

## **B Tech Food Engineering & Technology (Self Supportive Course)**

### **INTRODUCTION**

With liberalization of Indian economy, all-round industrial growth has been witnessed in all sectors with improvements in social and economic conditions of our people. This has created demand for more and better quality foods. With advancement in production technology, high yield levels will lead to large amount of marketable surplus of food grains and crop residues, demanding appropriate handling, processing, preservation, storage, marketing and utilization.

Though Kerala has the unique distinction of producing a number of agricultural commodities of commercial importance, the production front is yet to receive a commercial orientation in the real sense. The primary export commodities are cereals, spices, plantation crops, fruits, vegetables and their processed products, and marine products but fast growing specialty products have also penetrated in foreign markets. Considering the contribution of these products in Indian export, it is necessary to have appropriate technology of handling and processing of agricultural produce. Agro processing sector of the state failed to receive due recognition and importance till date and consequently many of the agricultural commodities produced in Kerala are traded in their raw form after some primary processing.

Food Engineering and Technology is a branch of science in which the food science is applied in manufacturing and preservations of food products by eliminating losses and making more balanced and nutritious foods. The B.Tech course in Food Engineering & Technology is designed to train the best talents of the nation in order to provide a support base for the country's food security. The course deals with diversified aspects of formulation, processing and preservation of foods; it also enables students to effectively design and fabricate food processing machineries. This course aims to give adequate training and knowledge to candidates regarding analyzing the quality of raw materials, packing standards and methodology, processing technologies, storage and food values. The future of the food industries, on a global scale, is in the hand of food technologists. The syllabus of the course is framed to enable the students to comprehend the whole gamut of the fast changing food scenario of the world and it comprises mainly of food technology, microbiology, food preservation techniques and food packaging.

Food has become a high-profit industry by reason of the scope it offers for value addition, particularly with the food processing industry getting recognized in India as a high-priority area. In order to achieve the expected returns on investment through good quality and right value addition, application of technology has become imperative, leading to an unprecedented demand for scientists, technologists and other professionals who can manage the emerging challenges of the food processing industry effectively.

#### **Degree awarded**

B.Tech in Food Engineering and Technology

#### **Placement and scope of job opportunities for the scholars**

Food processing industry is rapidly growing in India and several employment opportunities are available in various industries. Many of the research institutes in the state as well as country are urgently in need of suitable candidates with specialization in Food Engineering. The food technology course offers numerous job opportunities in various areas like food processing industries, research laboratories, soft drink factories, quality control and manufacturing industries as Quality assurance manager, Production manager, Laboratory supervisor and Food packaging manager. Some of the institutes are: ICAR Institutes, CFTRI,

IARI, Food Engineering Institute, DRDL, etc. There is immense scope for the candidates coming out of this course.

### **Number of seats**

The maximum number of candidates to be admitted in each year will be 30 subject to the manpower requirements and facilities. However the number of candidates to be admitted in an academic year shall be decided by the Academic Council from time to time. The sponsored candidates will be admitted over and above the seats so fixed with the approval of the Academic Council.

### **Mode of selection and qualifications for admission**

The selection of candidates for admission shall be made as per rules in force. The qualifications for this programme shall be as suggested by Government and prescribed by the Academic Council from time to time.

### **Reservation**

Ten percent seats are filled by Indian Council of Agricultural Research, New Delhi through a National Level entrance Examination.

### **System of Teaching**

The pattern of teaching and evaluation is the Semester Course credit system with internal and external evaluation. The minimum grade point required for passing the course shall be 5.0 out of 10.0. To complete the degree requirement the student shall have to get a minimum OGPA of 5.5 out of 10.0. A separate minimum of 40% marks in theory examination and practical are essential for passing a course.

### **Duration of the degree programme**

The minimum prescribed duration of this programme shall be eight semesters (four academic years) excluding the period of temporary discontinuance, if any. The maximum time limit permitted to complete the programme shall be fourteen semesters including the period of discontinuance, if any.

### **Inter semester break**

An inter semester break of 15 days may be given at the end of semester I of the academic year and a break of about 30 days may be given at the end of the II semester of the academic year, as far as possible.

### **Credit load in a semester**

The maximum credit load including repeat courses in a semester should not exceed 27 excluding the credits for in plant training, project work and the courses registered as re-examination courses. However, a student can take up to 32 credits which will include regular, repeat and re-examination courses.

## Fee structure and Deposits

Sl.No.	Particulars	Amount (Rs.)
<b>a. Fees per Semester*</b>		
1.	Tuition fee	26500.00
2.	Lodging fee	350.00
3.	Special fee	400.00
4.	Library fee	250.00
5.	Examination fee	1000.00
6.	Sports fee	200.00
7.	Computer lab fee	600.00
8.	Electricity fee	400.00
9.	Placement fee	250.00
10.	Academic Calendar	50.00
<b>TOTAL (a)</b>		<b>30,000.00</b>
<b>b. One time payment (First Semester only)</b>		
11	Caution Money deposit**	2500.00
12	Smart Card Identity Card	150.00
13	Blazer and Uniform**	1500.00
14	Counseling Fee	2000.00(1000.00 for SC&ST)
15	Rules and syllabus book/CD	100.00
<b>TOTAL(b)</b>		<b>6250.00</b>
<b>GRAND TOTAL(a + b)</b>		<b>36,250.00</b>
<p>*Amount to be remitted at the time of counseling/ provisional admissions is non refundable when discontinued.</p> <p>** Caution money and Blazer and uniform fee only refundable when discontinued. All other fees are non refundable</p>		

### 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.	Fdqu.2105	Food Microbiology	1+1
3.	Meen.2104	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.2103	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.	Meen.2205	Boiler and steam Engineering	1+1
7.	Cien.2204	Mechanics and Strength of Materials	2+1
8.	Fden.2207	Unit Operations in Food Engineering	2+1
<b>Total</b>			<b>13+8</b>

<b>Semester V</b>			
1	Meen.3106	Systems Engineering	1+1
2.	Fdsc.3103	Entrepreneurship and agribusiness management	2+0
3.	Fdsc.3104	Food Safety and Quality Management	1+1
4.	Fdsc.3105	Fermentation Technology	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	2+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</b>			<b>15+8</b>
<b>Semester VI</b>			
1	Fdpr.3204	Post Harvest engineering of Plantation Crops	2+1
2	Fdsc.3206	Food Industry Waste Management	2+0
3	Fden.3208	Energy for Food Industries	1+1
4.	Fden.3209	Food Process Equipment Design and Plant Layout	2+1
5.	Elen.3202	Instrumentation and Process Control	2+1
6	Fden.3210	Computer Aided Drafting of Food Processing Equipments	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</b>			<b>13+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
10.	Sist.4101	South India Study Tour	0+0
<b>Total</b>			<b>13+7</b>
<b>Semester VIII</b>			
1.	Idtl.4201	Industrial Training	0+9
<b>Total</b>			<b>0+9</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+8= 23
6	VI	9	13+8= 21
7	VII	9	13+7= 20
8	VIII	1	0+9= 9
		<b>64</b>	<b>96+ 64= 160</b>

DEPARTMENTWISE DISTRIBUTION OF COURSES		Page No.	Credit
<b>Department of Food Engineering</b>			
Fden.1201	Engineering Properties of Biological Materials	10	2+1
Fden.1202	Heat and Mass Transfer	11	1+1
Fden.2103	Refrigeration and Cold Storage	13	1+1
Fden.2104	Crop Process Engineering	14	2+1
Fden.2205	Food Process Engineering	17	2+1
Fden.2206	Dairy Engineering and Technology	19	2+1
Fden.2207	Unit Operations in Food Engineering	22	2+1
Fden.3208	Energy for Food Industries	24	1+1
Fden.3209	Food Process Equipment Design and Plant Layout	25	2+1
Fden.3210	Computer Aided Drafting of Food Processing Equipments	27	1+1
<b>Total</b>		<b>16+10</b>	<b>(15.72%)</b>
<b>Department of Food Processing</b>			
Fdpr.2201	Post Harvest Engineering of Horticultural Crops	32	2+1
Fdpr.3102	Meat and Poultry Technology	34	2+0
Fdpr.3103	Oil Chemistry and Technology	35	2+1
Fdpr.3204	Post Harvest Engineering of Plantation Crops	37	2+1
Fdpr.4105	Food Packaging Technology	39	2+1
Fdpr.4106	Processing of Marine Products	41	2+0
Fdpr.4107	Storage and Preservation Technology	43	1+1
<b>Total</b>		<b>13+5</b>	<b>(11.32%)</b>
<b>Department of Food Science</b>			
Fdsc.1101	Food Science and Nutrition	48	2+1
Fdsc.2202	Baking and Confectionery Technology	49	1+1
Fdsc.3103	Entrepreneurship and agribusiness management	51	2+0
Fdsc.3104	Food Safety and Quality Management	52	1+1
Fdsc.3105	Fermentation Technology	55	1+1
Fdsc.3205	Food Industry Waste Management	54	2+0
Fdsc.4107	Food Industry Management	57	2+1
Fdsc.4108	Sanitation and Hygiene in Food Industries	59	2+0

<b>Total 13+5(11.32%)</b>			
<b>Department of Food Quality</b>			
Fdqu.1201	Fundamentals of Biochemistry	64	2+1
Fdqu.1202	General Microbiology	65	1+1
Fdqu.2103	Bio Chemical Engineering	67	1+1
Fdqu.2104	Biochemistry of Processing and Preservation	68	1+1
Fdqu.2105	Food Microbiology	70	1+1
<b>Total 6+5(6.92%)</b>			
<b>Department of Supportive Engineering</b>			
Cien.1101	Basic Civil Engineering	73	2+1
Cien.1102	Engineering Drawing	75	0+2
Meen.1101	Production Technology	76	2+1
Elen.1201	Basic Electrical Engineering	78	2+1
Meen.1202	Machine Drawing	80	0+1
Meen.1203	Engineering Thermodynamics	80	2+1
Cien.2103	Fluid Mechanics	82	2+1
Meen.2205	Boiler and steam Engineering	84	1+1
Cien.2204	Mechanics and Strength of Materials	86	2+1
Meen.2104	Kinematics of Machinery	88	2+1
Cien.3105	Design of Structures	90	1+1
Meen.3106	System Engineering	92	1+1
Meen.3107	Machine Design	94	2+1
Elen.3202	Instrumentation and Process Control	95	2+1
<b>Total 21+15(22.01%)</b>			
<b>Department of Basic Science</b>			
Basc.1101	Communicative English	99	2+0
Basc.1102	Engineering Mathematics - I	100	3+0
Basc.1103	Engineering Physics	102	2+1
Basc.1104	Engineering Chemistry	104	2+1
Basc.1205	Engineering Mathematics II	106	3+0
Basc.1206	Information Technology	108	1+1
Basc.2107	Computer Programming	109	1+1
Basc.2108	Engineering Mathematics III	111	2+1
Basc.2209	Numerical Methods for Engineering Applications	113	1+1
Basc.3110	Statistics	114	1+1
Basc.3111	Economics of Food Processing and Marketing	116	2+1
Basc.4112	Extension Methods and Transfer of Technology	118	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.4101	South India Study Tour	0+0
<b>Total</b>		<b>6+15(13.84%)</b>

Sl No.	Name of Department	No. of Courses	Credit Hours
1	Department of Food Engineering	10+1*	16+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+15
7	Department of Basic Science	12	21+9

\* Electives

#### List of Electives

Sl.No.	Course No	Name of the course	Page No.	Credit hours
1	Fden.0001	Emerging Non Thermal Methods of Food Preservation	28	3+0
2	Fdpr.0001	Beverage Processing	45	3+0
3.	Fdsc.0001	Food Biotechnology	60	3+0

**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	Engineering Properties of Biological Materials	2+1	10
2	Fden.1202	Heat and Mass Transfer	1+1	11
3	Fden.2103	Refrigeration and Cold Storage	1+1	13
4	Fden.2104	Crop Process Engineering	2+1	14
5	Fden.2205	Food Process Engineering	2+1	17
6	Fden.2206	Dairy Engineering and Technology	2+1	19
7	Fden.2207	Unit Operations in Food Engineering	2+1	22
8	Fden.3208	Energy for Food Industries	1+1	24
9	Fden.3209	Food Process Equipment Design and Layout	1+1	25
10	Fden.3210	Computer Aided Drafting of Food Processing Equipments	1+1	27
11	Fden.0001	Emerging Non Thermal Methods of Food Preservation	3+0	28

## **Fden.1201 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

### ***Lecture schedule***

1. Introduction, Different properties of food grains and importance
2. Physical characteristic- size, shape, volume- Definitions and its measurement
3. Definition of density and porosity and its measurements
4. Determination of specific gravity, surface area and its measurements
5. ASTM standard, terms – stress, strain and its relationships
6. Definitions, Hooks law, proportional limit, modulus of elasticity
7. Rheology - definitions and classifications
8. Physical states of material, classical ideal bodies- elastic, plastic, viscous bodies
9. Rheological models - definitions and models
10. Kelvin and Generalized Kelvin model, construction and equations
11. Maxwell and Generalized Kelvin model, construction and equations
12. Four element burger model , its construction and equations
13. Visco elasticity, creep and stress relaxation time
14. Newtonian and Non Newtonian liquids
15. Force - deformation, stress - strain, elastic - plastic behaviour.
16. Viscometry- definition and types of viscometers
17. Capillary and rotational viscometer, construction and equations
18. Mid semester examination
19. Contact stresses between bodies - Hertz problems
20. Textural properties- Definitions, firmness and hardness - mechanical damage - dead load and impact damage - vibration damage
21. Textural properties measurement and its classification- sensory and instrumental methods
22. Equipments used for textural properties measurement
23. Friction, definition, effect of load, sliding velocity, temperature, water film and surface roughness
24. Static, dynamic and co efficient of friction and its measurements
25. Friction in agricultural materials - rolling resistance - angle of internal friction
26. Angle of repose - static and dynamic, flow of bulk granular materials
27. Aero dynamics of agricultural products - drag coefficients - Terminal velocity.

28. Thermal properties - definitions specific heat, enthalpy and determination
29. Thermal conductivity, thermal diffusivity - methods of determination
30. Steady state and transient heat flow
31. Optical properties, definitions and measurements.
32. Electrical properties – Definitions dielectric loss factor, loss tangent, A.C. conductivity and dielectric constant
33. Methods to determine various electrical properties
34. 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 Bagelalay, 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.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, Equimolar diffusion. Convective mass transfer, Analogy between heat, mass and momentum transfer, Application of mass transfer phenomena in food processing.

### ***Lecture Schedule***

1. Introduction to the heat and mass transfer-different modes of heat transfer-conduction, convection and radiation.
2. Mechanism of thermal conduction solids, liquids and gases, Fourier's law-heat transfer at the interface of two solids.
3. Three dimensional Fourier conduction equation-derivations.
4. Steady state unidirectional heat flow through slabs, cylinders and spheres.
5. Heat flow through composite slabs, composite cylinders and composite spheres with consideration of heat transfer coefficient.
6. Insulators-introduction-purpose-critical thickness of insulation-low temperature insulation-economical thickness of insulation.
7. Convection-introduction boundary layer-type of convection-heat transfer coefficient.
8. Radiation- introduction-basic theories of radiant heat transfer-electromagnetic spectrum.
9. Transmission of radiation-black and grey bodies-emissivity-shape factor.
10. Heat exchangers-introduction-material selection-types-LMTD.
11. Analysis of regenerative heat exchanges-overall heat transfer coefficient-scaling of heat exchangers-NTU method to study the performance of heat exchangers.
12. Mid-semester examination.
13. Condensation heat transfer-introduction-film and drop-wise condensation.
14. Mass transfer-introduction –Fick's law of diffusion-steady state diffusion of gases and liquids through solids.
15. Diffusion mass transfer-equimolar diffusion-isothermal evaporation of water in to air-convective mass transfer.
16. Analogy between momentum, heat and mass transfer, dimensional analysis of convective mass transfer.
17. 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, equimolar 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, McGraw 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.

