteristic strength
5. Compression test on concrete cubes
6. Compaction factor test and slump test for workability of concrete
7. Graphical method of analysis of frames
8. Vicat's apparatus to test for the consistency of cement
9. Rockwell hardness test
10. Brinell and Vicker's hardness test
11. Torsion test
12. Spring test for open and close coiled springs
13. Verification of Clark- Maxwell's Theorem
14. Charpy and Izod impact test.
15. Practical Examination.

### **Suggested Reading**

1. Khurmi, R. S. (1997). *A Text Book of Engineering Mechanics*. S. Chand and Co.

New Delhi.

1. Ashok K. Jain. (1990). *Elementary structural Analysis*. Nem Chand & Brothers, Roorkee
2. Bansal, R.K. (1992). *Engineering Mechanics and Strength of materials*. Laxmi Publications, New Delhi.
3. Junnarkar, S.B. (1995). *Mechanics of structures* (Vol. I and II). Charotar Pub. House, Anand
4. Khurmi, R.S. (1996) *Strength of Materials*. S. Chand and Company Limited, New Delhi.
5. Kumar, K. L. (2003). *Engineering Mechanics*. Tata Mc Graw Hill Publishing Company, New Delhi
- 6 Ramamrutham. S. (1984). *Engineering Mechanics and strength of Materials* Dhanpat Rai and Sons, Nai Sarak, New Delhi

### **Meen.2105 KINEMATICS OF MACHINERY (2+1)**

Basic concept of machines - kinematics - links - pairs - chain - machines and mechanism - Different mechanisms and uses - Inversion of mechanisms - Four bar linkage - its inversions - synthesising a mechanism for predefined motion - velocity and acceleration in mechanisms - Determination by vector polygon and instantaneous centre methods.

Friction - pivot and collar friction - bearing - types - loss of power due to friction in bearings - theory of lubrication - viscosity ratings - Anti friction bearings - Types - Brakes - band - shoe - Clutches - types - single and multiple disc - cone and their applications.

Power drives - belt - flat and V belts - Tension ratio - centrifugal tension - creep - Chain drives - Gears - classification - terminology - profile - law of gearing - minimum number of teeth - interference between rack and pinion - efficiency - Gear trains - simple - compound - reverted- epicyclic.

Governors - watt and porter governor - sensitivity and hunting, fly wheel - function - fluctuation of speed and energy. Cam and follower - types - application - profiles for uniform velocity and acceleration - simple harmonic and cycloidal motion - uniform angular velocity. Balancing of masses in single and multiple planes.

#### **Practical schedule**

1. Drawing of locus of points in four bar and slider crank mechanisms.
2. Location of instantaneous centres in mechanisms.
3. Determination of velocity of points in mechanism by instantaneous centre method.
4. Determination of velocity by vector polygon method
5. Drawing of acceleration polygon for four bar and slider crank mechanisms.
6. Determination of acceleration in scotch yoke and shaper mechanisms.
7. Problems on belt transmissions.
8. Problems on clutches and brakes.
9. Drawing of cam profile for uniform velocity.
10. Drawing of cam profile of uniform acceleration and deceleration.
11. Drawing of cam profile for simple harmonic and cycloidal motions.
12. Balancing of masses in single and multiple planes.



13. Experiment with static balancing machine to find out the unbalanced mass and its position.
14. Problems on gears and gear trains.
15. Practical examination.

**Suggested Reading**

1. Ballaney, P.L. 1994. Theory of machines. Khanna publishers. New Delhi.
2. Jagdish Lal. 1992. Theory and mechanisms and machines. Metropolitan Book Pvt. Ltd. New Delhi
3. Khurmi, R.S. and Gupta, J. K. 1994. Theory of machines. Euarsia Publishing house. Calcutta.
4. Rao, J.S. and Dukkipatti, R.V. 1990. Mechanisms and machine theory, Wiley Eastern. New Delhi.
5. Rattan, S.S. 1993. Theory of machines, Tata McGraw Hill Publishing Co. New Delhi.
6. Thomas Beven. 1984. Theory of machines, CBS publishers and Distributors, New Delhi.

**Cien.3105 DESIGN OF STRUCTURES (1+1)**

Analysis and design of singly reinforced and doubly reinforced beams - Shear, bond and torsion - Design of T beams - Slabs - Design of one way and two way slab ( IS code method only) - Columns, Foundation~ Silos and Ferro cement tanks. loads and use of BIS codes - Design of riveted and welded connections - Design of structural steel members in tension, compression and bending. detailed and abstract estimates - Valuation - Estimate of small residential and farm buildings - Analysis of rates.

**Practical Schedule**

1. Design and drawing of singly reinforced beams, doubly reinforced beams.
2. Design and drawing of T beams.
3. Design and drawing of one way slabs two way slabs.
4. Design and drawing of RCC columns and a square footing
5. Types of structural steel sections.
6. Design and drawing of riveted and welded connections.
7. Design and drawing of tension members in steel.
8. Drawing of different types of compression member sections.
9. Design and drawing of compression members.
10. Drawing of various types of beam sections.
11. Design and drawing of structural steel beams -laterally unsupported case only
- 12 Detailed and abstract estimates
- 13 Detailed estimates for a farm and small building
- 14 Analysis of rates and preparation of abstract estimate.
- 15 Practical Examination.

