

DEPARTMENT OF FOOD ENGINEERING

Sr. No.	Course No.	Course Title	Credits	Semester
1	FE-111	Engineering Drawing	1 (0+1)	I
2	FE-112	Fluid Mechanics and Hydraulics	2 (1+1)	I
3	FE-123	Energy Generation and Conservation	3 (2+1)	II
4	FE-124	Heat and Mass Transfer	2 (1+1)	II
5	FE-235	Food Processing Equipments-I	3 (2+1)	III
6	FE-236	Food Packaging	3 (2+1)	III
7	FE-247	Food Processing Equipments-II	3 (2+1)	IV
8	FE-358	Refrigeration Engineering and Cold Chain	3 (2+1)	V
9	FE-359	Bio-Chemical Engineering	3(2+1)	V
10	FE-3510	Instrumentation and Process control	3 (2+1)	V
11	FE-3611	Food Plant Design and Layout	3 (1+2)	VI
		Total Credits	29 (17+12)	

DEPARTMENT OF FOOD ENGINEERING

FE-111 ENGINEERING DRAWING 1 (0+1)

Practicals

No. of Units	Topics	No. of Experiments
1	Drawing of lines, lettering and dimensioning, types of lines	2
2	Types of lettering, types of dimensioning	2
3	Drawing of scales Plain scale and diagonal scale	1
4	Drawing of screw threads Types of threads	2
5	Screw fastening Types of nuts, types of bolts and stud	1
6	Drawing of rivets and riveted joints, forms of rivet heads, types of riveted joints, failure of riveted joints	2
7	Drawing of welded joints Forms of welds, location and dimensions of welds	1
8	Drawing of keys, types of keys	2
9	Drawing of shaft couplings Rigid couplings and flexible couplings	1
10	Drawing of shaft bearings Journal bearings and pivot bearings	2
	Total	16

REFERENCE BOOKS

Elementary Engineering drawing
2 Machine drawing

N.D. Bhatt
N.D. Bhatt

FE-112 FLUID MECHANICS AND HYDRAULICS 2 (1+1)

Theory

No. of Units	Topics	No. of Lectures
1	Properties of fluids	2
2	Static pressure of liquids : Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid. Pressure on vertical rectangular	2

	surfaces. Compressible and non compressible fluids. Surface tension	
3	Pressure measuring devices: Simple, differential, micro, inclined manometer, mechanical gauges,	2
4	Floating bodies : Archimede's principle, stability of floating bodies. Equilibrium of floating bodies	2
5	Fluid flow : Classification, steady, uniform and non-uniform, laminar and turbulent, Bernoulli's theorem and its applications	2
6	Flow through pipes: Loss of head	1
7	Flow through orifices, discharge losses. Time for emptying a tank. Venturi meter, pitot tube, Rota meter. Water level point gauge, hook gauge. Reynold's number	2
8	Pumps : Classification, reciprocating, centrifugal pump. Pressure variation, work efficiency. Types of chambers, selection and sizing	2
	Total	15

Practicals

No. of Units	Topics	No. of Experiments
1	Study of different tools and fittings	1
2	To plot flow rate versus pressure drop with U-tube manometer	2
3	Verification of Bernoulli's theorem	2
4	Determination of discharge co-efficient for venturi, Orifice, V-Notch	2
5	Verification of emptying time formula for a tank	1
6	Determination of critical Reynold's number by Reynold' apparatus	2
7	Study of reciprocating, centrifugal and gear pump	2
8	Calibration of Rotameter	2
9	Study of different types of valves	1
	Total	15

REFERENCE BOOKS

- | | | |
|---|-----------------|---|
| 1 | Fluid Mechanics | V.L. Streeter (1983), McGraw Hill, New York |
| 2 | Fluid Mechanics | R.S. Khurmi (1994), Sultan Chand Publishers, Delhi. |
| 3 | Hydraulics | Jagdish Lal (1987), Metropolitan Publishers, New Delhi. |

FE-123 ENERGY GENERATION AND CONSERVATION 3 (2+1)