### ***Lecture Schedule***

1. Refrigeration-introduction-principles-COP-unit of refrigeration.
2. Application of second law of thermodynamic-heat engine-refrigerator-heat pump
3. Carnot cycle and reversed Carnot cycle.
4. Air refrigerator cycles and systems.
5. Refrigeration systems-mechanisms of vapour compression refrigeration system.
6. Vapour compression cycles and systems.
7. Dry and wet compression-effects-solving problems.
8. Study of compressors, condensers, expansion devices, evaporators.
9. Vapour absorption refrigeration systems-mechanism-types-COP-advantages of vapour absorption over vapour compression refrigeration system.
10. Domestic Electrolux refrigerator. Lithium bromide absorption refrigeration systems.
11. Refrigerants-introduction-classification-properties of an ideal refrigerant-secondary refrigerant.
12. Methods of refrigeration – centrifugal refrigeration systems, steam jet refrigeration systems, thermoelectric refrigeration systems,.
13. Method of refrigeration systems-vortex tube and solar refrigeration systems.
14. Low temperature refrigeration systems-cryogenics.
15. Cooling load estimation, Design of cold storage.

16. Psychrometry-introduction-psychometric terms-psychrometric chart.
17. Psychrometric process-by pass factor of heating and cooling coils-humidification and dehumidification

***Practical schedule***

1. Study of vapour compression and vapour absorption systems.
2. Study of a refrigerator and window air-conditioner
3. Study of Ice plants
4. Study of water coolers
5. Solving problems on refrigeration on vapor absorption system.
6. Experiments with the refrigeration tutor to study various components of refrigeration.
7. Determination of the coefficient of performance of the refrigeration tutor.
8. Experiments on the cooling efficiency of a domestic refrigerator.
9. Estimation of refrigeration load.
10. Estimation of cooling load for air conditioner.
11. Estimation of humidification and dehumidification load.
12. Design of complete cold storage system.
13. Visit to a cold storage unit and collection of working details.
14. 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.
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5. William, H.S., R.F. Julian, 1986. Air conditioning and Refrigeration. John Wiley & Sons, Inc. London.

**Fden.2104 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.

### ***Lecture schedule***

1. Post harvest losses in field crops – Importance and methods for minimizing post harvest losses-optimum stage of harvest
2. Moisture content – definition-wet and dry basis-methods of measurements - direct and indirect methods - moisture meters –Dual distillation methods-solving problems.
3. Equilibrium moisture content-Isotherms-determination of EMC-static and dynamic methods- Henderson’s equation-solving problems
4. Psychrometry - properties of air-water vapour mixture - solving problems.
5. Psychrometric chart - psychrometric processes related to crop processing - using psychrometric chart.
6. Processing operations – threshing –types of mechanical threshers-crop and machine factors affecting threshing.
7. Drying of grains- traditional methods of drying - merits and demerits- mechanical drying depending on modes of heat transfer.
- 8.Theory of grain drying - thin layer drying - constant and falling rate period of drying - effect of different factors on drying process - deep bed drying - solving problems.
9. Mechanical driers - batch type and continuous types - merits and demerits - construction details, hot air generating units, maintenance and safety
10. Cleaning and grading - principles - types – screens for sieving-types –selection
11. Effectiveness of separation of binary material-performance index-solving problems.
12. Types of separators-working principle of cyclone separator, air screen cleaner, spiral separator, disc separator, indented cylinder separator
13. Specific gravity separator, magnetic separator, colour sorter, inclined belt separator, magnetic separator.
14. Shelling and decortications - principles of operation - maize sheller and groundnut decorticator
15. Size reduction – principles of comminution – characteristics – particle size distribution – energy and power requirements – crushing efficiency.
- 16.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.
17. Rice processing – structure of paddy-constituents-parboiling of paddy-advantages and

- disadvantages-traditional methods-modern methods-CFTRI method-pressure parboiling.
18. Dehusking of paddy –traditional methods-Engleburg huller, under runner disc sheller, rubber roll sheller-working principle and construction details.
  19. Paddy separators-rice polishers – vertical and horizontal cone polishers-degree of polishing -constructional details and adjustments – products and byproducts from rice mills- layout of modern rice mills.
  20. Materials handling - functions and types - belt, bucket, screw and pneumatic conveyors.
  21. Belt conveyor and bucket elevator - construction, operation, maintenance and safety.
  22. Screw conveyor and pneumatic conveyor - construction, operation, maintenance and safety.
  23. Wheat - flour milling - cleaning - conditioning / hydrothermal treatment - grinding - different components of wheat mill.
  24. Modern flour milling - different unit operations and material flow through flow diagram.
  25. Corn - composition - corn dry milling - tempering and degerming - description of T.D. - system - Hydrothermal treatment - degerming - drying - hulling and grading.
  26. Midterm Examination
  27. Corn wet milling - cleaning - steeping - corn wet milling and refining process through flow diagram.
  28. Different food products obtained from corn wet milling - germ - fibre recovery - principle of starch - gluten separation.
  29. Importance of soyabean in India - processing of soyabean for different products through flow diagram- soy sauce – Tofu / Bean curd, break fast cereals.
  30. Processing of sorghum, ragi, barley– processed products
  - 31 Types of legumes and pulses – chemical composition, pretreatments of pulses – commercial methods of dehulling.
  32. 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/winnowers.
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. McCabe 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.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- Hysteresis 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.

#### ***Lecture schedule***

1. Introduction, Scope and importance of food processing-National and international perspective- sensory characteristics and nutritional properties of food.
- 2 Food properties- Texture of food materials- terms- sensory measurements
- 3Physical and functional properties of raw material- preparation for food processing-Energy conservation
4. Viscometry- basic concepts- types of viscometers- capillary and rotational viscometers, construction and comparison.
5. Rheology-basic rheological properties
6. Classical ideal bodies-maxwell model-kelvin model

7. Material and energy balance in food processing – Problems.
8. Processing methods -Heat processing - methods of applying heat to food –cooking and blanching
9. Thermal processing of food-microbial kinetics-time dependence of kinetics.
10. Thermo bacteriology, D value, Z value and thermal death time -Process calculation and selection of F value.
11. Sterilization - methods of sterilization- Equipments used - Bacteriological Filters.
12. Low temperature preservation- cooling-Freezing- Cooling and cold storage - changes during freezing and frozen storage-growth of the crystals- rate of freezing
13. Concentration – principles-Freeze concentration – crystallizers-separators
- 14 Ohmic heating- principle – application in food industry.
15. Canning-process-principle-application in food industry.
16. Fermentation- fermenters-types-application
17. Extrusion cooking- principle-single screw- double screw extruder-
18. Extruded food products- effect of extrusion cooking –packaging requirements.
19. Microwave heating - principles - absorption of microwave energy by foods – microwave oven-application in the food industry
20. Dielectric heating - principle - dielectric constant - loss factor-Dielectric properties of foods – application in food industry
21. Radiation preservation of foods - properties of ionizing radiation - effects of radiation on living organisms.
22. Application of radiation in food industries - irradiation sources - quality of irradiated foods
23. Dehydration,- methods of dehydration- preservation by dehydration.-Moisture content- free moisture - bound and unbound moisture - equilibrium moisture content.
24. Water activity - sorption behaviour of foods- Energy of binding of water - water activity and food stability.
- 25 Midterm Examination
26. Types of dryers – tray, tunnel, vacuum dryer-advantages and disadvantages.
27. Freeze drying - principles – applications-Heat and mass transfer in freeze-drying - heat of sublimation - methods - industrial freeze dryers
28. Osmotic dehydration- principle-foam mat drying of food materials.
29. Mixing of solids, pastes, and liquids- characteristics of mixtures- mixing-blending-emulsification.
30. Mixing equipment- liquid mixers- mixers for pastes- and high viscous masses criteria for mixer effectiveness- mixing index.
31. Agitation of liquids- equipments- impeller- propeller and flow patterns.
32. Food conservation operation -Size reduction- Fibrous foods, dry foods and liquid foods.
33. Material handling - types of handling and conveying system for food products
34. Design consideration of material handling equipments- capacity and power requirements

### ***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
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**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 washing-can washers-cleaning-in-place-centralised and decentralized 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.

### ***Lecture schedule***

1. Dairy development in India-collection and transportation of milk - milk collection centre - chilling centre - modes of transport
2. Milk – importance-composition –nutritive value-basic physical and chemical properties of milk-classification-recombined milk-special milk-toned and flavoured milk.
3. Principles, operation, installation and care of storage tanks - heat exchange equipments – coolers
4. Milk reception - clarification - separation - chilling - cans – tankers
5. Pasteurization principles, objectives and methods of pasteurization
6. LTLT/holding pasteurization – types – advantages and disadvantages.
7. HTST pasteurization – components and functions of HTST pasteurizer – milk flow diagram – regeneration of heat
8. UHT pasteurization – principles – methods – equipments
9. Sterilization-Inbottle sterilization-hydrostatic sterilizer-hydrolock sterilizer-hot air sterilizer
10. Heat exchangers- indirect heating systems using plate heat exchangers, Direct heating- Fouling of heat exchangers
11. Homogenization – definition – theory – effect of homogenization of milk
12. Types of homogenizers – stages of homogenization – importance
13. Homogenizer – components – valves – pumps – functions – efficiency of homogenization – operation and maintenance
14. Cream – definition – classification – principles of separation – gravity and centrifugal methods – Stoke’s law.
15. Clarification – clarifiers – types of separators – separation efficiency – factors affecting fat percentage in cream – fat loss in skim milk.
16. Construction of separator – components – Bactofuges.
17. Butter – classification – composition – method of manufacture
18. Churning of butter – definition – theories of churning – factors influencing churnability of cream.
19. Over run in Butter – continuous butter making – methods.
20. Packaging of butter – defects in butter – causes and prevention.
21. Cheese – definition – classification – composition – manufacture of cheddar cheese – process and equipments.
22. Curing of cheese – procedure – cottage cheese – method of manufacture.
23. Processed cheese – continuous cheese making – packing and storage.
24. Midterm Examination
25. Can washer - principles of can washers - stages in can washing.
26. Can washers – types – rotary and straight through – working principle.
27. Selection and maintenance of can washers.
28. Cleaning in place – definition – merits – types of CIP systems – procedure.
29. Liquid milk filling – types – gravitational and metering – equipments-Aseptic filling – types of aseptic filling systems – cartons – plastic pouches – plastic bottles
30. Dairy plant design and layout,

31. Drying – milk drying systems - Drum drying – classification of drum driers – components and working of drum drier.
32. Spray drying system – principles spray nozzles – components and working of spray drier
33. Ice cream – definition – classification – role of constituents – method of manufacture – Freezing of ice cream mix – change during freezing process – over run in ice cream.
34. Types of freezers – freezer components – hardening and storage – softy ice cream

### ***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, 1995Hall,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.
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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 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.

### *Lecture Schedule*

1. Basic concepts of unit operations- Units of measurements-dimensional analysis
2. Conservation of mass and energy. Material and energy balance in Food Engineering
3. Material and energy balance in Food Engineering
4. Evaporation-single effect and multiple effect evaporators.
5. Vapour recompression-boiling point elevation-evaporation of heat-sensitive materials-simple problems.
6. Evaporation equipments-open pans, short tube and long tube evaporators, forced circulation evaporators.
7. Mechanical separation Sedimentation-stokes law-Gravitational sedimentation-Floatation-sedimentation of particles in gas, settling under combined forces –simple problems
8. Centrifugal separation—centrifugation-problems
9. Filtration-filter media-constant rate filtration-constant pressure filtration-problems.
10. Filter resistance-filtration equipments-filter press.
11. Membrane separation process-reverse osmosis-principle-types of membranes
12. Membrane separation process-reverse osmosis-principle-types of membranes
13. Ultra filtration-principle-elecro dialysis-principle.
14. Size reduction-principles--size reduction in liquid foods-equipments.-Emulsification
15. Grinding and cutting-energy and power requirements in grinding-crushing efficiency.
16. Rittengers law,Bonds law and Kicks law of crushing. Problems on crushing.
17. Various grinding equipments –hammer mill,attrition mill,roll mill and ball mill -cryogenic grinding of spices.
18. Theory of mixing-equipments-liquid mixers-mixers for pastes and high viscous masses-rate of mixing.
19. Power requirement-effectiveness- mixing index.

20. Contact equilibrium - separation processes – concentrations- gas-liquid equilibria, solid-liquid equilibria
21. Equilibrium concentration relationships - operating conditions - equilibrium processes - gas absorption - rate of absorption
22. Stage equilibrium - absorption equipment –simple problems.
23. Leaching and Extraction-principles- rate of extraction - super critical fluid extraction.
24. Crystallization-equilibrium-rate of crystal growth-stage equilibrium crystallization-equipment.
25. Classification-agitated batch crystallizer- Evaporative crystallizers-problems
26. Mid Term Examination
27. Distillation – flash and differential distillation -Steam, vacuum and batch distillation - distillation equipments.
28. Irradiation-direct and indirect effect on foods-dose.-
29. Applications –preservations-regulations..
30. Extrusion cooking-principles-single screw and twin screw extruders.
31. Factors affecting extrusion-extruded food products-properties-packaging requirements.
32. 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.
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4. McCabe, W.L. and J.C.Smith.1976. Unit Operations of Chemical Engineering. McGraw-Hill. Inc. Kosaido Printing Ltd. Tokyo, Japan.
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## **Fden.3208 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.

### ***Lecture Schedule***

1. Energy basic concepts - energy sources - renewable and non-renewable - energy scenario of the world and India.
2. Energy auditing - Management of energy sources - efficiency and utilisation
3. Solar radiation - Characteristics of sun - solar energy availability - electromagnetic spectrum - solar constant - determination of solar time.
4. Solar collectors - thermal losses and efficiency of flat plate collectors - air collector and liquid collectors.
5. Evaluation of overall loss co-efficient - focusing type collectors - performance of solar collectors.
6. Forced and natural convection dryers - drying of agricultural products - performance of solar papain dryer.
7. Solar dryer for food and fruit products.
8. Principle of photo voltaic - semi conductor - cell characteristics - power output and conversion efficiency.
9. Mid semester examination
10. Application of PV system - submersible pumps - solar PV sprayer - advantages and disadvantages of PV system.
11. Solar distillation - principle of operation - industrial applications.
12. Wind energy - estimation of power from the wind.
13. Windmill - types and performance.
14. Fuel efficiency and performance of traditional and innovative furnaces.
15. Biomass gasification and application in food industries.
16. Heat energy recovery and waste heat utilization.
17. Energy recovery from vegetable and municipal solid wastes.

### ***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 (2+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 - 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- drying plant layout-drying process, drier types, selection of driers. Bake oven and frying plant-types, concepts and layout. Organization and trends in plant layout – sample layout, installation procedure for food processing plant.

***Lecture Schedule***

1. Introduction and scope of food process equipment designs
2. Application of Engineering Principles to design and selection of food processing equipments
3. Construction and design of pressure vessels - storage tanks
4. Construction and design of sterilizers, processing vats
5. Homogenizers, types, construction and design.
6. Cooling , definition and Design of coolers, heat exchangers
7. Design of flavour treating equipments
8. Evaporating definition and Design of evaporators and evaporating systems
9. Design of spray dryer and roller dryers
10. Freezing, definition and design of freezers
11. Design of equipments for pulping, crushing.
12. Juice extraction, definition and design of juice extractors
13. Extrusion, definition and single and twin screw extruders

14. Equipments for packing of food- sealing machines
15. Considerations for optimization of design of various equipments
16. Steps to scale up food processing equipments
17. Mid semester examination
18. Plant location, location theory and models
19. Different criteria for plant site selection
20. Plant layout objectives-classical and practical layout
21. Types of plant layout –process, product and layout
22. Fixed position and combination layout
23. Development and presentation of the layout
24. Preparation of machinery layout for fruit Processing Industry
25. Preparation of machinery layout for Vegetable Processing Industry
26. Different Size reduction machinery layout, size reducing mills
27. Types of machinery used for separation of products by size.
28. Types of machinery used for separation of products by shape and colour
29. Evaporation plant layout
30. Drying plant layout and different drying process.
31. Different types of driers and selection of driers for processing.
32. Bake oven and frying plant-types, concepts and layout
33. Organization and trends in plant layout – sample layout
34. 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

***Lecture Schedule***

1. Introduction to CAD and drafting - details of hardware and software, input and output devices.
2. Drawing editor-setting up the drawing- scale, units, and limits.
3. Draw commands-line, pline, circle, arc and ellipse.
4. Creation of layers, change colours and line types.
5. Snap, grid and pick commands
6. Edit and modify commands-fill, erase and move.
7. Edit commands- copy, rotate, mirror and fillet.
8. Edit commands-chamfer, extend, stretch and trim.
9. Mid Semester Examination
10. Edit commands-measure, divide and block
11. Edit commands-insert and polylines
12. Display commands-zoom, select and pan
13. Text and dimensions
14. Assembly or positioning the drawings-3D drawings-transforming 2D to 3D.
15. Design and drawing of components of food processing equipments-shaft and hopper.
16. Design and drawing of components of food processing equipments-bins and pulleys.
17. Preparation of production drawings and drawing outputs.