**Suggested Reading**

1. Gurcharan Singh. (1986). *Theory and Design of R.C.C. Structures*. Standard Publishers and Distributors, New Delhi.

2. Punmia, B.C., Ashokkumar Jain and Arunkumar Jain. (1994). *Reinforced Concrete Structures* (Vol. I). Ixmi Publications, New Delhi.
3. Raghupathi, M. (1998). *Design of Steel Structures*. Tata McGraw-Hill Publishers.
4. Ramachandra. (1989). *Design of Steel Structures* (Vol. I). Standard Book House, Delhi.
5. Ramamrutham, S. and Narayan, R. (1995). *Design of Steel Structures*. Dhanpat Rai and Sons, Delhi.
6. Ramamrutham, S. and Narayan, R. (1991). *Design of R.C.C. Structures*. Dhanpat Rai and Sons, Delhi.
7. Sushil Kumar. (1991). *Treasure of R. C. C. Design*. Standard Book House, Delhi.
8. Vazirani, V.N. and Ratwani, M.M. (1995). *Concrete Structures*. Khanna Publishers, New Delhi

### **Meen.3106 SYSTEM ENGINEERING (2+0)**

System concepts. Requirements for a linear programming problems. Mathematical Formulation of linear Programming problems and its Graphical solution. Response of Systems. Computer as a tool in system analysis. Simplex method. Degeneracy and Duality in linear programming. Artificial variable techniques, Big M method and two-phase methods. Mathematical models of physical systems. Modelling of Agricultural Systems and operations. Cost analysis. Transportation problems. Assignment problems. Waiting line problems; Project management by PERT/CPM. Resource scheduling.

#### **Suggested Reading**

1. Dharani. Sand Venkata Krishnan. (1990). *Operations Research Principles & Problems*. Keerthi Publishing homes Pvt. Ltd.
2. Gupta, P.K. and Man Mohan. (1994). *Problems in Operations Research*. Sultan chand & sons, New Delhi.
3. Kapoor, V.K. (1994). *Operations Research*. Sultan chand & sons, New Delhi.

### **Meen.3107 MACHINE DESIGN (1+1)**

Meaning of design, Phases of design, design considerations. Common engineering materials and their mechanical properties. Types of loads and stresses, theories of failure, factor of safety, selection of allowable stress. Stress concentration. Elementary fatigue and creep aspects. Cotter joints, knuckle joint. Design of threaded fasteners subjected to direct static loads, bolted joints loaded in shear. Design of shafts under torsion and combined bending and torsion. Design of keys. Design of muff, sleeve, and rigid flange couplings. Design of helical and leaf springs. Design of flat belt and V-belt drives. Design of gears. Design of levers, thin cylindrical shells. Design and selection of anti-friction bearings. Crane hooks, circular rings, universal coupling etc

#### **Practical Schedule**

1. Problems based on load and stress analysis of machine components
2. Problems based on practical application of theories of failure and fatigue and determination of factor of safety

3. Design and drawing of pin connections, Knuckle joint.
4. Design and drawing of cotter joint.
5. Exercises on design of levers and rocker arm for diesel engines.
6. Problems on design of shafts under uni- axial and biaxial loading
7. Design of keys.
8. Problems in selection/ design of belts
9. Selection of roller bearings use of catalogue
10. Problems on design of helical and leaf spring
11. Design of coupling.
12. Design of ball bearing.
13. Problems on design of spur gears
- 14 Practical Examination.

#### **Suggested Reading**

1. Chakravarti, A. (1978). *Design data Hand Book*.
2. Khurmi, R.S. and Gupta, J.K. (1984). *Machine Design*. Eurasia Publishing House, New Delhi.
3. Maleev and Hartman. (1978 ). *Mechanical Design of Machines*. CBS Publications, New Delhi.
4. Norton.R.L. *Machine Design*. Pearson Education, New Delhi.
5. Pandya, N.C. and Shah,C.S. (1981). *Machine Design*. Charotar'Book Stall, Anand.
6. PSG, Coimbatore. (1984). *Design data Hand Book*.
7. Sharma, P.c. and Aggrawal, D.K. (1985). *Machine Design*. Dhanpat Rai & Sons, New Delhi.
8. Shingley J.E and C.R Mischke. *Mechanical Engineering Design*, . Tata Mc Graw Hill India Ltd., New Delhi.

### **Elen.3202 INSTRUMENTATION AND PROCESS CONTROL (2+1)**

Process instrumentation: recording instruments, indicating and signaling instruments, transmission of instrument readings, control center, instrumentation diagram, diagrammatic control-center layer, process analysis, instrumentation in the modern plant. Thermoelectric temperature measurement: thermoelectricity, industrial thermocouples, thermocouple lead wires, thermal wells, industrial potentiometers. Résistance thermometers: thermal coefficient of resistance, industrial-resistance-thermometer bulbs, null-bridge resistance thermometers, deflectional resistance thermometer. Radiation temperature measurement: radiation receiving elements, radiation pyrometers, photoelectric pyrometers, optical pyrometers. Composition analysis-Spectroscopic analysis, adsorption spectroscopy, emission spectroscopy, mass spectroscopy. Analysis of solids by X-ray diffraction, color measurement by spectrometers, gas analysis by thermal conductivity, psychomotor method for moisture in gases, hygrometer method for moisture in gases, dew-point method, measurement of moisture in paper, textiles and lumber, pH ion concentration measurement. Pressure and vacuum measurement: measuring elements for gage pressure and vacuum, indicating elements for pressure gages, measurement of absolute pressure, measuring pressures in corrosive fluids. Level measurement: direct measurement of liquid level, pressure (level) measurements in open

vessels, level measurement in pressure vessels, measurement of interface level, level measurement by weighing, level of dry materials.