***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. Berghauser 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 Genevieve, 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.

## **ELECTIVE**

### **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 Technology- Enzyme Technology

### ***Lecture Schedule***

1. Introduction, scope of non thermal food preservation methods

2. Radiation- sources and types of radiation in food industries
3. Dosimetry - mode of action of ionizing radiation
4. Radiation effect on food constituents - direct and indirect effect
5. Radiation dose requirement for different products
6. Regulations involved in the application of radiation
7. Controlled atmosphere storage- Introduction and definition
8. Components of Controlled atmosphere storage and its equipments
9. Absorbents used in Controlled atmosphere storage and gas composition for different fruits and vegetables.
10. Respiration rate and Effect of CAS on respiration rate
11. Modified atmosphere storage, definition and importance
12. Gas composition in MAS and packaging requirements.
13. Diffusion channel technique – introduction and importance
14. Design consideration for Diffusion channel technique and its advantage
15. Controlled atmosphere packaging, definition and applications
16. Modified atmosphere packaging, Definition and its application in fruits, vegetable and meat
17. Vacuum packaging, introduction and advantages.
18. Need of modifying atmospheric gas composition
19. Types of scrubbers used in Controlled atmosphere storage
20. Minimal processing – Introduction and importance
21. Minimal processing of vegetables and its packaging recruitments
22. Minimal processing of fruits and its packaging recruitments
23. Hurdle technology – introduction and importance
24. Different types of hurdles occur in food spoilage
25. Different types of hazards, physical, chemical and biological hazards.
26. Various parameters which inhibits the growth of microorganism
27. Mid semester examination
28. Ozone – introduction and its role in food industry
29. generation of Ozone and its application
30. Different levels of ozone in fruit juice preservation
31. Intermediate moisture foods, definition and importance
32. Formulation and preparation of different intermediate moisture foods.
33. Membrane technology- introduction and terminologies
34. Different types of membrane and its significance
35. Different types of membrane modules and its importance
36. Osmosis- definition and application in food industries
37. Reverse osmosis- definition and application in food industries
38. Ultra filtration - definition and application in food industries
39. Changes in food during difference in concentration
40. Pulsed electrified sterilization – definition and significance
41. Application of Pulsed electrified sterilization in food industries
42. High pressure technology - importance and significance
43. Effect of High pressure technology and its application
44. Oscillating magnetic field sterilization- importance and significance
45. Effect of Oscillating magnetic field sterilization and its application
46. Ultra sound- importance and significance
47. Effect of Ultra sound and its application in food industries

48. Nano Technology - importance and significance
49. Effect of Nano Technology and its application in food industries
50. Enzyme Technology- importance and significance
51. Effect of Enzyme Technology and its application in food industries

***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.

**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	32
2	Fdpr.3102	Meat and Poultry Technology	2+0	34
3	Fdpr.3103	Oil Chemistry and Technology	2+1	35
4	Fdpr.3204	Post Harvest Engineering of Plantation Crops	2+1	37
5	Fdpr.4105	Food Packaging Technology	2+1	39
6	Fdpr.4106	Processing of Marine Products	2+0	41
7	Fdpr.4107	Storage and Preservation Technology	1+1	43
8	Fdpr.0001	Beverage Processing	3+0	45

## **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 during. 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.

### ***Lecture schedule***

1. Horticultural crops-introduction-classification-importance-status of production and export value.
2. Constituents and their importance in Indian directory
3. Post harvest losses in fruits and vegetables – direct and indirect losses-factors influencing losses- Enzymatic and textural changes during ripening.
4. Engineering properties of horticultural crops–physical, chemical and aerodynamic-Chemical composition and nutritional aspects – structural features
5. Harvesting maturity- criteria for physiological maturity- maturity indices and measurement
6. Post harvest physiology and ripening– changes during ripening – Post harvest changes in biochemical constituents of fruits and vegetables – loss of nutritive value
7. Environmental factor affecting Post Harvest deterioration- Environmental factor – stress –
8. high and low temperature stress, Gas stress, Water stress.
9. Mechanical injury – effect on fruits and vegetables. Plant hormone – role – importance.
10. Respiration – effects – methods to measure respiration, Transpiration
11. Pretreatments-cleaning-washing-grading-equipments-construction and operation.
12. Precooling-forced air-vacuum room cooling –ice cooling-packing station and its importance.
13. Handling and storage-refrigerated storage-evaporative cooled storage

14. Modified and Controlled atmosphere storage
15. Hypobaric and vacuum storage- recommended storage conditions of fruits, vegetables and flowers.
16. Principles of processing and preservation: blanching- types-canning-bottling-surface coatings-chemical dips.
17. Principles of processing and preservation-freezing-Refrigeration- Cold storage – cooling load calculation.
18. Drying and dehydration– importance – water activity-pretreatments before drying – drying curve – shrinkage, case hardening.
19. Thermo plasticity – chemical changes during drying.-osmotic dehydration-osmo vac dehydration and osmo air drying of fruits.
20. Types of dryer – tray, drum, pneumatic, spray, fluidized bed dryer,
21. Types of dryers-freeze dryer and foam mat during.Principles of processing-irradiation
22. Preparation of juice, jam, jelly & pickle –problems in their production
23. Minimal processing-fruits and vegetables-methods and principles
24. Processing of important fruits and vegetables-banana, mango.
25. Processing of important fruits and vegetables- pineapple, tomato and mushrooms-their by products
26. Packaging of horticultural products-materials-basic requirements of packaging materials.
27. Functions of packaging materials-types
28. Midterm Examination
29. Preservation of cut flowers-packaging materials and methods
30. Process flow charts for processing plants-basic principles-Design.
31. Control and maintenance of storage structures- Ethylene evolution during storage – methods to prevent ethylene production.
32. Physiological loss of weight – methods of storage – pests, insects, rodents, fungi – their nature, occurrence and control.
33. Modern techniques of infestation control.
34. Application of quality control techniques.-quality assurance for fruits ,vegetables and their products

### ***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

### ***Lecture schedule***

1. Introduction to meat processing-structure and composition. Grading and inspection-principle and equipment for grading.
2. Slaughtering- Pre-slaughter care-methods- Stunning of animals, methods of stunning.- Slaughtering, Bleeding & skinning of animals
3. Ageing of meat-mechanism-methods-softening-Artificial Tenderizing-Mechanical means
4. Suspension of Carcass- evisceration, splitting, washing & dressing of carcasses - Different types of cuts-curing of meat-fundamentals of curing-methods of curing
5. Processing steps-grinding-mixing-chopping-emulsifying-stuffing-linking and tying

6. Processing steps-grinding-mixing-chopping-emulsifying-stuffing-linking and tying
7. Preservation techniques--smoking and cooking-principles and equipments
8. Preservation techniques chilling-freezing—canning-
9. Packaging-materials and methods
10. Eating quality and sensory evaluation of meat and meat products.
11. Products and by-product utilization from meat
12. Poultry processing-transport and receiving-slaughtering-bleeding-scalding-disfeaturing-singeing –washing-pinning-transfer to evisceration room –neck slitting and removal of feet-removal of lungs and examination
13. Midterm examination
14. Preservation of poultry meat-chilling-freezing-curing-smoking-canning-irradiation-microwave heating.
15. Poultry products-and by products utilization
16. Structure, composition and nutritive value of eggs-microbial spoilage of eggs.
17. Egg - collection, grading, cleaning, packaging and transport
18. Preservation and maintenance of eggs-cleaning-oil treatment-cold storage-thermo stabilization-immersion in liquids

***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 oleoresins 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.

### ***Lecture Schedule***

1. Lipids, Oils and Fats-Occurrence and distribution in nature
2. Physical and chemical properties of fat and oil
3. Free fatty acids –physical and chemical reactions –hydrolysis, hydrogenation, Oxidation,
4. Free fatty acids –physical and chemical reactions-  
Polymerization, esterification, halogenation, isomerization
5. Enzymatic and chemical spoilage –rancidification and their control
6. Milling of oil seeds and other oil bearing materials
7. Milling of oil seeds and other oil bearing materials
8. Concept of oil extraction-ghanies
9. Concept of oil extraction-ghanies
10. Industrial production of oil
11. Production of oil-rendering-
12. pressing-cold pressing and hot pressing
13. Solvent extraction methods
14. Milling and extraction –removal and recovery of solvent from miscelle
15. Leaching system of leaching-
16. Leaching single stage multistage co current and multistage counter current
17. Leaching equipment-stationary bed and moving bed type.
18. Liquid extraction-extraction equipments
19. Mixer settler, spray and packed extraction towers,
20. Pulse column and centrifugal extractors
21. Super critical fluid extraction
22. Super critical fluid extraction
23. Extraction of oleoresins and essential oils from spices and aromatic plants.
24. Extraction of oleoresins and essential oils from spices and aromatic plants.
25. Mid term examination
26. Refining-filtration, winterization, deodorization and packaging
27. Refining-filtration, winterization, deodorization and packaging
28. Hydrogenation of unsaturated fats and oils-chemistry process conditions and techniques
29. Butter substitutes, solid oil,
30. Shortenings and oils of special use-inter esterification
31. Nutritional aspects of oils and fats
32. Metabolism of fats
33. Analytical methods of oils and fats-specification and standards
34. Analytical methods of oils and fats-specification and standards

### ***Practical Schedule***

1. Extraction of oil using a Soxhlet apparatus.

2. Determination of saponification value.
3. Determination of iodine 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, asgard 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

### ***Lecture schedule***

1. Plantation crops-classification-production & processing-Status and Exports
2. Processing of Tea-unit operation-flow chart, process and equipments
3. Process and equipments-various changes during processing and by product utilization
4. Processing of coffee-Dry and wet processing-Green and cherry Coffee
5. Unit operation-flow charts-equipments and operation
6. Instant coffee powder-flow chart-byproduct utilization of coffee industry
7. Processing of Cocoa-Important unit operation
8. Flow charts in cocoa processing-Equipments-Chocolate processing-flow charts

9. Processing of coconut-Dehusking-equipments drying
10. Different dryers-oil extraction-equipments and –methods
11. Wet processing of coconut-value added products-coconut based beverages process and equipments
12. Processing of coconut husk made products, shell made products & wood made products
13. Processing of arecanut-different products-unit operation-flow chart equipment and operation
14. Processing of rubber-different products
15. Flow chart-related equipments-different grades of rubber
16. Processing of oil palm-unit operations-flow chart
17. Refining of palm oil-equipments and operation
18. Processing of cashew nut-unit operations-flow chart
19. Equipments and operation-quality standards
20. Cashew apple processing-various products-flow chart
21. By products of cashew nut industry-shall, CNSL and peels
22. Unit operations in spice processing-cleaning, drying, milling, and grading
23. Cryogenic grinding and freezing
24. Mid term examination
25. Processing of pepper-value added products-flow chart-packaging methods
26. Processing of cardamom-stages of harvest-cleaning, drying, grading equipments
27. Processing of clove-stages of harvest-cleaning, drying, grading equipments
28. Processing of turmeric-boiling and polishing-drying methods-equipments and operation
29. Processing of ginger-flow chart-various products. Processing of chilies-drying-dryers, value added products
30. Processing of medicinal plants
31. Processing of aromatic plants
32. Extraction of oleoresins and essential oils from medicinal plants and spices-steam distillation and solvent extraction of oleoresins and essential oils
33. Packaging of processed products-materials-methods-packaging equipment-types-construction and operation

### ***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 PACKAGING 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.

### ***Lecture schedule***

1. Introduction to packaging-Factors affecting shelf life of food material during storage
2. Introduction to packaging-Factors affecting shelf life of food material during storage
3. Spoilage mechanism during storage; definition, requirement
4. Spoilage mechanism during storage; definition, requirement
5. Importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system
6. Importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system
7. Importance and scope of packaging of foods; types and classification of packaging system; advantage of modern packaging system
8. Different type of packaging material used. Different forms of packaging, metal container, glass container, plastic container, paper boards
9. Different type of packaging material used. Different forms of packaging, metal container, glass container, plastic container, paper boards
10. Different type of packaging material used. Different forms of packaging, metal container, glass container, plastic container, paper boards
11. Flexible films, shrink packaging, vacuum & Gas packaging
12. Flexible films, shrink packaging, vacuum & Gas packaging
13. Flexible films, shrink packaging, vacuum & Gas packaging
14. Aseptic packaging-principle and equipment-advantages
15. Packaging requirement & their selection for the raw & processed foods

16. Packaging requirement & their selection for the raw & processed foods
17. Lamination and sealing techniques-principles and equipments
18. Lamination and sealing techniques-principles and equipments
19. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities
20. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities
21. Advantages & disadvantages of these packaging materials; effect of these materials on packed commodities
22. Package testing-various ISI tests used for packaging materials
23. Package testing-various ISI tests used for packaging materials
24. Printing-equipment used, labeling-principle-method-and lamination
25. Mid term examination
26. Printing-equipment used, labeling-principle-method-and lamination
27. Economics of packaging
28. Performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements
29. Performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements
30. Performance evaluation of different methods of packaging food products; their merits and demerits; scope for improvements
31. Disposal and recycle of packaging waste
32. 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 produce
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. Saccon & 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.

#### ***Lecture Schedule***

1. Introduction to fish processing-importance-composition
2. Chilling of fish-methods and equipment for chilling, icing-quality of ice, ice-making
3. Refrigeration-principle-Refrigerated or chilled sea water, chilling rate
4. Refrigeration-principle-Refrigerated or chilled sea water, chilling rate
5. Spoilage of fish during chilled storage; use of chemicals and radiations to extend storage life
6. Spoilage of fish during chilled storage; use of chemicals and radiations to extend storage life
7. Spoilage of fish during chilled storage; use of chemicals and radiations to extend storage life
8. Freezing of fish-principle-fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate and freezing time; methods of freezing
9. Freezing of fish-principle-fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate and freezing time; methods of freezing
10. Freezing of fish-principle-fundamental aspects; heat units; freezing point depression, eutectic point; freezing rate and freezing time; methods of freezing
11. Preparation of commercially important fish and shell fish for freezing, freezing and frozen storage of fish, shell fish and other food products
12. Preparation of commercially important fish and shell fish for freezing, freezing and frozen storage of fish, shell fish and other food products
13. Preparation of commercially important fish and shell fish for freezing, freezing and frozen storage of fish, shell fish and other food products
14. Canning-thermal processing-principle and unit operations in canning
15. Canning-thermal processing-principle and unit operations in canning

16. Heat resistance of micro organisms-survivor curve-TDT curve. Report pouch packing-principles and techniques
17. Heat resistance of micro organisms-survivor curve-TDT curve. Report pouch packing-principles and techniques
18. Heat resistance of micro organisms-survivor curve-TDT curve. Report pouch packing-principles and techniques
19. HTST process and aseptic packing-principles and techniques
20. HTST process and aseptic packing-principles and techniques
21. Fish products and byproducts-introduction to various products and byproducts from fish
22. Fish products and byproducts-introduction to various products and byproducts from fish
23. Preservation by drying-principle significant of water activity method, equipments, solar dryers, mechanical dryers
24. Preservation by drying-principle significant of water activity method, equipments, solar dryers, mechanical dryers
25. Mid term examination
26. Preservation by drying-principle significant of water activity method, equipments, solar dryers, mechanical dryers
27. Processing steps equipment used for drying
28. Salting-principle-wet and dry salting methods-quality of salt-spoilage changes and control measures
29. Salting-principle-wet and dry salting methods-quality of salt-spoilage changes and control measures
30. Salting-principle-wet and dry salting methods-quality of salt-spoilage changes and control measures
31. Smoking-principles and various methods of smoking-equipments-changes during smoking-quality of smoked fish
32. Smoking-principles and various methods of smoking-equipments-changes during smoking-quality of smoked fish
33. Equipments for pickling/ marinating-principle of preservation-various methods of picking
34. Equipments for pickling/ marinating-principle of preservation-various methods of picking
35. Various processed products from fish and their preparation
36. Various processed products from fish and their preparation
37. Various processed products from fish and their preparation
38. Fermentation-principle, various fermented fish products-fish sauces, fish pastes etc.
39. Fermentation-principle, various fermented fish products-fish sauces, fish pastes etc.
40. Fermentation-principle, various fermented fish products-fish sauces, fish pastes etc.
41. Fish oil and Liver oil-extraction methods
42. Fish oil and Liver oil-extraction methods
43. Miscellaneous products such as fish leather, shark fin rays, gelatin, fish glue etc.
44. Miscellaneous products such as fish leather, shark fin rays, gelatin, fish glue etc.
45. Miscellaneous products such as fish leather, shark fin rays, gelatin, fish glue etc.
46. Feasibility report making of fish processing industry
47. Feasibility report making of fish processing industry
48. Visit to fish processing industry
49. Layout, operation flow chart and flow process chart for the processing industry
50. Layout, operation flow chart and flow process chart for the processing industry

### ***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.

### ***Lecture Schedule***

1. Introduction - storage and preservation - importance, requirements and methods for food grains and foods - causes of spoilage in perishables and durables - physiological and environment factors - remedies
2. Storage of food grains - traditional and improved methods- factors affecting storage - climatic, rodents and crop parameters - types of storage - bag and bulk storage - bag storage - requirement
3. Bag storage – open field storage - dunnage - fumigation in bag storage, rat proof godown.
4. Design requirements of godowns - construction – dunnage – aeration – lighting and fumigation.
5. Bulk storage - storage structures - types - Hapur bin, plywood bin, plastic silo construction and maintenance – material selection.
6. Large bins – design requirements – construction.
7. Grain handling – safety – fumigation – grain dust – accumulation – characteristics – explosion and prevention.
8. Modified atmosphere storage of grains – concept - requirements – advantages - structure requirement, construction and operation - selection of gases - mixing and controlling.
9. Storage of fruits and vegetables - importance and requirement - principles - techniques of storage - storage under ambient conditions - losses - storage requirements
10. Evaporative cooling - principles and concept – requirement - types - construction and operation.

11. Low temperature storage - refrigeration - principles - storage cabinet - storage losses
12. Mid semester examination
13. Irradiation method of storage - equipment - operation and effect on storage.
14. Controlled atmosphere storage of fruits and vegetables - concept and principles – requirement - gases used - effect of gases - mixing of gases - requirements
15. Controlled atmosphere storage - packaging requirement for packaging of fruits and vegetables - toxicity of gases and spoilage of fruits and vegetables on storage
16. Storage and preservation of processed fruits and vegetables – requirements – methods of storage for pulp and other liquid type – processed items.
17. Storage and preservation of dehydrated products of 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. Derosier. 1987. The Technology of Food Preservation. CBS, Publishers & Distributors, New Delhi.
4. Multon, J.L., Reimbert A.M., Marsh D., and Eydt 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.

**Elective**  
**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.

***Lecture schedule***

1. Beverage-definition and current status in the world and india.
2. Significance of beverage and health aspects
3. Classification of beverage.-Nutritive value
4. Ingredients- its role -water, carbon dioxide, sugar, flavors, colour, sweeteners,
5. Ingredients emulsifiers and stabilizers,
6. Beverage fermentation –methods-role of malt, yeast ,hops, cereal adjuncts.
7. Beer manufacturing –Malting – wort -its changes.
8. Brewing.-different processes-fermentation systems.
9. Fermentation storage -Finishing and packaging.
10. Wine- classification –red and white – ingredients- fermentation
11. Packaging of wine - Containers and closures - storage.
12. Carbonation-use-methods -Procedures of carbonation equipments.
13. Carbonation equipments and machineries.
14. Stimulating beverages-Coffee-varieties- nutrition-harvesting methods
15. Processing of Coffee – changes -bean preparation.
16. Brewing of coffee-Decaffeination.
17. Instant coffee.-process-flow chart.
18. Tea –plucking methods- types.
19. Tea processing.
20. Tea types- black, green and Oolong-processing methods
21. Midterm examination
22. Cocco –varieties –processing –equipments
23. Chocolate processing-flow chart
24. Fruit juices based beverages preparation.
25. Fruit juices based beverages –squash.
26. Fruit juices based beverages – RTS.
27. Isotonic Beverages-purpose –effects –types –isotonic, hypertonic and hypotonic
28. Preparation methods –nutritional value
29. Packaging methods of isotonic beverages-storage and keeping quality.
30. Packing and filling methods of beverages- .
31. Inspection and quality controls.
32. Sanitation and hygiene in beverage industry.
33. Quality of water used in beverages.

34. 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

**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	48
2	Fdsc.2202	Baking and Confectionery Technology	1+1	49
3	Fdsc.3103	Entrepreneurship and agribusiness management	2+0	51
4	Fdsc.3104	Food Safety and Quality Management	1+1	52
5	Fdsc.3205	Food Industry Waste Management	2+0	54
6	Fdsc.3105	Fermentation Technology	1+1	55
7	Fdsc.4107	Food Industry Management	2+1	57
8	Fdsc.4108	Sanitation and Hygiene in Food Industries	2+0	59
9	Fdsc.0001	Food Biotechnology	3+0	60

## **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.

### ***Lecture Schedule***

1. Food- functions and groups.
2. Food science- objectives and applications.
3. Methods of cooking.
4. Nutrient losses during cooking.
5. Cooking qualities of cereals.
6. Cooking qualities of pulses.
7. Cooking qualities of vegetables.
8. Classification and physical properties of colloids- emulsion and foams.
9. Classification and physical properties of colloids- sol and gel.
10. Fermentation.
11. Denaturation.
12. Parboiling of rice.
13. Gelatinization and crystallization.
14. Enzymatic and non- enzymatic browning.
15. Classification and Dietary requirements of minerals.
16. Classification and role of food colours.
17. Classification and role of flavours.
18. Mid-semester examination.
19. Classification of food additives.
20. Purpose and role of thickeners, sweeteners.
21. Purpose and role of stabilizers, emulsifiers.
22. Purpose and role of leaveners, colours, flavouring agents.
23. Purpose and role of preservatives.
24. Concepts of mal nutrition and under nutrition.
25. Concepts of mal nutrition and under nutrition.
26. Nutrition- definition.
27. Concepts of mal nutrition and under nutrition.
28. Balanced diets- recommended dietary allowances (RDA) for various age groups.
29. Energy value of foods.
30. Energy requirements of the body estimation.
31. Water balance, nutritional deficiency disorders.

32. Food laws and standards.
33. Food packaging.
34. 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.

### ***Lecture Schedule***

1. Introduction-Status of bakery and confectionary industries in India –
2. Raw materials for bakery products – flour, sugar, shortening agent, yeast, salt.
3. FPA specification of raw materials.
4. Wheat – varieties – qualities for baking – quality grading system for wheat –
5. Wheat milling, refined wheat flour, aging.
6. Technology of baking
7. Dough rheology
8. Preparation of breads, biscuits, crackers,
9. Cakes, buns, pizza
10. Mid-semester examination
11. Extruded products- pasta food likes macaroni, noodles and spaghetti.
12. Types of confectionery goods - processing of raw materials –
13. Machinery required for manufacture of toffees, chocolates, fruit drops, candies, marshmallows,
14. Bars, chewing gums and special confectionery goods –
15. Colour, flavor and texture in confectionery.
16. Quality control and sanitation-Quality control of baking items –
17. 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.
1. 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.
2. Lee, R. and E.B. Jackson. 1973. Sugar Confectionery and Chocolate manufacture, Leonard Hill Books, International Text book Company Ltd., Britain.

3. Manfie, "Chocolate, Cocoa and Confectionery Science & Technology (3<sup>rd</sup> edition) Advance Books, Jaipur.
4. Matz, "Bakery Technology and Engineering", Elsevier, Tokyo.
5. 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 agribusiness. Commodity trading and forecasting for agribusiness. Retail and supply chain management, Management of cooperation.

#### ***Lecture Schedule***

1. Introduction and scope of entrepreneurship and agribusiness management in India
2. Basic management concepts and its significance
3. Personal and production material management concepts and importance
4. Scope and concepts of financial management- importance
5. Marketing managements concept and importance
6. Problem solving management techniques and innovation decision management
7. Different industrial laws and significance
8. Different business laws and its significance in food industries
9. Different steps involved in Entrepreneurial motivation.
10. Environmental analysis techniques and various progress involved
11. Different steps involved in project selection
12. Considerations required in Project appraisal
13. Different analogies involved in Modification/finalization of projects
14. Points to consider for Collaboration of research and management
15. Preparation steps for launching of innovation and machinery
16. Concepts of trial run and test marketing- importance.
17. Mid semester examination
18. Mini Project Report Writing- importance and steps
19. Preparation of Mini Project Report with respect to food industries
20. Management of agribusiness project and enterprise, concepts and significance
21. WTO – importance and regulations for food industries
22. Management of agribusiness trade in WTO environment
23. Agriculture and food policy according to WTO
24. Rural environment and institution regulations as per WTO
25. Scope of Marketing of Agricultural input in India

26. Importance of marketing of Agricultural product and its regulations
27. Significance of Market research for agribusiness
28. Commodity trading and its importance
29. Different techniques for forecasting for agribusiness
30. Retail and supply chain management - introduction and scope in India
31. Problems in Retail and supply chain management and remedies
32. Different steps involved in management of cooperation
33. Layout of management practices in fruit juice industries
34. Layout of management practices in dairy industries

***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.

***Lecture schedule***

1. Introduction to food safety and food quality-importance
2. Introduction to food safety and food quality-importance
3. Quality attributes of food in the production chain
4. Factors affecting quality
5. Quality management activities with respect to safe food chain
6. Quality management activities with respect to safe food chain
7. Food safety-Biological hazards, chemical hazards, physical hazards and miscellaneous hazards in food
8. Food safety-Biological hazards, chemical hazards, physical hazards and miscellaneous hazards in food
9. Food safety-Biological hazards, chemical hazards, physical hazards and miscellaneous hazards in food
10. Types and means of Biological, Physical and chemical contamination
11. Types and means of Biological, Physical and chemical contamination
12. Types and means of Biological, Physical and chemical contamination

13. Concept of quality assurance systems and food safety
14. Concept of quality assurance systems and food safety
15. Principles of quality assurance, TQM, SOP, SSOP.GMP
16. Principles of quality assurance, TQM, SOP, SSOP.GMP
17. Principles of quality assurance, TQM, SOP, SSOP.GMP
18. Principles of ISO, Codex Alimentarius
19. Principles of ISO, Codex Alimentarius
20. HACCP-principles-application of HACCP in food industries
21. Risk management process and food safety, risk assessment, risk communication and principles of enterprise risk management
22. Risk management process and food safety, risk assessment, risk communication and principles of enterprise risk management
23. Risk management process and food safety, risk assessment, risk communication and principles of enterprise risk management
24. Mid term examination
25. Traceability in food supply chains, relationship between quality systems and traceability in food chains
26. Traceability in food supply chains, relationship between quality systems and traceability in food chains
27. Traceability in food supply chains, relationship between quality systems and traceability in food chains
28. Traceability systems
29. Consumer preparation of food safety
30. Ethics in food safety
31. Organic food production-quality and safety aspects-factors

### ***Practical Schedule***

- 1 Design and implementation of HACCP system for fruit processing plants.
2. Design and implementation of HACCP system for milk processing plants
3. Design and implementation of HACCP system for meat processing plants
- 4 Design and implementation of HACCP system for fish processing plants.
5. Design and implementation of HACCP 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.

#### ***Lecture Schedule***

1. Introduction and definition for wastes with respect to food.
2. Different sources of wastes from food industries and their availability in India
3. Nature of different waste and its effect on environment
4. Different Wastes from rice mill and its utilisation
5. Thermal and biotechnological uses of rice husk
6. Pyrolysis- Definition and steps involved in pyrolysis of rice husk
7. Gasification- Definition and steps involved in Gasification of rice husk
8. Use of rice husk in Cement preparation and different thermal applications
9. Stabilization- definition and its utilisation of rice bran
10. Defatted bran- definition and its utilization
11. Processes for Waste utilization from fruit and vegetable industries
12. Distillation- definition and steps involved in production of alcohol from waste
13. Oil extraction- definition and steps involved in extraction of oil from waste
14. Waste management in sugar mills
15. Different process involved in citric acid production from fruit waste
16. Waste from tuber crops and its utilization in food industries
17. Mid Term examination
18. Effluent safe disposal - bio gas production and anaerobic treatments
19. Layout of waste recycling plant and steps involved
20. Feasibility report for food industries using food waste and by products

21. Fish industry by products and waste utilisation
22. Meat industries waste and recycling
23. Poultry industries waste and its utilization
24. By products of wheat milling and significance of its effects
25. germs and bran utilization in food industries
26. Pulse milling and its significance
27. By products of pulse milling and its importance
28. Husk, germs and broken utilization in food industries
29. Steps involved in Coconut processing
30. Coconut processing waste and its utilization
31. Briquetting technique- definition and importance
32. Methods involved in making waste to briquette
33. Calorific value of briquettes by different wastes
34. Layout of waste disposal from fruit processing industries

***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.3105 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 fermentation Sterilization – Principles, sterilization of fermentation media, fermenter– in-batch & continuous process – development of inoculum for industrial fermentation – criteria for transfer of inoculums – aseptic inoculation. Basic functions of fermentor – Design of fermentor – types of fermentor – different 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.

***Lecture Schedule***

1. Introduction to fermentation process – Development of fermentation industry-benefit of fermentation – nutritive value of fermented foods-components and range of fermentation process.

2. Selection of industrial important microorganism -production of single cell protein- Media for industrial fermentation- medium composition –
3. Energy sources – carbon, nitrogen, minerals, and growth factors- buffering and foam agents buffering and foam agents.– microbial biomass – microbial enzymes – microbial metabolites - recombinant products.
4. Microbial growth kinetics – batch culture – continuous culture – multistage system – feedback systems -Comparison of batch and continuous culture in industrial process – fed batch culture – application – use.
5. Isolation of industrially important organisms – selection of desired characters – enrichment technique using liquid culture and solidified medium
6. Screening methods – preservation of microorganisms at reduced temperature, liquid nitrogen – dehydrated form – dried culture, lyophilization
7. Development of mutants – selection of stable strains – improvement of industrial strains by modifying properties other than the yield of product. Nutrient recycling – precursors and metabolic regulators – oxygen requirements – antifoams – pH – medium optimization
8. Mid Term examination
9. Fermentation types- Ethonolic fermentation – mixed alcoholic and acid fermentation – Lactic acid fermentation.
10. Sterilization – principles – sterilization of fermentation media, air
11. Sterilization of fermenter, feeds and liquid wastes
12. Development of inoculums for industrial fermentation – need – and their importance. Development of inoculums for yeast process – breading and baking yeast.
13. Development of inocula for bacterial process. Development of inoculums for mycelial process – sporulation on solidified, solid media – submerged culture – technique.
14. Design of fermenter – basic functions of a fermenter – types of fermentor – different parts – agitator, impellers, aerator, baffles, process control, function and maintenance of various parts of fermentor -aeration – agitation – types of fermentation vessels.
15. Recovery and purification of fermentation products – removal of cell, foams – membrane process – drying- filtration – batch and continuous types – fermentor accessories
16. 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
17. Fermented food products – and their important in food and dairy industry. Fermentation economics for application of fermentation process at industry level.