**Practical Schedule**

1. Introduction to measuring and testing instruments - multimeter and oscilloscope.
2. Circuit practice on 741 op-amp applications
3. Building timer based circuits using 555 IC.
4. Power supplies - building basic rectifier supplies.
5. Using TTL counter ICs to build event counters.
6. LDR transducer for displacement sensing.
7. Strain gauge transducer - mounting and wiring, Capacitive rotational displacement transducer.
8. Inductive pick up - Piezoelectric pick up.
9. Photoelectric and variable reluctance pick up.
10. Thermo couple - use and calibration.
11. Experiments on RTD - Thermistor and expansion gauges.
12. Using pH meters, discharge meters and Anemometers.
13. Study of 8085 and 8031 microprocessor kits - their functions.
14. Data loggers - Computerized data acquisition and data processing.
15. Practical examination

**Suggested Reading**

1. Donald P. Eckman, 1993, Industrial Instrumentation, Wiley Eastern Limited,
2. Galen W. Ewing, 1985 Instrumental Methods of Chemical Analysis, 5<sup>th</sup> Edn., McGraw Hill, New York,.
3. Hobart H. Willard, Lynne L. Merritt and John A. Dean, 1986 Industrial Methods of Analysis, 6<sup>th</sup> Edn., CBS, New Delhi.

**Department of Basic Science**

**LIST OF COURSES**

SI No	Course number	Course Title	Credit Hours	Page No
1	Basc.1101	Communicative English	2+0	58
2	Basc.1102	Engineering Mathematics - I	3+0	58
3	Basc.1103	Engineering Physics	2+1	59
4	Basc.1104	Engineering Chemistry	2+1	60
5	Basc.1205	Engineering Mathematics II	3+0	61
6	Basc.1206	Information Technology	1+1	61
7	Basc.2107	Computer Programming	1+1	62
8	Basc.2108	Engineering Mathematics III	2+1	63

9	Basc.2209	Numerical Methods for Engineering Applications	1+1	64
10	Basc.3110	Statistics	1+1	65
11	Basc.3111	Economics of Food Processing and Marketing	2+1	66
12	Basc.4112	Extension Methods and Transfer of Technology	1+1	67

### **Basc.1101 COMMUNICATIVE ENGLISH (2+0)**

Speaking--Expressing Opinions (agreement / disagreement) – Offering Suggestions  
 Technical Definition - Defining – Describing Objects – Exercise Audio equipment:  
 Types of Pronunciation – Word stress / social context, science and technology context-  
 sentence stress and intonation.

Reading– Reading Comprehension – Transferring Information - Exercise – An unseen  
 passage should be given and questions may be asked in the form of True or False  
 statements, MCQ, short answers. Transcoding: Interpreting tables, flow charts-Writing  
 reports based on the sample.

Writing Technical Report Writing – Lab Report - Exercise– Technical Essay Writing -  
 Exercise Letter Writing – Formal Letters — Letter Inviting Dignitaries – Letter of  
 Application – Placing an Order – Curriculum Vitae — Exercise Note Making – Strategies  
 – Organizing Notes - Exercise

Communication – Basic Concepts – Process – Kinds – Routes – Forms – Factors –  
 Barriers – Triangles – Communication (Communicate through Computers – Power Point  
 & Tele Conferencing). TOEFL and GRE, Computer based text and computer adaptive  
 test – a curtain raiser

#### **Suggested Reading**

1. Abraham Benjamin Samuel “Practical Communication (*Communicative English*)

ALSRW2000,SRMEC - June 2002 Edition.

- Herbert. A.J. 1995. The structures of Technical English Orient Longman
- Pickett and Laster, 1997. 'Technical English, Writing, Reading and Speaking', New York Harper and Row Publications
- Swan, Michael, 1984. 'Basic English Usage', Oxford University Press, Interactive course in phonetics and spoken English published by Acoustics Engineers (ACEN) 2002.
- Warner, Tony, 1996. "Communication Skills for Information Systems", Pitman Publishing, London,
- Munter, Mary, 1987. "Business Communication Strategy and Skill", Prentice Hall Inc., New Jersey,
- Day Robert.A. 1983, "How to Write and Publish a Scientific Paper" Vikas Publishing House Pvt Ltd, New Delhi,

### **Basc.1102 ENGINEERING MATHEMATICS I (3+0)**

Linear Algebra :- Matrices : Introduction to elementary transformation of a matrix. Transpose , adjoint , inverse and Rank of a matrix. Linear dependence of vectors, Consistency of linear system of equations : Rouche's theorem. Characteristic equation: eigen vectors , properties of eigen values, Cayley – Hamilton theorem. Quadratic form , nature of a Quadratic form , Reduction of Quadratic form to canonical form, Reduction to diagonal form.

Differential calculus: Taylor's and Maclaurin's expansions, indeterminate form, curvature, asymptotes, tracing of curves, function of two or more independent variables, partial differentiation, homogeneous functions and Euler's theorem, composite functions, total derivatives, derivative of an implicit function, change of variables, Jacobians, error evaluation, maxima and minima of functions of more than one variable; Integral calculus: Reduction formulae, rectification of standard curves, volumes and surfaces of revolution of curves, double and triple integrals, change of order of integration, Gamma and Beta functions, application of double and triple integrals to find area and volume;

#### **Suggested Reading**

- Grewal B.S. *Higher Engineering Mathematics*. Khanna Publishers.
- Grewal B.S. *Elementary Engineering mathematics*. Khanna Publishers, New Delhi.
- Kreyszing, Erwin. (2006). *Advanced Engineering Mathematics* (8 ed.). Wiley.
- Piskunov. *Differential and Integral calculus*. MIR Publishers, Moscow.
- Ramana, B.V. *Higher Engineering Mathematics*. Tata McGraw-Hill.
- Sharma G.S. , K.L.Ahuja & U.S. Sarana. *Advanced Mathematics for Engineers and Scientists*(Vol. I and II).
- Stewart, James. *Calculus Concepts and Contexts* (2 ed.).
- Thomas, G.B. *Calculus and Analytical geometry*. Addison Wesley London.
- Wylie, C.R., & Barret, L.C. *Advanced Engineering Mathematics* (6 ed.). McGrawHill, New York.

### **Basc.1103 ENGINEERING PHYSICS (2+1)**

Newtons rings, surface tension, viscosity, stokes method, diffraction grating. Dia, Para and ferromagnetism-classification. Langevin theory of dia and paramagnetism. Adiabatic demagnetization, Weiss molecular field theory and ferromagnetism. Curie-Weiss law. Qualitative explanation of Zeeman effect, Stark effect and Paschen Back effect, Raman spectroscopy. Distinction between metals, insulators and semiconductors, Intrinsic and extrinsic semiconductors, law of mass action, Determination of energy gap in semiconductors, Donors and acceptor levels. Superconductivity, critical magnetic field, Meissner effect, Isotope effect, Type-I and II superconductors, Josephson's effect DC and AC, Squids, Introduction to high T<sub>c</sub> superconductors. Spontaneous and stimulated emission, Einstein A and B coefficients, Population inversion, He-Ne and Ruby lasers, solid state diode laser, Nd-Yag laser. Ammonia maser and Ruby laser, Holography-Note. Optical fiber, Physical structure, basic theory. Mode type, input output characteristics of optical fiber and applications.

### **Practical Schedule**

1. To determine the energy band gap in a semiconductor using a p-n Junction diode
2. To determine the slit width from Fraunhofer diffraction pattern using laser beam
3. Determination of ultrasonic wave velocity in a liquid medium
4. To find the numerical aperture of optical fiber
5. To set up the fiber optic analog and digital link
6. To study the phase relationships in L.R.circuit
7. To study the variations of thermo e.m.f. of a copper-constantan thermocouple with temperature
8. To find the wave length of light by prism
9. Fresnel's prism
10. Spectrometer and angled of prism
11. Spectrometer refractive index
12. Spectrometer normalization of grating
13. Surface tension capillary rise
14. Viscosity Stokes method
15. Practical Examination.

### **Suggested Reading**

1. Arumugam M. *Engineering Physics*. Anuradha Agencies.
2. Avadhanulu M.N. & P.G. Kshirasagar. *Engineering Physics*. S. Chand & Company Ltd.
3. Gupta S. & Land R.K. Gaur. *Engineering Physics*. Dhanpat Rai & Sons.
4. Halliday, Resnick and Krane. *Physics* (Vol. 2). John Wiley & Son.
5. Hecht, Eugene. *Optics* (4 ed.). Pearson Educational Publishers.
6. Jenkins F. A. and H. E. White. (1987). *Fundamentals of Optics* (4 ed.). McGraw-Hill Int. Ed. Singapore.
7. Kachaava, C.M. *Solid State Physics* (2 ed.). Tata McGraw Hill.
8. Laud 6.6. *Lasers and Non Linear Optics* (2 ed.). New Age International Ltd.
9. Mark Ratner and Daniel Ratner. *Nanotechnology*. Pearson Education.
10. Raghavan V. *Materials Science and Engineering*. Prentice-Hall India.

## **Basc.1104 ENGINEERING CHEMISTRY (2+1)**

Water- temporary and permanent hardness, disadvantages of hard water, scale and sludge formation in boilers, boiler corrosion, demineralization, desalination, disinfection of water. Waste water Treatment: Importance of dissolved oxygen in water – Determination of COD, BOD. Fuels - classification, calorific value, Coal -classification, analysis of coal proximate and ultimate methods. Petroleum, synthesis of petrol, coal gas and biogas. Analysis of flue gas by Orsat apparatus. Corrosion- causes, types and method of prevention. Polymers- types of polymerization, properties and uses of different types of high polymers. Lubricants- classification, properties . verification of Beer Lambert's Law. Chromatography. Measurement of conductance – Different types of electrodes, Electrochemical cell – reversible and irreversible cell – concentration cells - Nernst equation, – Application of EMF measurements.

### **Practical Schedule**

1. Estimation of temporary and permanent hardness of water by EDTA method.
2. Determination of Chloride content in water by Volhard's method.
3. Determination of COD and BOD in water.
4. Determination of Available chlorine in bleaching powder.
5. Determination of acidity of water sample.
6. Determination of alkalinity of water.
7. Determination of a solid and liquid fuel by Bomb Calorimeter
8. Analysis of flue gas by orsat apparatus.
9. Determination of molecular weight of polymer by viscosity average – method.
10. Determination of dissolved oxygen in a water sample by Winkler's method
11. Determination of corrosion rate.
12. Estimation of Copper in ore.
13. Estimation of nickel in steel.
14. Determination of carbonated and noncarbonated hardness by soda reagent
15. Practical Examination.