### ***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.

***Lecture schedule***

1. Introduction to food industries and management-classification of food industries-production management-principles and techniques
2. Labourisation-characteristics-wags-fixing of wages-time wage system-piecwage system
3. Balance and debt system-incentive wage plan-halsey plan-Rowan premium plan-time keeping and time recording
4. Decision making-strategic and tactical decisions-effective decision-quantitative techniques of decision making operations research
5. Organisation theory-organisation
6. Structure-span of management-authority responsibility-line and staff relationship-group dynamics
7. Motivation-theories of motivation
8. Leadership styles-communication process-management by exception
9. Production planning and control-techniques of production control-PERT/CPM techniques

10. Manufacturing systems-job production-Batch and mass production-production chart-process chart-routing and scheduling
11. Work study-time study-motion study-fatigue study
12. Man-machine chart-different movements-application
13. Material management and inventory control-types of inventory-ABC analysis-VED analysis-economic order quantity record lever
14. Plant location-factors affecting location-plant layout-product layout-process layout-combined layout
15. Principles of layout-basis of layout-design
16. Quality control and inspections-statistical quality control-sampling techniques-variables-attributes and probability
17. Optimization techniques-network analysis-inspection standards kinds of inspection
18. Financial management-kinds of capital-mixed and working capital-source of capital funds
19. Budgetary control-break even analysis-small business investment act
20. Institution of industrial finance-IFCI, ICICI, NIDC, NSIC, IDBI, IRBI, SIDBI
21. Personnel management-manpower planning-recruitment-selection and placement-promotion-job evaluation
22. Industrial relations and labour welfare-collective bargaining
23. Workers participation in management
24. Mid term examination
25. Marketing management-consumer behavior and market segmentation
26. Product mix-product brand-product life cycle
27. Channels of distribution-sales promotion and advertising-advertising media
28. Personal selling-marketing research
29. Management information systems in agro-food processing units
30. Design of MIS evaluation of MIS-MIS and computer
31. Responsibility centers-management reporting
32. Social responsibility of management and business-to the owners-to the employees-to the consumer-to the community
33. Prospects of agro food processing industries in the emerging economic scenario

### ***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. What steps 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.GoodManufacturingPractice. 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

***Lecture Schedule***

1. Introduction and scope of sanitation and hygiene in food industries
2. Sanitation- Definition and importance
3. Need for sanitation and its application in food industries
4. Laws and regulations involves in sanitation
5. Standards involved in performance of sanitation.
6. Safe handling- definition and different steps involved in safe handling
7. Sources for cross contamination and its effect on food products
8. Different Cleaning practices and machineries used for cleaning
9. Materials and steps for good sanitation practices.
10. Good Manufacturing Practice- definition and significance
11. Different steps involved in GMP
12. Application of GMP in food industries
13. Management and Sanitation, in food industries
14. ISO 9000, significance and importance in food applications

15. ISO 14000, significance and importance in food applications
16. Microorganisms and their relationship to Sanitation.
17. Mid term exam
18. Food Plant Design and Construction
19. Layout of food plant with effective sanitation.
20. Air Sanitation, definition and application in food industries
21. Equipment for Effective Sanitation
22. Waste water Sanitation procedures.
23. Sanitation procedures with related to environment
24. Different types of sanitizers and its significance in food industry.
25. Layout of Waste Disposal from food industries .
26. Personal Hygiene practices and Clean in place practices,
27. Pest Control Sanitizing procedures and its importance.
28. Packaging Sanitation procedures and applications in food industries
29. Food Storage Sanitation procedures and its importance
30. Food Transport Sanitation procedures and applications in food industries
31. HACCP- basic principles and its application
32. Design and implementation of HACCP system in fruit process industries
33. Design and implementation of HACCP system in milk process industries
34. Design and implementation of HACCP system in meat process industries

***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.

**Elective**

**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, 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.

## ***Lecture Schedule***

1. Introduction to biotechnology – definition , description on traditional and modern biotechnology
2. Structure and functions of biomolecules – proteins and nucleic acids
3. Definition and description of cloning – types and applications
4. Genetics – definition and functioning of genes
5. Different methods of recombination in organisms
6. Introduction to genetic engineering/recombinant DNA technology –objectives
7. Procedure in rDNA technology – isolation of DNA
8. Procedure in rDNA technology - enzymatic tools
9. Procedure in rDNA technology - Vectors –definition,properties, types and applications
10. Procedure in rDNA technology - Transformation – definition and methods
11. Methods of selection, cloning and expression
12. Technique of PCR, its application
13. Technique of AGE and application
14. Technique of southern hybridization and application
15. Application of genetic engineering in different areas
16. Application of genetic engineering in food production
17. Role of different areas of science in biotechnology – description - role of microbiology and bio process technology in biotechnology industry
18. Fermentation – definition and process – preparation of starter cultures
19. Methods of screening suitable micro organism
20. Methods of inoculums development
21. Composition and Preparation of culture media
22. Methods of sterilization - objectives and methods
23. Strain improvement –objectives and methods
24. Process development –scale up process
25. Bioreactors and types of fermentation
26. Downstream processing – principle and objectives
27. Methods in downstream processing
28. Methods in downstream processing
29. Methods in downstream processing
30. Immobilization – techniques and applications
31. Immobilization – techniques and applications
32. Applications in metabolite production
33. Production of commercially important enzymes
34. Production of commercially important enzymes
35. Production of commercially important enzymes
36. Applications of enzymes in various food Industries
37. Production of commercially important organic acids
38. Production of commercially important organic acids
39. Production of commercially important organic acids
40. Production of amino acids and applications
41. Production of bio alcohol and applications
42. Production of bio fuels
43. Application and advantages of bio fuels

44. Production of bio products for food industries
45. Production of bio products for food industries
46. Production of food flavours and colours
47. Production of bio preservatives, its advantages
48. Commercial potential of biotechnology
49. Regulatory aspects – ethical, legal and social implications
50. Regulatory aspects – ethical, legal and social implications
51. Issues on patenting

***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.

**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	64
2	Fdqu.1202	General Microbiology	1+1	65
3	Fdqu.2103	Bio Chemical Engineering	1+1	67
4	Fdqu.2104	Biochemistry of Processing and Preservation	1+1	68
5	Fdqu.2105	Food Microbiology	1+1	70

## **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.

### ***Lecture Schedule***

1. Chemistry of biomolecules: Carbohydrates - classification and structures.
2. Physical and chemical properties of monosaccharide.
3. Physical and chemical properties of monosaccharide.
4. Disaccharides, oligosaccharides & Polysaccharides.
5. Disaccharides, oligosaccharides & Polysaccharides.
6. Pectin, seed gums, sea weeds and algal polysaccharides.
7. Amino acids –chemistry, structure & properties.
8. Amino acids –chemistry, structure & properties.
9. Protein - classification based on solubility and functional properties.
10. Structure of proteins-Primary, Secondary
11. Structure of proteins-Primary, Secondary
12. Tertiary and quaternary.
13. Nutritional quality of proteins-egg, milk and meat.
14. Lipids - classification, structure.
15. Lipids - classification, structure.
16. Properties of lipids: Fatty acid classification.
17. Fatty acid: classification, chemistry and properties.
18. Enzymes –classification, structure and biological importance.
19. Co-enzymes and co-factors. Activators and inhibitors of enzymes
20. Activators and inhibitors of enzymes
21. Enzymes kinetics- Factors affecting enzyme action.
22. Enzymes kinetics- Factors affecting enzyme action.
23. Mechanism of enzyme action and active site.
24. Mechanism of enzyme action and active site.
25. Industrial application of enzymes Immobilized enzymes, enzyme technology.
26. Midterm Examination.
27. Metabolism of carbohydrates- glycolysis.
28. TCA cycle, cellular respiration.
29. TCA cycle, cellular respiration.

30. Lipid metabolism –lipases and phospholipases. Fatty acid metabolism-beta oxidation.
31. Fatty acid metabolism – Beta oxidation, Synthesis of fatty acid
32. Metabolism of proteins – Proteolytic enzymes; Metabolism of aminoacids – Transamination, Deamination.
33. Metabolism of proteins – Urea cycle, Fate of carbon skeleton of aminoacids.
34. Metabolic Interrelationship

### ***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

### ***Lecture schedule***

1. Scope of microbiology-History of microbiology-Spontaneous generation theory-Germ theory of diseases-Contributions of Anton Van Leeuwenhoek Louis Pasteur, John Tyndall,Robert Koch, Joseph Lister , Winogradsky, Beijerinck, Alexander Fleming and Waksman
2. Characterization, classification and identification of Microorganisms. General principle and outline of classification of bacteria, fungi, algae
3. Microscopy-resolving power- numerical aperture-magnification ,types of microscope-light microscope, dark field
4. Phase contrast, U.V microscope, Electron microscope(scanning- transmission type)
5. Structure and organization of microbial cell-prokaryotes-eukaryotes,morphology and fine structure of bacteria, fungi ,algae, protozoa
6. Methods of isolation and purification-pure culture techniques, preservation of bacteria
7. Preparation of media-types of nutritional media, nutritional types of bacteria
8. Staining techniques- simple ,differential, structural staining
9. Growth curve- continuous culture, synchronous culture, chemo stat
10. Energy production by aerobes , anaerobes and photosynthetic organisms
11. Biosynthesis of proteins(transcription and translation) and other macromolecules
12. Mid semester examination
13. Viruses and bacteriophages-chemical nature-lytic and lysogenic types-importance
14. Microbial genetics-mutation-induction of mutation-conjugation
15. Transformation, transduction, heterokaryosis-general mechanism of gene transfer techniques in genetic engineering.
16. Principles of immunology-antigen and antibody reaction
17. 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.
- 6.

**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

***Lecture Schedule***

1. Introduction – basic biochemical concepts.
2. Amino acids – proteins – enzymes.
3. Enzyme catalysts- cofactors specificity – effect of activation energy..
4. Simple enzyme kinetics - Michaelis Menten kinetics.
5. Applied enzyme catalysis in food processing.
6. Ideal batch reactors - continuous flow stirred tank reactors.
7. Oxygen requirement - gas Liquid mass transfer - concepts.
8. Rates of oxygen utilization - measurement of K<sub>la</sub> using gas liquid reactions.
9. Mass transfer for freely rising of falling bodies - mass transfer coefficient for bubbles.
10. Mid semester examination.
11. Forced convection mass transfer – general concepts and key dimensionless groups
12. Aeration and agitation in fermenters - bubble aeration and mechanical agitation.
13. Sterilization of gases and liquids - reactors - batch.
14. Fermenter design, configurations, geometrical ratios.
15. Instrumentation and fermenter operation.
16. Product recovery - recovery of particulates - filtration.
17. Applications of fermenter 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. Stanbury, 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.

### ***Lecture Schedule***

1. Chemistry of cooking- biochemical changes in carbohydrates during cooking
2. Biochemical changes in proteins during cooking
3. Biochemical changes in lipids during cooking
4. Caramellization of sugars, browning and Maillard reactions

5. Loss of nutrients and prevention of loss during cooking.
6. Food storage- biochemical changes during storage of food grains
7. Food storage- biochemical changes during storage of fruits
8. Food storage- biochemical changes during storage of vegetables
9. Mid term Examination
10. Cold storage and freezing of foods- factors affecting quality of foods and biochemical changes.
11. Food preservation- biochemical changes during preservation of foods; and mechanism of action
12. Biochemical changes during processing of foods- pickling,
13. Biochemical changes during processing of foods- malting
14. Biotechnology in food processing and preservation.
15. Instrumental biochemistry: chromatography
16. Electrophoresis-principle and its application
17. Spectro photometry –principle and its applications.

### ***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.2105 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, seafoods, 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.

### ***Lecture Schedule***

1. Introduction - Occurrence of microorganisms in food. Sources of microorganisms found in food Intrinsic and extrinsic parameters of food affecting microbial growth.
2. Types of microorganisms in foods like meat, poultry and sea foods, cereals, vegetables and fruits. Parameters affecting the growth of microorganisms
3. Assessing microbial population in the food. Microbial spoilage of meat, poultry, fish and dairy products, etc
4. Microbial spoilage of fruits and vegetables, Cereals and bakery products.
5. Food poisoning – principles, Food preservation using physical method – low temperature preservation – characteristics of psychrotrophs – high temperature food preservation – characteristics of thermophilic microorganisms.
6. Food preservation using chemical methods. Preservation of foods by radiation – limitations and commercial application of radiation.
7. Microorganisms as food – single cell protein – bacteria, fungi, yeast, algae. Production techniques of single cell protein
8. Fermented food – pickles – sauerkraut – vinegar and lactic acid, Milk products - sources of micro-organisms.
9. Preservation of milk - Pasteurization - Bacteriological standard - grading of milk. milk products - Fermented products, curd, butter, cheese, ghee.
10. Microbiology of cereals and cereal products, Vegetables.
11. Microbiology of fruits, spices and condiments.
12. Mid semester examination
13. Microbiology of meat, meat products fish and fish products, poultry and egg., bread and baked products
14. Canning of food - method of canning – type of spoilage in canned food. Food borne infection - prevention of food infection.

15. Food borne diseases- *Salmonella*, *Clostridium*, *Vibrio* -prevention, Food poisoning – symptoms, causes and control.
16. Microbiological standard of food materials, HACCP- food borne pathogen
17. Food sanitation – Indicator organisms – Coliform bacteria. Food processing - Plant sanitation - Microbiological standard.

### ***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 Publishrs, 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	73
2	Cien.1102	Engineering Drawing	0+2	75
3	Meen.1101	Production Technology	2+1	76
4	Elen.1201	Basic Electrical Engineering	2+1	78
5	Meen.1202	Machine Drawing	0+1	80
6	Meen.1203	Engineering Thermodynamics	2+1	80
7	Cien.2103	Fluid Mechanics	2+1	82
8	Meen.2205	Boiler and steam Engineering	1+1	84
9	Cien.2204	Mechanics and Strength of Materials	2+1	86
10	Meen.2104	Kinematics of Machinery	2+1	88
11	Cien.3105	Design of Structures	1+1	90
12	Meen.3106	System Engineering	2+0	92
13	Meen.3107	Machine Design	2+1	94
14	Elen.3202	Instrumentation and Process Control	2+1	95

## 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

### *Lecture Schedule*

1. Materials and buildings – Materials – Stone – classification of rocks – Natural bed of stone and its importance - Qualities of good building stone – Common building stones in India
2. Brick – Composition of good brick earth – Harmful ingredients in brick earth – classification of brick according to shape – Qualities of good bricks.
3. Cement - properties of cement – Composition of cement – Functions of cement ingredients – setting action of cement – BIS tests for cement – Uses of cement
4. Steel – Properties of mild steel and hard steel – Market forms of steel – Uses of steel - Cement concrete – Properties –Materials required for CC and RCC
5. Buildings- classification-components-substructure-super structure- types, functions and requirements-capacity
6. Introduction to surveying and levelling – Principles and basic concepts – Principles of chain surveying.
7. Types of ranging – chaining – folding and unfolding of chains – Types of chains – Measurement of offsets – plotting chain survey
8. Error in length due to incorrect chain – compensating and cumulating errors - chain and tape corrections – Problems.
9. Compass surveying – Prismatic compass – Surveyor's compass – Whole circle and reduced bearings – Problems.
10. True and magnetic bearing – dip and declination – local attraction – traversing –plotting – error of closure – Problems
11. Plane table survey – instruments and accessories – setting up – orientation – different methods – radiation – intersection –traversing.
12. Two point problem
13. Three point problem – errors in plane tabling.

14. Levelling – definitions – types of levels – Temporary adjustments of level – Types of bench marks - Principles in leveling - booking the readings.
15. Reduction of levels- collimation system – Problems
16. Rise and Fall system – Problems.
17. Theodolite Surveying – definitions - Parts of theodolite – adjustments - measurement of angles - horizontal angles – different methods – vertical angles
18. Tachometry- Stadia method - calculation of distances and reduced levels.
19. Tangential method - calculation of distances and reduced levels
20. Area and volume computation – Mid ordinate rule – average ordinate rule – trapezoidal rule – Simpsons rule – Volumes Trapezoidal formula
21. Water Supply and Sewage Disposal- Water Supply- Domestic water demand – sources of water supply
22. 23 & 24. Standards of drinking water- water quality - analysis of water- physical, chemical and bacteriological tests.
25. Water processing – sedimentation – Theory, purpose and location- types of sedimentation tanks – design aspects
26. Coagulation – Principle and purpose – Flocculation – usual coagulants- Jar test.
27. Filtration – Theory – Classification of filters – Slow sand filters – rapid sand filters – Pressure filters.
28. Disinfection – Theory and necessity – methods – Chlorination – action of chlorine – application of chlorine – Forms of chlorination – Tests for chlorine.
29. Water distribution systems - methods of distribution.
30. Water pollution and its control- types of water pollution and preservative measures
31. Introduction of Sanitary Engineering- sewage – Collection and conveyance of refuse – Systems of sewerage - Estimation of quality- characteristics- treatment.
32. Sludge disposal - Methods.
33. 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.1101 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.

***Lecture Schedule***

1. Fundamentals of alloys – structure of solids-Grain formation-deformation of metals – metal alloys – solidification of metals – Iron – Carbon equilibrium diagram.
2. Introduction to Properties of metals – Mechanical properties of metals
3. Ferrous metals and alloys – Properties – Pig iron, cast iron, wrought iron
4. Steel making processes. Introduction to Non ferrous metals and alloys
5. Mechanical working of metals – principal methods of hot working of metals

6. Principal methods of cold working of metals
7. Forging – forgeability – advantages – basic forging operations – forging tools – types of forging
8. Introduction to power forging and forging machines
9. Welding – classification – arc welding – principle and tools used – welding terminologies
10. Gas welding – techniques – equipment used. Arc welding methods – resistance welding methods
11. Special welding process – defects in weld – weld symbols
12. Welding of various metals – brazing – soldering – 0 bronze welding
13. Wood – structure – grains in wood – seasoning – process involved in carpentry – wood working tools
14. Carpentry joints – powered wood working tools
15. Pattern making – pattern materials – pattern making tools – allowance
16. Types of pattern – core boxes – core prints – colour coding for pattern
17. Mid semester examination
18. Foundry – moulding tools – moulding sand – types of moulding sand – properties
19. Moulding process – machine moulding
20. Special moulding processes
21. Casting – methods of casting – defects in casting
22. Fitting – operations commonly used – fitting tools
23. Surface coating of metals – cleaning – chemical cleaning – mechanical cleaning – metallic coating – plastic coating
24. Lathe functions – principal parts – types of lathe – tools used
25. Mechanism of lathe – Basic operations on lathe
26. Drilling machines – principal parts – types – tools used – operations
27. Shaper – principal parts – types – tools used – operations
28. Planner – principal parts – types – tool used – operations
29. Kinds of grinding – grinding machines
30. Milling machines – types – tools used – basic operations
31. Surface finishing processes
32. Sheet metal works – metals used – tools and operations
33. Plastics – types – types of processing – moulding processes
34. Measuring tools and their uses

### ***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 – Resistors, 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.

***Lecture schedule***

1. Review of fundamental electrical quantities, definitions and units-circuits and elements.
2. DC circuits-Ohm's law-series- parallel combination of resistances-Kirchoff's laws.
3. Network theorems-Thevenin's theorem-equivalent circuit-steps to thevenize a circuit.
4. Super position theorem.
5. Network transformation-Star Delta conversion-derivation.
6. Magnetic circuits-inductance-self and mutual-Law of electro magnetic induction.
7. Single phase AC circuits & basics-RMS and Average quantities.
8. Vectorial representation of AC-phase angle-phasor notations

9. Concept of leading and lagging phasors-series & parallel.
10. Three phase AC circuits-star and delta-line and phase values of current and voltage.
11. Expression of power –power factor.
12. Load estimation in processing industry.
13. Wiring-accessories for wiring-preparation of wiring plan-equipments and working principles.
14. Heating –types of heaters.
15. Electrical tariff and safety.
16. Electronics: electronic components and devices.
17. Passive components-resistors, inductors and capacitors and their types.
18. Semiconductors- pn junction –p and n type semiconductors.
19. Biasing-forward and reverse biasing-barrier potential.
20. VI characteristics of pn junction-reverse breakdown –Zener-avalanche.
21. Diodes-types-zener-LED-photo.
22. Diode as a circuit element-rectifiers-half wave-full wave.
23. Ripples-Filters-capacitive-inductive-LC filter
24. Bipolar junction transistors-structure and operation
25. PNP Transistor-NPN transistors
26. Different configurations –CB-CE-CC-Comparison
27. Input and output characteristics
28. Amplification in transistors-basic amplifier circuit
29. special semiconductor devices –FET-SCR-VI characteristics and applications
30. Digital electronics-digital fundamentals-number systems.
31. Boolean theorems-Demorgan's theorems-logic gates
32. Implementation of Boolean expression using gates.
33. Integrated circuits –IC fabrication
34. 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 Kirchhoff'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, Ericsson 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.

### ***Lecture Schedule***

1. Concepts and Definitions of systems.
2. Concept of continuum, state and properties of system.
3. Extensive and intensive properties - Specific weight and volume - Pressure-Expression in various units
4. Concept of equilibrium, path, process, cyclic process, quasi static process.
5. Zeroth law and temperature scales.
6. Pdv work, path function - heat and flow work.
7. Heat - Specific heat - Perfect gas and gas laws - Boyle's law, Charle's law
8. Characteristic equation of gas or equation of state -Avogadro's law
9. Internal energy - Enthalpy, specific heat. Heat and work -steady flow process.
10. First law of thermodynamics - Joule's experiment - Energy, Internal energy - Adiabatic work
11. Conservation of energy - Non flow systems
12. Isometric , Isobaric processes
13. Isothermal and polytropic processes
14. Constant internal energy process- steady flow process - energy equation.
15. Flow processes - Throttle process - applications on Nozzle flow, boiler and emptying tanks
16. Second law of thermodynamics - Kelvin Plank statement -Clausius statement-reversible cycle - Carnot cycle
17. Mid semester Examination.
18. Carnot theorem - Thermodynamic temperature scales - Clausius inequality - Entropy
19. Entropy changes during Isobaric and Isometric processes.
20. Entropy changes during Isothermal and polytropic processes
21. Temperature Entropy diagram – Principle of entropy change - Concepts on entropy - Examples explaining entropy change
22. Air cycles - Carnot , Otto Cycles - efficiency.
23. Diesel cycle - efficiency.
24. Dual cycle - efficiency.
25. Stirling cycle, Ericsson cycle - efficiency.
26. Brayton cycle - efficiency.
27. Reciprocating air compressor - Construction - Single stage -Shaft work, thermal and volumetric efficiency
28. Two stage compressor – inter cooling - Work done, efficiency, heat rejected / kg of air, entropy change with inter cooling

29. Properties of vapours - Phase transformation - P-V-T data - Pressure temperature curve for steam
30. Steam tables - Wet steam - dryness fraction, Enthalpy, specific volume, Entropy of water and steam
31. Super heated steam - properties - T-S chart for steam
32. Processes of vapour - pv and Ts diagrams and heat transferred for steam under Isobaric, Isometric processes.
33. Steam under Adiabatic, Isothermal and Polytropic processes.  
Throttling of steam -Steam calorimetry

***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.2103 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.

### ***Lecture Schedule***

1. Definition of fluid-Classification of fluids-properties of fluids
2. Mass density, Specific weight, specific volume, specific gravity.
3. Viscosity, surface tension, capillary rise.
4. Atmospheric pressure-gauge, vacuum pressure, absolute pressure and relation between them.
5. Measurement of pressure- simple manometers.
6. Differential manometers and mechanical gauges and problems.
7. Hydrostatics-Pascal Law-Proof of Pascal Law
8. Pressure at a point-variation of pressure in a fluid.
9. Buoyancy and flotation-Expression for buoyant force and centre of buoyancy
10. Metacentre and determination of metacentric height-experimental method and analytical method.
11. Kinematics of fluid flow-types of fluid flow
12. Steady and unsteady flow-uniform and non uniform flows.
13. Laminar and turbulent flows, rotational and irrotational flows, vorticity.
14. Vortex motion-free vortex and forced vortex.
15. Path lines, streak lines and stream lines, stream function, velocity potential and flow net.
16. Dynamics of fluid flow-Euler and Bernoulli's equation of motion.
17. Application of Bernoulli's equation- Venturimeter, orifice meter and nozzle meter
18. Determination of coefficient of discharge.
19. Pipe flow- Laminar and turbulent flow in pipes
20. Equation for head loss-Darcy's equation.
21. Dimensional analysis and similitude
22. Units and dimension-dimensional homogeneity.
23. Rayleigh's method, example problems.
24. Buckingham's method, example problem.
25. Types of similarities and similitude, dimensionless numbers
26. Froude, Reynolds, Weber, Euler, Cauchy and Mach numbers.
27. Open channel hydraulics- types of flow in channels, velocity distribution.
28. Specific energy and critical depth.
29. Flow measuring devices-orifices and mouth pieces.
30. Notches and weirs- classification and flow through them-triangular, rectangular and Cipolletti weirs.
31. Broad crested and submerged weirs.

32. Parshall flumes, cut throat flumes and venturi flumes.
33. Velocity measurement in channels
34. Pitot tube and current meter.

***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.

**Meen.2205 BOILER AND STEAM ENGINEERING (1+1)**

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.

### ***Lecture schedule***

1. Types of fuels - Properties of fuels
2. Heating values of fuels – net and gross, Determination of calorific value of fuels Bomb calorimeter– standard formula - Dulong formula – Boie's formula.
3. Theory of combustion of fuels – stoichiometric air requirement of fuels.
4. Gravimetric and volumetric analyses of products of combustion., Conversion of gravimetric to volumetric analysis and vice versa.
5. Properties of steam – pure substance – P.V.T. data on phase transformation.
6. Thermo dynamic properties of steam – sensible heat, entropy, latent heat, dryness fraction, wet fraction, priming, quality – super heated steam.
7. Steam tables – determination of enthalpy and entropy of steam-problems
8. Temperature - entropy diagram and Mollier chart, throttling of steam – its uses
9. Chimney design Introduction – Classification of draught – natural, forced, artificial, induced draught-draught losses – advances of mechanical draught.
10. Mid Term Examination
11. Determination of height and diameter of chimney – condition of maximum discharge – efficiency of chimney
12. Boilers – working principle – classification. Fire tube and water tube boilers – working principle.
13. Cochran and Lancashire boilers– working principle. Vertical and horizontal return tube boilers - construction.
14. Velox boiler and Manning boiler – working principle
15. Merits and demerits of fire tube and water tube boilers. Fitting safety and maintenance- Selection of size of steam pipes
16. Layout of pipe lines – Energy audit of steam boilers – economy of heat utilization –
17. 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; Structural Mechanics: Analysis of perfect frames - Method of joints and method of sections - Statically determinate frames. Analysis of perfect frames by graphical method. Simple stresses and strains - Basic concepts - stresses on inclined planes - Mohr's circle - Principal stresses and strains; Dynamics: Motion under variable acceleration. Angular motion. Laws of motion and its applications; D'Alembert's principle; Motion of connected bodies on inclined plane, 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 - 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; Torsion of shafts and springs.

***Lecture Schedule***

1. Statics: Basic concepts – Force systems – Resultant of forces – Analytical and graphical methods.
2. Method of resolution – Principle of resolution (Theorem of resolved parts) – Problems
3. Moment of a force – Geometrical representation of moment – Varignon’s theorem and its applications – Position of resultant forces – Levers.
4. Parallel forces and couples – Centre of parallel forces – Characteristics of couple.

5. Equilibrium of forces – Principle of equilibrium – Free body diagram – Lame’s theorem and its applications – Graphical study of equilibrium of forces – Conditions of equilibrium – Types of equilibrium
6. Centre of gravity of plane figures – Problems.
7. Moment of inertia of plane figures – Problems.
8. Radius of gyration and modulus of section – Perpendicular axis theorem and its applications – Parallel axis theorem and its applications.
9. Friction – Limiting friction – Laws of friction – angle of friction – Cone of friction – Friction of bodies on inclined plane.
10. Ladder friction and its applications.
11. Wedge friction and its applications.
12. Structural mechanics: Analysis of perfect frames – Method of joints – Method of sections – Applications to simple problems (vertical and lateral loads only).
13. Graphical method for analysis of frames.
14. Stresses on inclined planes – one-dimensional and two-dimensional stress cases – Principal planes and principal stresses – Mohr’s circle.
15. Dynamics: Motion under variable acceleration – Angular motion.
16. Laws of motion and its applications – D’Alembert’s principle – Motion of connected bodies on inclined plane.
17. Collision of elastic bodies, Work, power and energy.
18. Simple stresses and strains – Elasticity – Stress – strain relationship – Elastic limit – Hooke’s law- Young’s modulus – Problems.
19. Bars of varying section – Composite section – Temperature stresses – simple problems.
20. Linear strain – Lateral strain – Poisson’s ratio – Volumetric strain – Problems.
21. Bulk modulus – Relation between elastic constants – Problems.
22. Resilience and strain energy.
23. Shear force and bending moment diagrams for cantilever beams – Problems.
24. Shear force and bending moment diagrams for simply supported beams – Problems.
25. Relation between SF and BM and intensity of load – Derivation of equation.
26. Bending stresses in beams – Theory of simple bending – Moment of resistance – Simple problems.
27. Shear stresses in beams – Simple problems.
28. Deflections of cantilever and simply supported beams.
29. Deflection by Macaulay’s method – Problems.
30. Combined bending and direct stresses – limit of eccentricity – middle third rule for rectangular sections.
31. Columns and struts – Derivation of Euler’s buckling load.
32. Stresses in thin cylindrical shells – Hoop stress and circumferential stress – Simple problems.
33. Torsion – Power transmitted by a shaft – Strength of a solid shaft - Simple problems.
34. Close and open coiled springs - Simple problems

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

### **Meen.2104 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.

### ***Lecture Schedule***

1. Definitions - kinematic links - pairs - chain - explanation with examples.
2. Structure and machine - machine and mechanism - difference - examples and explanations.
3. Different types of the mechanisms and their applications.
4. Four bar chain - inversions of mechanisms - slider crank chain.
5. Velocity and acceleration in mechanisms.
6. Relative velocity and acceleration - concepts and derivations.
7. Methods of finding velocity and acceleration - principles involved and brief descriptions - Kennedy's theorem.
8. Instantaneous centre method and solving velocity problems.
9. Vector polygon method and its application for finding velocity of points in mechanisms.
10. Corriolis acceleration - Acceleration polygon .
11. Friction - introduction - coefficient of friction and angle of repose - force analysis of a sliding body - Friction on inclined plane - Nut with screw.
12. Pivot and collar friction - flat - collar - conical pivots.
13. Bearings - lubrication - oils - viscosity rating
14. Different types of bearings - expression for loss of power - calculation of friction moment
15. Rolling friction - types of anti friction bearings.
16. Brakes - types -Band and internal shoe brakes - description and principle of working.- Determination of pressure and braking torque
17. Mid semester examination
18. Clutches - types - torque transmitted - description and working principles
19. Problems related to brakes and clutches, trouble shooting and remedies.
20. Belt transmission - flat and V - belts - Open and cross belting - Determination of belt length V belt specification and classes
21. Expression for tension ratio - centrifugal tension - creep - power transmitted by belts. Pulleys - flat, V, stepped, cone - crowning
22. Chain drives - kinematics - chain classification - chain length determination - sprocket terminology
23. Toothed gears - introduction - Nomenclature - types and application - law of gearing.
24. Involute functions - characteristics of involute - Interference - Number of teeth of gears and length of contact.
25. Gear trains - Applications.
26. Method of solving problems for simple compound and reverted trains
27. Cams - types and application - followers - types and application.
28. Procedure for obtaining cam profile for uniform velocity, acceleration and deceleration.
29. Cam profile for simple harmonic and cycloidal motions.
30. Governors – Watt and Porter – principle of operation – problems
31. Sensitivity and hunting of governors – governor power and effort
32. Fly wheel – introduction – fluctuations of speed and energy – its expression – problems.
33. Balancing - static and dynamic - balancing of rotating masses in single plane. Balancing of rotating masses in 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 -Design of T beams - Slabs - Design of one way and two way slab ( IS code method only) - Columns, wall footing- 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. Detailed and abstract estimates - Valuation - Estimate of small residential and farm buildings.