### **Suggested Reading.**

1. Uppal M.M, "A text book of Engineering Chemistry", Khanna Publishers.1986.
2. Dara S.S, Chand S. & Co., "A text book of Engineering Chemistry", 10<sup>th</sup> revised Ed, 2003.
3. Glasstone .S & Lewis, "Elements of Physical Chemistry" MacMillan Education 2<sup>nd</sup> Ed, 1987.
4. Kuriacose J.C. and Rajaram J. "Chemistry in Engineering and Technology", Volume II, Tata McGraw Hill p.b. Co., 1988

## **Basc.1205 ENGINEERING MATHEMATICS II (3+0)**

Sequence and series: Introduction to sequences. Real sequences and its convergence. Infinite Series: Infinite series and its convergence, comparison tests, ratio test, cauchy's root test, integral test, rabis's test, , absolutely and conditionally convergent series .Ordinary differential equations: Exact and Bernoulli's differential equations, equations reducible to exact form by integrating factors, equations of first order and higher degree,



Clairaut's equation, Differential equations of higher orders, methods of finding complementary functions and particular integrals, method of variation of parameters, Cauchy's and Legendre's linear equations, simultaneous linear differential equations with constant coefficients, series solution techniques, Bessel's and Legendre's differential equations; Partial differential equations: Formation of partial differential equations, Lagrange's linear equation, Higher order linear partial differential equations with constant coefficients, solution of non-linear partial differential equations, Charpit's method, application of partial differential equations (one dimensional wave and heat flow equations, two dimensional steady state heat flow equation (Laplace equation)).

### **Suggested Reading**

1. Grewal B.S. *Higher Engineering Mathematics*. Khanna Publishers.
2. Kreyszing, Erwin. (2006). *Advanced Engineering Mathematics* (8 ed.). Wiley.
3. Ramana, B.V. *Higher Engineering Mathematics*. Tata McGraw-Hill.
4. Sharma G.S. , K.L. Ahuja & U.S. Sarana. *Advanced Mathematics for Engineers and Scientists* (Vol. I and II).
5. Wylie, C.R.,& Barret, L.c. *Advanced Engineering Mathematics* (6 ed.). McGraw Hill, New York

## **Basc.1206 INFORMATION TECHNOLOGY (1+1)**

Introduction– Difference between information technology and computer science, basic components of IT and Computer science-hardware, software, types of computers-digital, analog, hybrid, business, scientific computers, computers generation ,computer organization, I/O devices-CPU-Memory devices-processors-keyboard-printers, Number systems, base of a number system -decimal, binary, octal, hexadecimal, representation, conversion between various representations, character representations (ASCII, ISCII, Unicode).

Operating systems- introduction, types of OS, Functions of OS

Data base management - Introduction to data, Ms Access-Record, file and database - File creation - input - update, edit and delete records - data manipulation using built in commands - query and select, sort and merge files, Report generation.

Network - Data communication media, Use of network - LAN and WAN - types of connections Internet Applications - role of electronic communications - e-mail - internet Introduction to computer language- Programming in C.

### **Practical Schedule**

1. File creation in Access
2. Data manipulation using built in commands
3. Sorting of files
4. Merging of files
5. Report generation
6. Control statements in C
7. For loop
8. While loop
9. Do While loop

10. One dimensional Arrays
11. Two dimensional arrays
12. Functions
13. Recursion
14. Programming examples of engineering applications
15. Practical Examination

### **Suggested Reading**

1. Data communication –Behrouz A.Forouzan
2. Sheela Kumar.T., Sridhar.S.S. 2003.Computer Practice, Anuradha Publishers,
3. Vikas Gupta, 2002. Computer Course Kit,Wiley-dreamtec India Pvt Ltd,
4. Mullish Cooper, 2002. , The Sprit of C , Jaico Books.

## **Basc.2107 COMPUTER PROGRAMMING (1+1)**

Beginning with c++ - Introduction, tokens, expressions and control structures-keywords, identifiers, data types, user defined data types, derived, symbolic constants, type compatibility –declaration of variables-dynamic initialization of variables, reference variables –operators in c++, scope resolution operator Input output statements- decision making, iterative, pointers pass arguments by value and reference. Managing console I/O operations-formatted, unformatted, managing with manipulators.

Functions in c++- function prototyping call by reference, return by reference, inline functions, default arguments, const arguments, unction overloading, friend and virtual functions.

Classes and Objects-specifying a class, defining member functions, making an outside function inline, private member functions, arrays within class, memory allocation of objects, static data members.Constructors and destructors-Parameterized constructors, multiple constructors in a class, default arguments, destructors.Operator overloading and type conversion-defining operator overloading-unary operators, binary operators, type conversions.Inheritance-extending classes –introduction-defining derived classes ,single inheritance, multi level inheritance, multiple inheritance.File handling-input output file operations-multiple file programming and project applications.

### **Practical Schedule**

1. 1. A simple program-its compilation, execution
2. I/O statements in c++
3. Use of mathematical operators - expressions and hierarchy of operations
4. Program with decision making statements
5. Use of built in functions.
6. Program with jump statement - go to and switch statements
7. Use of arrays - single and two dimension arrays
8. String manipulations
9. Programs with pointers
10. User defined functions - passing by value & passing by reference
11. Programming using structure
12. Programming using Unions
13. Programs with simple classes and objects

14. Programs with default and parametric constructors and destructors

15. Practical Examination

### **Suggested Reading**

1. Object Oriented Program with c++ (Second Edition) by E.Balagurusamy, Tata McGraw-Hill Publishing company Limited, New Delhi.
2. C++, The complete reference, Third Edition, Herbart Schildt, Tata McGraw-Hill Publishing company Limited, New Delhi.
3. Robert Lafore, 1998, OPP in Turbo C++, Goltotia Publications Pvt.Ltd., India
4. Computer Architecture and Organization, John P.Hayer, McGraw-Hill International Edition.

### **Basc.2108 ENGINEERING MATHEMATICS III (2+1)**

Vector calculus: Differentiation of vectors, scalar and vector point functions, vector differential operator Del, Gradient of a scalar point function, directional derivative , Divergence and Curl of a vector point function and their physical interpretations, identities involving Del, second order differential operator; line, surface and volume integrals, Statement of Gauss's Green's and Stokes theorems and their applications.

Fourier Analysis: Periodic functions, Fourier series, Euler's formulae, Dirichlet's conditions, functions having arbitrary period, even and odd functions, half range series, Harmonic analysis. Complex Fourier series, Approximation by trigonometric polynomials, Fourier integrals, Fourier sine and cosine transforms, Fourier transform , Fourier inverse transform; Complex Analysis: Complex functions, Derivative, Analytic function, Cauchy - Reimann equations, harmonic functions , Laplace's equation, Geometry of Analytic functions: Conformal mapping, Linear conformal Transformations, (translation , Rotation , Magnification , inversion) , Bilinear Transformations . Complex Integration, Line integral in the Complex plane, Cauchy's Integral Theorem, Cauchy's Integral formula, Derivatives of analytic functions. Power series, Functions given by power series, Taylor series and Maclaurin's series. Laurent's series, Singularities and Zeros, Residue, integration method, Evaluation of real Integrals..

### **Practical Schedule**

1. Differentiation of vectors , Gradient of a scalar point function , directional derivative , application of del to find normal to a surface , angle between two surfaces , problems on divergence and curl of vector point functions.
2. Problems on line, surface and volume integrals.
3. Verification of Gauss's Green's and Stokes theorems
4. Verification of Gauss's Green's and Stokes theorems
5. Fourier expansion of functions
6. Half range series expansions
7. Application of Fourier transform and inverse Fourier transform
8. Continuity and Differentiability of complex functions , determination of analytic function given its real or imaginary parts , Harmonic functions.
9. Cauchy's theorem.
10. Bilinear transformation and elementary transformation
11. Cauchy's integral formulae

12. Power series, Functions given by power series
13. Taylor series, Maclaurin's series and Laurent's series.
14. Classification of Singularities , calculation of residues , evaluation of real integrals
15. Practical Examination.

### **Suggested Readings**

1. Grewal B.S. *Higher Engineering Mathematics*. Khanna Publishers.
2. Kreyszing, Erwin. (2006). *Advanced Engineering Mathematics* (8 ed.). Wiley.
3. Ramana, B.V. *Higher Engineering Mathematics*. Tata McGraw-Hill.
4. Sharma G.S. , K.L.Ahuja & U.S. Sarana. *Advanced Mathematics for Engineers and Scientists* (Vol. I and II).
5. Wylie, CR., & Barret, L.C. *Advanced Engineering Mathematics* (6 ed.). McGraw Hill, New York.

### **Basc.2209 NUMERICAL METHODS FOR ENGINEERING APPLICATION (1+1)**

Numerical vs. Analytical Methods – Errors and Approximations – Relative and Absolute errors. Theory of Equations – Relations between roots and coefficients of the polynomial equations – Transformations of Equations. Solution of Algebraic and Transcendental Equations – Bisection method and Newton's – Raphson method – Horner's method – Solution of linear algebraic equations: Gauss Elimination method and Gauss Jordan method Crout's method. Finite Differences, first and higher order differences – forward and backward differences – differences of a polynomial – Operator  $E$ ,  $\Delta$ ,  $\nabla$ ,  $\mu$  and  $\delta$ . Interpolation – Newton's forward and backward Interpolation formulae.

Interpolation with unequal intervals – divided differences – Newton's divided difference formula – Lagrange's Interpolation formula. Numerical Differentiation – Newton's forward and backward formulae – Numerical Integration – Trapezoidal and Simpson's  $1/3^{\text{rd}}$  rule. Difference equations – Solution of difference equations with constant coefficients finding Complementary Function and Particular Integral. Numerical Solution of Ordinary Differential Equations – Solution by Taylor Series – Euler's method and Euler's Modified method – Runge Kutta methods: Second and Fourth Order Method.

Numerical Solution of Partial Differential Equations – Difference quotients – Classification of partial Differential Equations of the second order. Solution of Elliptic, Parabolic and Hyperbolic Differential Equations

### **Practical Schedule**

1. Problems in relation between roots and coefficients and Transformation of Equations.
2. Newton's Raphson method and Bisection method
3. Horner's method
4. Gauss Elimination Method and Gauss Jordan Method.
5. Crout's Method.
6. Problems in Finite Differences and Relations between Operators  $E, \Delta, \nabla, \mu$  and  $\delta$ .
7. Newton's forward and backward Interpolation formulae.
8. Lagrange's Interpolation formula.
9. Newton's Divided Difference Interpolation formula.

10. Numerical Differentiation using Newton's forward and backward Interpolation formulae.
11. Trapezoidal rule and Simpson's  $1/3^{\text{rd}}$  rule
12. Finding Complementary function and particular integral of Difference Equations with Constant Coefficients.
13. Solving Ordinary Differential Equations – Taylor series method and Euler's method, Euler's modified method and. Runge Kutta Methods
14. Problems in Solution of Elliptic Equations – Liebermann's Iteration Process. Solution of Parabolic Equations – by Crank Nicolson Method and Solution of Hyperbolic Equations.
15. Practical Examination.