### ***Lecture Schedule***

1. Design of concrete structures – Concept of analysis and design – Working stress method of design – Factor of safety based on stress and load – Grades of concrete and steel – characteristics of concrete and steel – Assumptions for the design of RCC structural elements.
2. Balanced and unbalanced sections – Balanced design – Balanced section as an economical and critical section – Fundamental equations for design – Design constants – Computation of design loads – Use of BIS codes.
3. & 4. Analysis of singly reinforced beams – Different types of problems.
5. Design of singly reinforced beam.
6. Analysis of doubly reinforced beams – Problems.
7. Design of doubly reinforced beam.
8. Analysis of T beams – Different types of problems

9. Design of T beams.
10. Analysis of slab – one way slab - Design.
11. Design of two way slab ( IS code method only).
12. Design aspects of RCC columns. – short and long columns – Problems.
13. Design aspects of RCC footings- Design problems – square footing only
14. Design aspects of silos and ferro-cement tanks
15. Design of riveted and welded connections.
16. Design of structural steel members in tension, compression and bending.
17. Detailed and abstract estimates - Estimate of small residential and farm buildings - Analysis of rates

### ***Practical Schedule***

1. Design and drawing of singly reinforced beams.
2. Design and drawing of doubly reinforced beams.
3. Design and drawing of T beams.
4. Design and drawing of one way slabs
5. Design and drawing of two way slabs.
6. Design and drawing of RCC columns and a square footing
7. Types of structural steel sections.
8. Design and drawing of riveted and welded connections.
9. Design and drawing of tension members in steel.
10. Drawing of different types of compression member sections.
11. Design and drawing of compression members.
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). Laxmi 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. S. 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 (1+1)

System concepts, System approach and decision making. Operations Research - History, importance and relevance to Food engineering. Linear Programming Problems (LPP) - Introduction, Terminologies, Requirements, Assumptions, Applications. Formulation of LPP and Graphical solution of LPP. Simplex Method, Artificial variable techniques - Big M method & Two phase technique. Degeneracy in LPP, Duality in LPP. Formulation of dual problem, Dual simplex method.

Transportation problem - Introduction, assumptions, terminology and formulation. Methods for finding optimal solutions – Northwest Corner Method (NCM), Least Cost Method (LCM), Vogel's Approximation Method (VAM), Test for optimality. Assignment models - Definition, Mathematical representation, Comparison with transportation model, Solution methods, Hungarian method of solution

Queuing models - Introduction, Structure, Single queuing model and its solution. Decision analysis – decision making environments, decision making under uncertainty, EMV, EVPI, EOL. Inventory management and Model

Project Management - Basic tools and techniques, Network techniques. Introduction to CPM and PERT, Critical Path Method (CPM), Programme Evaluation and Review Technique (PERT), Investment and Break even analysis, Simulation basics - Introduction, Advantages, Limitations, Application.

### *Lecture Schedule*

1. System concepts, System approach and decision making  
Operations Research - History, importance and relevance to Food engineering
2. Linear Programming Problems (LPP)  
Introduction, Terminologies, Requirements, Assumptions, Applications  
Formulation of LPP
3. Graphical solution of LPP
4. Simplex Method
5. Artificial variable technique - Big M method
6. Artificial variable technique - Two phase technique  
Degeneracy in LPP
7. Duality in LPP  
Formulation of dual problem
8. Dual simplex method
9. Transportation problem  
Introduction, assumptions, terminology and formulation  
Methods for finding optimal solutions – Northwest Corner Method (NCM), Least Cost Method (LCM), Vogel's Approximation Method (VAM)  
Test for optimality
10. Assignment models  
Definition, Mathematical representation, Comparison with transportation model,

- Solution methods, Hungarian method of solution
11. Queuing models  
Introduction, Structure, Single queuing model and its solution
  12. Decision analysis – decision making environments, decision making under uncertainty, EMV, EVPI, EOL
  13. Inventory management and Model
  14. Project Management  
Basic tools and techniques, Network techniques  
Introduction to CPM and PERT
  15. Critical Path Method (CPM)
  16. Programme Evaluation and Review Technique (PERT)
  17. Investment and Break even analysis
  18. Simulation basics - Introduction, Advantages, Limitations, Application

***Practical schedule***

1. Problems in formulation of LPP
2. Problems in Simplex method
3. Problems in Simplex method
4. Problems in artificial variable technique – Big M method
5. Problems in artificial variable technique – Two phase method
6. Problems in formulation of dual problem  
Problems in dual simplex method
7. Problems in Transportation problems
8. Problems in Transportation problems
9. Problems in Assignment problems
10. Problems in Assignment problems
11. Problems in decision analysis
12. Problems in network analysis
13. Problems in CPM
14. Problems in PERT
15. Problems in break even analysis

***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 (2+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

### ***Lecture Schedule***

1. Meaning of design
2. Phases of design
3. Design considerations
4. Common engineering materials
5. Mechanical Properties of engineering materials
6. Types of loads and stresses
7. Theories of failure
8. Factor of safety and selection of allowable stress
9. Stress concentration
10. Elementary fatigue and creep aspects
11. Design of Cotter joints
12. Design of knuckle joint
13. Design of threaded fasteners subjected to direct static loads
14. Design of bolted joints loaded in shear
15. Design of shafts under torsion
16. Design of shafts under bending
17. Design of shaft under combined twisting and bending moment
18. Types of Keys
19. Design of keys
20. Mid term Examination
21. Types of coupling
22. Design of sleeve or muff coupling
23. Design of flanged coupling
24. Design of universal coupling
25. Types of springs
26. Design of helical spring
27. Design of leaf spring
28. Design of flat belt drive
29. Design of V-belt drive
30. Design of gears
31. Design of levers
32. Design of thin cylindrical shafts
33. Design of anti friction bearings
34. Selection of anti friction bearings

### 35. Design of crane hooks and circular rings

#### ***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.

### ***Lecture Schedule***

1. Process instrumentation
2. Recording instruments and signaling instruments
3. Transmission of instrument readings, control center, instrumentation diagram
4. Diagrammatic control-center layer, process analysis, instrumentation in the modern plant
5. Thermoelectric temperature measurement, thermoelectric effect, temperature measuring instruments, industrial thermocouples
6. Thermocouple materials, advantages and disadvantages of thermocouples
7. Thermocouple thermometers, thermal wells, industrial potentiometers
8. Electrical resistance thermometers or Resistance temperature detectors(RTD)
9. Thermal coefficient of resistance, industrial-resistance-thermometer bulbs
10. Null and deflection type resistance thermometer
11. Introduction to thermal radiation, Radiation temperature measurement
12. Radiation receiving elements, radiation pyrometers , advantages and disadvantages of radiation pyrometers, photoelectric pyrometers, optical pyrometers
13. Sources of errors and precautions in measurement of temperature
14. Factors influencing the response of temperature sensing device
15. Composition analysis-Spectroscopic analysis,
16. Adsorption spectroscopy, emission spectroscopy, mass spectroscopy
17. Analysis of solids by X-ray diffraction
18. Color measurement by spectrometers, gas analysis by thermal conductivity
19. Psychometric method for moisture in gases, hygrometer method for moisture in gases, dew-point method
20. Measurement of moisture in paper, textiles and lumber, pH ion concentration measurement
21. Definition of pressure, units for pressure and measuring instruments
22. Pressure and vacuum measurement: measuring elements for gage pressure
23. Electrical pressure transducers, resistance type pressure transducer
24. Inductive and capacitive type pressure transducers, photoelectric pressure transducer
25. Manometers, simple and differential manometers,
26. Manometric liquids, advantages and limitations
27. Indicating elements for pressure gauges, measurement of absolute pressure, measuring pressures in corrosive fluids
28. Measurement of high pressures (Bridgman gauge),
29. Measurement of low (vacuum) pressure(Mcleod gauge, thermocouple gauge, pirani gauge)
30. Level measurement: direct measurement of liquid level(dip sticks and Lead lines)
31. Indirect measurement of liquid level (Chain or float gauge)
32. Pressure (level) measurements in open vessels
33. Level measurement in pressure vessels, measurement of interface level
34. 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**

<b>Sl No</b>	<b>Course number</b>	<b>Course Title</b>	<b>Credit Hours</b>	<b>Page No</b>
1	Basc.1101	Communicative English	2+0	99
2	Basc.1102	Engineering Mathematics - I	3+0	100
3	Basc.1103	Engineering Physics	2+1	102
4	Basc.1104	Engineering Chemistry	2+1	104
5	Basc.1205	Engineering Mathematics II	3+0	106
6	Basc.1206	Information Technology	1+1	108
7	Basc.2107	Computer Programming	1+1	109
8	Basc.2108	Engineering Mathematics III	2+1	111
9	Basc.2209	Numerical Methods for Engineering Applications	1+1	113
10	Basc.3110	Statistics	1+1	114
11	Basc.3111	Economics of Food Processing and Marketing	2+1	116
12	Basc.4112	Extension Methods and Transfer of Technology	1+1	118

## **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.

### ***Lecture Schedule***

#### **I. Essence of Speech**

1. Speaking- Expressing Opinions (agreement/disagreement)- Offering Suggestions  
Technical Definition-4 Lectures
2. Defining- Describing Objects- Exercise Audio equipment: Types of Pronunciation-  
Word stress/ social context, science and technology context- sentence stress and  
intonation-4 Lectures

#### **II. Reading Comprehension**

1. Reading- Reading Comprehension-Transferring Information-1 Lecture
2. Exercise- An unseen passage should be given and questions may be asked in the form of  
True or False statements, MCQ, short answers-3 Lectures
3. Transcoding: Interpreting tables, flow charts- Writing reports based on the sample-4  
Lectures

Mid Term Examination

#### **III. Types of Writing**

1. Writing Technical Report- Lab Report- Exercise- Technical Essay Writing Exercise-3  
Lectures
2. Letter Writing- Formal Letters- Letter Inviting Dignitaries- Letter of Application-  
Placing an Order-2 Lectures
3. Curriculum Vitae-1Lecture
4. Exercise Note Making- Strategies- Organizing Notes- Exercise-2 Lectures

#### **IV. Types of Communication**

1. Communication- Basic Concepts- Process- Kinds- Routes- Forms- Factors- Barriers-  
Triangles-3 Lectures
2. Communication Through Computers- Power Point & Tele Conferencing-3 Lectures
3. TOEFL and GRE, Computer based text and computer adaptive test- a curtain raiser-2  
Lectures

### ***Suggested Reading***

1. Abraham Benjamin Samuel “Practical Communication (*Communicative English*) ALSRW2000,SRMEC - June 2002 Edition.
2. Herbert. A.J. 1995. *The structures of Technical English* Orient Longman
3. Pickett and Laster, 1997. ‘*Technical English, Writing, Reading and Speaking*’, New York Harper and Row Publications
4. Swan, Michael, 1984. ‘*Basic English Usage*’, Oxford University Press, Interactive course in phonetics and spoken English published by Acoustics Engineers (ACEN) 2002.
5. Warner, Tony, 1996. “*Communication Skills for Information Systems*”, Pitman Publishing, London,
6. Munter, Mary, 1987. “*Business Communication Strategy and Skill*”, Prentice Hall Inc., New Jersey,
7. Day Robert.A. 1983, “*How to Write and Publish a Scientific Paper*” Vikas Publishing House Pvt Ltd, New Delhi,

### **Bas.c.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.

### ***Lecture Schedule***

1. Introduction to elementary transformation of a matrix.
2. Transpose.
3. Adjoint.
4. Inverse
5. Rank of a matrix.
6. Rank of a matrix.
7. Linear dependence of vectors.
8. Consistency of linear system of equations: Rouche’s theorem.
9. Characteristics equation, eigen vectors
10. Characteristics equation, eigen vectors
11. Properties of eigen values
12. Cayley-Hamilton theorem.
13. Quadratic form.
14. Nature of a Quadratic form.

15. Reduction of Quadratic form to canonical form.
16. Reduction to diagonal form.
17. Taylors and Maclaurins expansions.
18. Indeterminate form.
19. Curvature
20. Curvature
21. Asymptotes
22. Asymptotes
23. Tracing of curves
24. Tracing of curves
25. Tracing of curves
26. Function of two or more independent variables.
27. Partical differentiation
28. Homogeneous function and Euler's theorem.
29. Composite functions.
30. Total derivatives.
31. Derivatives of implicit functions.
32. Change of variables.
33. Jacobians.
34. Jacobians.
35. Error evaluation.
36. Maxima and minima of functions of more than one variable.
37. Reduction formulae.
38. Reduction formulae.
39. Reduction formulae.
40. Rectification of standard curves.
41. Volumes and surfaces of revolution of curves.
42. Volumes and surfaces of revolution of curves.
43. Double and triple integrals.
44. Double and triple integrals.
45. Change of order of integration.
46. Gamma and Beta functions.
47. Gamma and Beta functions.
48. Application of double and triple integrals to find area and volume.
49. Application of double and triple integrals to find area and volume.
50. Application of double and triple integrals to find area and volume.
51. Application of double and triple integrals to find area and volume.
52. Application of double and triple integrals to find area and volume.

### ***Suggested Reading***

1. Grewal B.S. Higher Engineering Mathematics. Khanna Publishers.
2. Grewal B.S. Elementary Engineering mathematics. Khanna Publishers, New Delhi.
3. Kreyszing, Erwin. (2006). Advanced Engineering Mathematics (8 ed.). Wiley.
4. Piskunov. Differential and Integral calculus. MIR Publishers, Moscow.
5. Ramana, B. V. Higher Engineering Mathematics. Tata McGraw-Hill.
6. Sharma G.S. , K.L.Ahuja & U.S. Sarana. Advanced Mathematics for Engineers and Scientists (Vol. I and II).

7. Stewart, James. Calculus Concepts and Contexts (2 ed.).
8. Thomas, G.B. Calculus and Analytical geometry. Addison Wesley London.
9. Wylie, C.R., & Barret, L.C. Advanced Engineering Mathematics (6 ed.). McGraw Hill, 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.

#### ***Lecture Schedule***

1. Newtons Rings-Experimental arrangement-condition for bright and dark fringe-circular fringes-Radii of dark ring-Fringes of equal thickness.
2. Dark central spot in Newtons rings explanation –Determination of wavelength of light.
3. Determination of refractive Index of liquid-Newtons rings in transmitted light-Necessity of an extended source.
4. Surface Tension-Definition-Surface film-surface energy-Excess pressure inside a liquid drop-excess pressure inside a soap bubble.
5. Expression for the shape of liquid in a capillary tube.
6. Expression for the rise of liquid in a capillary tube.
7. Determination of surface tension by capillary rise method-effect of temperature on surface tension.
8. Viscosity-Coefficient of viscosity-definition-Streamline & Turbulent Flow-Stokes law.
9. Terminal Velocity-Determination of Coefficient of viscosity by falling sphere method-Determination of Coefficient of viscosity for a liquid by capillary flow method.
10. Diffraction-distinction between Interference and diffraction-Fresnel & Fraunhofer Diffraction-Diffraction Grating.
11. Determination of wavelength of light using Diffraction Grating.
12. Diamagnetism-Classical & Quantum theory-Distinction between dia & paramagnet.
13. Langevin's theory of Diamagnetism.
14. Paramagnetism-explanation using classical & quantum theory.
15. Langevin's theory of Paramagnetism.
16. Ferromagnetism-Statement of Curie-Weiss Law-Ferromagnetic materials.
17. Antiferromagnetism-Domain wall-Hard & soft magnetic materials.
18. Zeeman Effect-definition-Normal Zeeman Effect-Anomalous Zeeman effect.
19. Stark effect-Explanation-Nuclear magnetic Resonance-NMR spectrometer.

20. Paschen Back effect-explanation of energy level.
21. Raman effect-definition-quantum & classical theory of explanation-application.
22. Distinction between metals, semiconductors & insulators-Intrinsic & extrinsic semiconductor-donors & acceptor levels.
23. Superconductivity-Effect of applied magnetic field-Persistent current.
24. Meissner effect-London equations-London penetration depth.
25. Thermodynamics of superconducting phase transition-entropy & specific heat in the superconducting state.
26. Heat capacity-energy gap-isotope effect-BCS theory-Cooper pair
27. Type-1 & Type II Superconductivity.
28. Josephson effect-AC Josephson effect-DC Josephson effect-Josephson tunneling.
29. High temp superconductors-SQUIDS-Josephson Junction switch-Application.
30. LASER-Spontaneous & Stimulated emission-Population Inversion-coherence-Spatial & Temporal Coherence-band width.
31. Laser Doppler Broadening-collisional Broadening-Population Inversion-Pumping-Active medium-resonant cavity.
32. Ruby laser-He-Ne laser.
33. ND-Yag laser-PN junction diode laser.
34. Co<sub>2</sub> laser-MASER=Ammonia maser-application.
35. Holography-recording and reproduction of a hologram-applications.
36. Optical fibers-Numerical aperture-Acceptance-angle-step index & Graded index Fibers. Fabrication of optical fibers-applications-fiber optic communication system a brief Note

### ***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 5 Land RKGaur. 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.