### **Suggested Reading**

1. Singaravelu, A. 1997. Numerical method, Meenakshi Agency, Pushpa Nagar, Chennai.
2. Venkataraman, M.K. 1996. Numerical methods in Science and Engineering, The National Publishing Company.
3. Sastry, S.S. 1986 Numerical Analysis, Macmillan Publishers
4. Jain, Iyengar and Jain, 1986. Numerical Methods for Scientific and Engineering Computations, Sultan Chand and Sons Publishing

### **Basc.3110 STATISTICS (1+1)**

Least square techniques for the estimation of constants in fitting curves – fitting by orthogonal polynomials – by iterative methods – testing the significance of the estimated constants. Testing of hypothesis – basic concepts – testing significance of means using t test – testing association between attributes using chi square test. Basic concepts of experimental design – completely randomized design – randomized block design. Correlation – Pearson's correlation coefficients – simple linear regression – non-linear regression. Quality control – control charts – X, R, p, np and c charts. Test for single mean, mean difference, proportion, difference between proportion – small sample tests-based on t and F distribution – test for – single mean, difference between means – paired t test, testing the goodness of fit. ANOVA – one-way – two way classification. Definition of probability – Laws of addition and multiplication of probabilities – parameter and statistics – population and sample – mean variable, standard deviation, standard error of mean and coefficient of variation. Frequency distribution of data and the calculation of sample statistics. Measures of central tendency – measure of dispersion – Skewness and Kurtosis – Correlation and regression. Theoretical frequency distribution – student 't' distribution – binomial, Poisson and normal distribution, Chi-square and F-distribution.

### **Practical Schedule**

1. Problems on probability – using probability laws
2. Fitting of binomial and Poisson distributions.
3. Fitting of normal distribution
4. Calculation of mean, variance, standard deviation and coefficient of variation for raw and grouped data
5. Estimation of hazard rate and mean time to failure

6. Selection of samples using simple random sampling method and calculation of standard error and confidence limits for mean
7. t test for comparing a sample mean with a population mean and paired t test
8. t test for comparing two sample means – independent t test (variances equal and unequal cases)
9. Chi square test for a 2 x 2 contingency table and r x c contingency table and chi square test for goodness of fit – binomial, Poisson and normal distributions
10. One-way analysis of variance (CRD)
11. Two-way analysis of variance (RBD)
12. Pearson's correlation coefficient and testing its significance
13. Fitting a simple linear regression equation and testing the significance of regression coefficient
14. Control charts – X and R charts, p and np charts and c charts.
15. Practical Examination.

### **Suggested Reading**

1. Gupta S.P.2005. Statistical Methods. Sultan Chand and Sona Educational Publishers, New Delhi.
2. Kapoor, J.N. Saxsena, V.C. 1997. Mathematical statistics. S Chand &Co.
3. Pandey and Sukame, "Statistical Methods ", ICAR Publication, New Delhi.
4. Rangasamy, R. 2002. A text book of Agricultural Statistics. New Age International Publishers, New Delhi.
5. Richard A Johnson 1994. Miller and Freund's Probability and Statistics for Engineers, Eastern Economy Edition, Prentice Hall of India P/Ltd., New Delhi.

### **Basc.3111 ECONOMICS OF FOOD PROCESSING AND MARKETING (2+1)**

Nature of farm products. Cost concepts, cost curves and short run and long run equilibrium. Returns to scale and Economies of scale. Project preparation and feasibility analysis. Financial management. Demand, markets, marketing, market structure, marketing management and pricing strategies of firms. Marketing environment and Consumer buying behavior. Market segmentation, market measurement, market plan, marketing promotion, management of distribution and market research. Market Information System, export and government regulations, GATT and WTO.

### **Practical Schedule**

1. Discussion on scope of food processing units - problems and prospects
2. Estimation of cost of production / processing and returns and breakeven analysis
3. Investment analysis - discounted measures , undiscounted measures
4. Visit to financial institution for raising funds
5. Preparation of bankable project on Food Processing Units
6. Balance Sheet - preparation and analysis
7. Cash flow statement - preparation and analysis
8. Income statement - preparation and analysis
9. Estimation of market potential
10. Market segmentation - Methods
11. Pricing Strategies of Firms

12. Market promotion methods
13. Visit to Food Processing units
14. Presentation and discussion of project reports
15. Practical examination

### **Suggested Reading**

1. Brigham, Eugene F. 1989. Fundamentals of Financial Management, The Dryden Press
2. Chanda, Prasanna, 1989. Financial Management: Theory and Practices, Tata McGraw - Hill Publishing Company Limited, New Delhi
3. Philip Kotler. 1993. Marketing Management Analysis Planning and Control, Prentice Hall Inc., Engle Wood Cliffs, New Jersey
4. Price Gittinger, J. 1992. Economic Analysis of Agricultural Projects, The Johns Hopkins University Press, Baltimore.
5. Metha, P.L. 1999. Managerial economics - Analysis, Problems and Cases, Sultan Chand and Sons, New Delhi.

### **Bas.c.4112 EXTENSION METHODS AND TRANSFER OF TECHNOLOGY (1+1)**

Extension education – meaning, importance, concepts and scope in Food Engineering. Current extension and rural development programmes. Agrl Communication-features and present trends. Diffusion, adoption and Transfer of Technology (TOT) Food engineering innovations-classical and modern theories of adoption and diffusion. Extension methods-individual, group and mass methods-their planning and conducting. Audio visual aids and equipments-their planning and use. Motivation and its role in extension-study of agricultural situation-surveys, focused group interviews, PRA and PLA. Training for development and TOT. Organizational behavior process. Public relations for Food Engineering Extension

#### **Practical Schedule**

1. Lettering principles and drawing techniques practice in drawing different letters.
2. Preparation of posters, charts and graphs
3. Preparation of flashcards and flannel strips.
4. Practicing preparation of literature - personal letter, circular letter, leaflet, folder, pamphlet and new stories.
5. Script writing for farm broadcast.
6. Script writing for telecast and video programmes.
7. .Projection techniques - handling of slide, overhead, VCP, VCR and LCD projectors.
8. Practice in handling cameras and taking photographs.
9. Practicing art of public speaking.
10. Understanding the functioning of AIR.
11. Observing the functions of news paper publishing.
12. Organizing exhibition/ demonstration / campaign at village level.
13. Visit to village to study the spread and acceptance of latest farm technologies.
14. Presentation and evaluation of visual aids.