#### ***Lecture Schedule:***

##### **Water**

- 1) Sources of water, Impurities in water, Nature of impurities and their removal; Hardness of water – Effect of hardness, Determination of hardness.
- 2) Softening of water – (1) Lime – soda process (2) Zeolite method
- 3) Demineralization method or Ion-exchange method – (1) Process that separate water from salt water – Evaporation / Distillation, Solvent extraction and Reverse osmosis (2) Process that separate salt from saline water – Electrodialysis.
- 4) Water treatment – Removal of bacteria and micro organism by sterilization – Bleaching powder, Chlorine, Chloramine, Ozone and UV light.
- 5) Potability of water, Various methods of treatment of industrial waste and radio active waste.

##### **Fuels**

- 6) Classification of fuels, Calorific Values, Gross and net calorific values, Coal – Origin and its classification.
- 7) Proximate and ultimate analysis of coal; Petroleum – Origin and classification.
- 8) Fractionation of Petroleum, Refining of petrol, Knocking Property, Octane number, Knocking and anti knocking agents.
- 9) Cracking of petrol, Synthesis of Petrol – Fischer Tropsch and Bergius Process.
- 10) Gaseous fuels – Manufacture, Composition and Calorific values of Coal gas and Biogas, Flue gas analysis by Orsat apparatus.

##### **Corrosion**

- 11) Definition and cause of corrosion, Types of corrosion, Theories of corrosion.
- 12) Galvanic cell corrosion, Concentration cell corrosion, Pitting corrosion,

- 13) Stress corrosion, Dezincification corrosion, Microbial corrosion, Atmospheric corrosion.
- 14) Control of corrosion – By Purification, Alloying, Cathodic protection, Using inhibitors and passivators.
- 15) Protective coatings – Paint, Lacquer, Enamel and Varnish.

#### Polymers

- 16) Types of polymerization, Properties and uses of different types of high polymers.
- 17) Plastics – Types of plastics, Compounding of plastics; Rubber – Natural rubber, Synthesis of rubber.
- 18) Fibers – Natural and synthetic fibers and Use of Nylon, Terylene and Rayon.
- 19) Mid Semester Examination

#### Lubricants

- 20) Classification and types of Lubrication,
- 21) Properties and tests – Viscosity and viscosity index.
- 22) Flash and fire point, Cloud and pour point, Emulsification.

#### Analytical methods

- 23) UV spectra – verification of Beer Lambert's Law; Applications Using Beer Lambert's Law.
- 24) Chromatography – Principle, Types of Chromatography – Adsorption chromatography, Partition chromatography.
- 25) Paper chromatography, Thin layer chromatography.
- 26) Importance of R<sub>f</sub> value, Gas – liquid chromatography, Ion exchange chromatography.
- 27) Gel filtration chromatography, Affinity chromatography, High performance liquid chromatography.

#### Conductance

- 28) Conductance, Specific conductance or conductivity, Equivalent conductance.
- 29) Molar conductance, Measurement of conductance; Cell constant, Effect of dilution on equivalent conductance.
- 30) Kohlrausch's Law – Calculation of absolute ionic mobilities, Relation between Equivalent and Molar conductance at infinite dilution, Theory of weak electrolytes. Electrochemical cell
- 31) Electrochemical cell – electrolytic cell, galvanic cell or Voltaic cell, Daniel cell; Difference in electrolytic cell and Galvanic cell; Salt bridge and its significance, Representation of electrochemical cell,; Reversible and Irreversible cell.
- 32) Concentration cell; Fuel cell; Electrode potential – standard electrode potential, Standard Hydrogen Electrode, Measurement of standard electrode potential, Zn<sup>2+</sup>/Zn electrode, Cu<sup>2+</sup>/Cu electrode.
- 33) Cell potential or electromotive force equation, Measurement of e.m.f, Relationship between Gibb's free energy and cell potential – Nerst equatuion, Primary voltaic cell (Dry cell), Secondary voltaic cell (Lead battery storage).
- 34) Reference electrodes, Secondary reference electrode – Saturated calomel electrode (SCE), Ion – Selective electrode (ISE); Application of e.m.f measurement.

#### ***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).

***Lecture Schedule***

1. Introduction to sequence.
2. Real sequence and its convergence.
3. Comparison test
4. Ratio test
5. Cauchy's root test.
6. Integral test, rabis's test.

7. Absolutely and conditionally convergent series.
8. Exact and Bernoulli's and differential equations.
9. Equations reducible to exact form by integrating factors.
10. Equations reducible to exact form by integrating factors.
11. Equations of first order higher degree.
12. Equations of first order higher degree.
13. Clairaut's equation.
14. Differential equations of higher orders.
15. Methods of finding complementary functions and particular integrals.
16. Methods of finding complementary functions and particular integrals.
17. Methods of finding complementary functions and particular integrals.
18. Methods of variations of parameters.
19. Cauchy's and Legendre's linear equations.
20. Simultaneous linear differential equations with constant coefficients.
21. Series solution techniques.
22. Series solution techniques.
23. Series solution techniques.
24. Bessel's and Legendre's differential equations.
25. Bessel's and Legendre's differential equations.
26. Bessel's and Legendre's differential equations.
27. Formation of partial differential equations.
28. Lagrange's linear equation.
29. Higher order linear partial differential equations with constant coefficients.
30. Higher order linear partial differential equations with constant coefficients.
31. Higher order linear partial differential equations with constant coefficients.
32. Solution of non-linear partial differential equations.
33. Char pits method.
34. Char pits method.
35. Application of partial differential equations.
36. One dimensional wave equations.
37. One dimensional wave equations.
38. One dimensional heat equations.
39. One dimensional heat equations.
40. One dimensional heat equations.
41. One dimensional heat equations.
42. Two dimensional steady state heat flow equation (Laplace equation).
43. Two dimensional steady state heat flow equation (Laplace equation).
44. Two dimensional steady state heat flow equation (Laplace equation).
45. 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.

#### ***Lecture Schedule***

1. Introduction– Difference between information technology and computer science, basic components of IT and Computer science-hardware, software - Types of computers-digital, analog, hybrid computers-business, scientific computers, computer generation.
2. Computer organization, - CPU - -processors- Memory devices -primary memory –secondary storage devices.
3. I/O devices- keyboard-printers.
4. Number systems, base of a number system -decimal, binary-conversion between decimal and binary.
5. Octal, hexadecimal - representation, conversion between various representations, character representations (ASCII, ISCII, Unicode).
6. Types of software - Operating systems- introduction, types of OS, functions of OS- utility software-application software –examples-Data base management Systems – data –record - file-database – functions of DBMS.( Introduction only, commands not necessary)
7. Network - Data communication media, Use of network - LAN and WAN- types of connections.
8. Internet - Internet Applications - role of electronic communications - e-mail.
9. Introduction to computer language- C Programming language-data types –identifiers-constants.
10. Arithmetic operators in C – printf , scanf, -library functions-header files.
11. Control statements-if structures
12. While loop, do-while loop
13. Midterm Examination
14. For loop-nested loops
15. One dimensional arrays
16. Two dimensional arrays
17. User defined function

### ***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.

### ***Lecture schedule.***

1. Beginning with C++ - Applications of C++ - A simple C++ program – More C++ statements – An example with Class – structure of C++ program – creating source file – Compile and linking.
2. Tokens, Expressions and Control Structures – Keywords – Identifiers – Basic Data Types – User .
3. Defined Data Types – derived Data Types – Symbolic Constants – Type Compatibility – Declaration of variables
4. Dynamic initialization of variables, reference variables –operators in C++, scope resolution operator
5. Input output statements- decision making, iterative, pointers pass arguments by value and reference. .
6. Managing console I/O operations-formatted, unformatted, managing with manipulators
7. Functions in C++ - The main function – Function Prototyping – Call by Reference – Return by Reference – Inline functions
8. Default arguments, const arguments, unction overloading, friend and virtual functions.
9. Virtual functions. Managing Console I/O operations – C++ streams – C++ stream classes – Unformatted I/O operations – Formatted I/O operations – Managing with Manipulators
10. Classes and Objects – C structures – specifying a class – defining member functions – A C++ program with class – Making an outside function Inline.
11. Private member functions – Arrays within a class – memory allocation for objects.
12. Static Data members – static member functions-Arrays of objects – objects as function arguments – friendly functions.
13. Constructors and Destructors – Parameterized constructors – Multiple constructors in a class-Default Arguments – constant Arguments
14. Midterm Examination
15. Operator overloading and type conversion – defining operator overloading – overloading unary operators –binary operators – type conversions.
16. Inheritance: Extending classes – Introduction – Defining derived classes – single inheritance
17. Multilevel inheritance – multiple inheritance. File handling – input and output file operations – multiple file programming and project applications

### ***Practical Schedule***

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.

### ***Lecture Schedule***

1. Differentiation of vectors.
2. Gradient and directional derivatives.
3. Divergence and curl of vector
4. Line integrals.
5. Surface and volume integrals.
6. Application of Gauss theorem.
7. Application of Stoke's theorem.
8. Periodic functions, Fourier series.
9. Euler's formulae.
10. Dirichlet's conditions, functions having arbitrary period
11. Even and odd functions
12. Half range series
13. Complex Fourier series
14. Approximation by trigonometric polynomials
15. Fourier integrals
16. Fourier sine and cosine transforms
17. Fourier transform

18. Complex analysis: Complex functions.
19. Derivative.
20. Cauchy- Reimann equation.
21. Laplace's equation.
22. Geometry of Analytic functions
23. Conformal mapping
24. Linear functional transformations
25. Schwarz- Christoffel transformation
26. Transformation by other functions.
27. Complex integration.
28. Line integral in the complex plane.
29. Cauchy's integral Theorem
30. Cauchy's integral formula,(problems)
31. Derivatives of analytic functions
32. Power series
33. Functions given by power series
34. Taylor series and Maclaurin's series
35. Laurent's series.
36. Singularities and Zeros
37. Residue
38. Integration method
39. Evaluation of real Integrals.

### ***Practical Schedule***

1. Differentiation of vectors , Gradient of a scalar point function , directional derivative , application of  $\nabla$  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. Kreyszig, 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

#### ***Lecture Schedule***

1. Numerical methods – an overview – Errors and Approximations – Relative and Absolute errors.
2. Theory of Equations – Relation between roots and coefficients – Transformation of Equations.
3. Newton’s Raphson method and bisection method for solving algebraic and transcendental equations.
4. Gauss elimination Method and Gauss Jordan Method.
5. Crout’s Method.
6. Finite Differences Operator  $E$ ,  $\Delta$ ,  $\nabla$ ,  $\mu$  and  $\delta$  and the relations between them.
7. Newton’s Forward and Backward Interpolation formulae.
8. Lagrange’s Interpolation formula and Newton’s Divided Difference Interpolation formula.
9. Numerical Differentiation
10. Numerical Integration Trapezoidal rule and Simpson’s  $1/3^{\text{rd}}$  rule
11. Solution of Difference Equations – Second order with constant coefficient
12. Mid-Semester Examination
  
13. Solution of Ordinary Differential Equations – Taylor Series Method and Euler’s Method and Euler’s modified method.
14. Runge Kutta Methods

15. Partial Differential Equations – Classification – Solution of Elliptic Equations – Liebmann’s Iteration Process.
16. Partial Differential Equations – Solution of Parabolic Equations – by Crank Nicolson Difference Method.
17. Partial Differential Equations – Solution of Hyperbolic 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<sup>rd</sup> 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 Publishiing.

**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.

### ***Lecture Schedule***

1. Population and sample, parameter and statistics, frequency distribution of data and the calculation of sample statistics, measures of central tendencies
2. Measures of dispersion, coefficient of variation,
3. Skewness and kurtosis
4. 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
5. Correlation -Pearson's coefficient of correlation
6. Regression –simple linear and non-linear
7. Binomial and Poisson distributions, Normal distributions
8. Sampling distributions- chi-square, t and F distributions
9. Mid Term Examination
10. Basic concepts, test for single mean ,mean difference
11. Test for proportion , difference between proportions .
12. Small sample tests –based on t and F distribution ,test for single mean , difference between means
13. Testing significance of mean using t-test, Paired t test
14. Testing association between attributes using chi-square test ,goodness of fit
15. ANOVA –one way , two way classification
16. Basic concepts of experimental design ,CRD , RBD
17. Control Charts – $\bar{X}$  , R, np and C charts

### ***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.

***Lecture Schedule***

1. Nature of farm products - with reference to processing
2. Cost concepts and seven cost curves.
3. Short run and long run equilibrium
4. Engineering cost curves
5. Break even analysis and Returns to scale
6. Economies of scale
7. Project preparation for food processing units - technical, institutional, organizational, managerial aspects
8. Project preparation - commercial, financial and economic aspects
9. Project cycle - identification, formulation, appraisal, implementation and evaluation
10. Financial management - Assessing, acquiring allocation of funds.
11. Financial statements - cash flow statement, statement and balance sheet, financial ratios
12. Time value of money - compounding and discounting
13. Demand - determinants of demand, change in demand, change in quantity demanded
14. Market and Marketing - concepts
15. Market structure - types and characteristics
16. Price determination in Purely competitive and Oligopoly markets
17. Mid semester exam
18. Price determination in Monopolistically competitive markets

19. Pricing strategies of firms - cost oriented pricing.
20. Pricing strategies of firms - competition oriented pricing.
21. Marketing management - concepts, consumer markets, business markets
22. Marketing Environment - demographic, economic, natural, technological and political environment
23. Consumer buying behavior - factors influencing consumer buying behaviour
24. Evolution of Marketing department
25. Market segmentation - nature, pattern and basis for segmentation and variables influencing segmentation
26. Market measurement and forecasting
27. Marketing plan - executive summary, situation analysis, objectives and goals, strategy statement, action programme, budget and controls
28. Management of distribution channel - direct selling, distribution, dealer and retailer network, franchise
29. Market promotion - Sales promotion and Personal selling
30. Advertisement, publicity and public relations
31. Market Information System
32. Market research
33. Export Trade and Government Intervention  
GATT and World Trade Organisation regulations

### ***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.

### **Basc.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

#### ***Lecture Schedule***

1. Extension education- its meaning, importance, concepts and scope in the field of agricultural engineering.
2. State- of- the- art of extension and rural development approaches for agricultural development with special emphasis on agril. Engineering- different agencies- current extension and rural development programs- their mode of operation. Decentralised planning and administration- Peoples planning programme.
3. Communication- levels of communication. Agricultural communication- its special features. Socio- physiological barriers to effective communication. Recent trends in Agril. communication.
4. Diffusion, adoption and Transfer of Technology(TOT) of agricultural engineering innovations- concepts- adoption dynamics- classical and modern theories and hypotheses of decision making adoption and diffusion.
5. Extension teaching methods: Classification and characteristics of extension methods- Individual methods- their types, Objective, planning and preparation.
6. Group methods- planning and conducting group discussion, buzz sessions, brainstorming sessions and negotiation. Method demonstration, result demonstration, on farm trials, adaptive trials verification trials and Front Line Demonstration related to the testing and transfer of technology of farm implements and machinery, soil and water conservation, Irrigation and drainage and Post harvest technology.
7. Seminars, symposia, farm clinics, workshops, Agril.skill contests, farmer/- scientists interaction sessions- their planning and implementation
8. Mass methods- planning and conducting campaign and field days. Exhibitions- planning, preparation and implementation- Farm publication- planning and preparing leaflets, folders, booklets, news letters- Writing for dailies and farm magazines- writing for farm radio visual equipment and devices.
9. Audio visual aids- their classification and role in Agril. Engineering Extension.
10. Mode of preparation and use of audio aids, non-projected and projected visual aids, and audio- visual aids for training situation and transfer of technology works. Latest audio visual equipment and devices.
11. Motivation and its role in extension – theories of motivation , types of motives- their use for effective extension work among individuals and in groups.
12. Mid semester Examination

13. Training for development and transfer of technology- training approaches and methods- assessment of training needs- How to be a good extension trainer and facilitator.
14. Organizational behavior process in organization – organizational communication- leadership- motivation from concept to application- incentives and morale.
15. Decision making in organizations- responsibility and authority. Organizational change- how to cope with change . How to deal with crisis and stress situations in organizations.
16. Public relation for Agril. Engineering extension work and management- its fundamentals, theory and practice.

### ***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.