## 15. Practical Examination

### **Suggested Reading**

1. Practical examination. Annamalai, R., M. Manoharan, S. Somasundaram and K. N. Krishnakumar. 1987. Extension Methods and their principles: Palaniappa Printers, Tirunelveli.
2. Annamalai, R., M. Manoharan, S. Somasundaram and R. Netaji Seetharaman. 1994. Programme Planning.
3. Berlo. 1970. Process of communication: Holt Rinehart Winston Inc., New York.
4. Chitamber, J.B. 1973. Introductory rural Sociology. Wiley Eastern Ltd., New Delhi.
5. Dahama, O.P. and O.P. Bhatnagar. 1985. Education and communication for development. Oxford and IBH Publishing Company, New Delhi.
6. Ranganathan, G. and S. Somasundaram. 1996. Rural Sociology and educational Psychology in Extension Education. Om Sakthi Printers, Trichy.
7. Ray, G.L. 1971. Extension communication and Management, Naya Prakash, Calcutta.
8. Reddy, A.A. 1985. Extension Education. Sree Lakshmi Press, Bapatla.
9. Supe, S.V. 1983. An Introduction to Extension Education. Oxford & IBH Publishing Co. Pvt.Ltd., New Delhi.



## **ELECTIVES**

### **Fden.0001 EMERGING NON THERMAL METHODS OF FOOD PRESERVATION (3+0)**

Introduction, type and sources of radiation, dosimetry, mode of action of ionizing radiation –direct and indirect effect, radiation effect on food constituents, dose requirement for different products and regulations.

Controlled atmosphere storage- modified atmosphere storage- Diffusion channel - controlled atmosphere packaging, modified atmosphere packaging, vacuum packaging - need of modifying atmospheric gas composition – types of scrubbers

Minimal processing – hurdle technology – various parameters which inhibits the growth of microorganism. Ozone – its role in food industry – generation – application. Intermediate moisture foods – formulation - preparation

Membrane technology – terminologies-types of membrane- types of membrane modules- osmosis- reverse osmosis- ultra filtration- changes during concentration.

Pulsed electrified sterilization - application. High pressure technology – application, Oscillating magnetic field sterilization, Ultra sound – application in food industry.. Nano Technologo-Enzyme Technology

#### **Suggested Reading**

1. Lal and Siddappa. 1986. Fruit and Vegetable preservation, ICMR.
2. Manoranjan Kalia and Sangita. 1996. Food preservastion and processing. Kalyani Publishers. Ludhiana.
3. Srivastha R.P. and Sanjeev kumar. 1998. Fruit and vegetable Preservation.
4. Fellows, P.J.2001. Food Processing Technology.
5. Leninger, H.A. and Beverlod, W.A. Food Process Engineering, D.Reicle Pub. Corp.

### **Fdpr.0001 BEVERAGE PROCESSING (3+0)**

Beverage-definition-why we drink beverage-ingredients-water, carbon dioxide, sugar, flavors, colour, sweeteners, emulsifiers and stabilizers. Ingredients-Malt-hops-cereal adjuncts-water, Beer manufacturing, malting – wort, brewing, fermentation storage, finishing and packaging. Wine-fermentation-types –red and white. Procedures-carbonation equipments and machineries-ingredients-preparation of syrups-packaging-containers and closures. Coffee bean preparation-processing-brewing-decaffeination-

instant coffee-Tea-types-black, green and oolong-fruit juices based beverages-squash, RTS, isotonic Beverages. Filling-inspection and quality controls- sanitation and hygiene in beverage industry-Quality of water used in beverages-threshold limits of ingredients.

**Suggested Reading**

1. Technology of carbonated beverage, AVI Publications
2. Formulation and production of carbonated soft drinks by AJ Mitchel Blackie Publishers
3. Hui et al., Hand book of food and beverage fermentation

**FDSC.0001 FOOD BIOTECHNOLOGY (3+0)**

Introduction -Biotechnology relating to the food industry – application of genetics to food production – role of bio process engineering in biotechnology industry. Regulatory and Social aspects of biotechnology of foods.

Production of commercially important enzymes and recombinant protein-Protease, amylase, lipase, cellulase, pectinase, isomerase and other commercially important enzyme for the food industry.

The process of production of some commercially important organic acids – citric acid, lactic acid, acidic acid, gluconic acid, amino acids and alcohol– Bio products for food industries – Natural bio-preservatives – Nisin.

Principle of downstream processing – small, medium and large scale processing. Bacterial starter culture, methods of inoculation, medium preparation – slurry processing and product isolation.

Production of food flavor – color – enzymes – immobilized enzymes. Application in enzyme in meat industry, fruit and vegetable industry, dairy industry.

**Suggested Reading**

1. Board R.B. Jones.D 1995. Microbial Fermentation Beverages, Foods and Feeds.
2. Sarah Elderidge. 2003. Food Biotechnology; Current issues and perspectives. Nova science pub. Inc.
3. Gustavo F. Gutierre. 2003. Food science and food biotechnology. GRC Pub.
4. Brian J. Ford 2000. Future of Food . WW Norton and Co. Inc.