Theory

No. of Units	Topics	No. of Lectures
1	Units and dimensions, Basic concepts : systems, processes, cycles, energy,	3

	The Zeroth Law of Thermodynamics	
2	Ideal gases : Equation of state, Compression and expansion of gases	2
3	The first Law of Thermodynamics : Internal energy, enthalpy	2
4	Renewable energy sources like solar, wind and biogas and their utilization in food processing	3
5	Related equipment and machineries to renewable energy sources	2
6	Fuels : Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels	3
7	Properties of steam : Wet, dry saturated, superheated steam, Use of steam tables	2
8	Steam generators : Fire tube boilers, Water tube boilers	2
9	Boiler mountings and Boiler accessories	2
10	Measurement of Height of boiler chimney	2
11	Condensers	2
12	Layout of pipe-line and expansion joints	2
13	Boiler trial : Codes, Indian Boiler Regulation acts. Air Compressors : Reciprocating, Single and two stage air compressors	3
	Total	30

Practicals

No. of Units	Topics	No. of Experiments
1	Application of thermodynamics in engineering problems	2
2	Determination of dryness fraction of steam	2
3	To study the boiler installed in Model Plant, Water softening plant, Babcock and Wilcox boiler, Electrode boiler, Boiler mounting and steam-line layout and steam traps	6
4	Visit to sugar mill or rice mill plant with steam utilization	3
5	Study of solar water heater and biogas plants and appliances	2
	Total	15

REFERENCE BOOKS

- | | | |
|---|--|--|
| 1 | Engineering Thermodynamics | C.P. Gupta & Rajendra Prakash (1991), Nemi Chand and Sons, Roorkee |
| 2 | Elements of Heat Engines | N.C. Pandya & C.S. Shah. (1990) Charotar Publishing House, Anand |
| 3 | Indian Boiler Regulation Codes. (1991) | |
| 4 | Dairy Plant Engg. and Management | Tufail Ahmed (1996), Kitab Mahal New Delhi |

FE-124 HEAT AND MASS TRANSFER 2 (1+1)**Theory**

No. of Units	Topics	No. of Lectures
1	Basic heat transfer process, thermal conductivity, Overall heat transfer coefficient, physical properties related to heat transfer	2
2	One-dimensional steady state conduction : Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian co-ordinates, Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity	2
3	Heat transfer through composite walls and insulated pipelines	1
4	Steady-state heat conduction with heat dissipation to environment :Introduction to extended surfaces (FINS) of uniform area of cross-section. Equation of temperature distribution with different boundary conditions. Introduction to unsteadystate heat conduction	1
5	Convection : Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number. Prandtl number, Reynolds number,	2
6	Radiation : emissivity, absorptivity, transmissivity, Radiation through black and grey surfaces, determination of shape factors	2
7	Heat Exchangers : General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers,Shell and tube and plate heat exchangers,	2
8	Application of different types of heat exchangers in dairy and food industry	1
9	Mass transfer : Fick's law of diffusion, steady state diffusion of gases and liquids through solids, isothermal evaporation of water into air, mass transfer coefficient, applications in Dairy and Food industry	2
	Total	15

Practicals

No. of Units	Topics	No. of Experiments
1	To study various types of heat exchangers used in Dairy & Food Industry	2
2	Preparation and calibration of thermocouples	2
3	Determination of thermal conductivity : milk, solid dairy & food products.	2
4	Determination of overall heat transfer co-efficient of : Shell and tube, plate heat exchangers Jacketted kettle used in Dairy & Food Industry	3
5	Studies on heat transfer through extended surfaces.	2
6	Studies on temperature distribution and heat transfer in HTST pasteurizer	2
7	Design problems on heat exchangers	2
	Total	15

REFERENCE BOOKS

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|---|----------------------------------|--|
| 1 | A course in Heat & Mass Transfer | S. Domkundwar, (1993), Danpat Rai and Sons, New Delhi |
| 2 | Heat Transfer | C.P. Gupta (1964), Prentice hall of India, New Delhi |
| 3 | Principles of Heat Transfer | F. Kretith, and M.S. Bohn, (1986), Harper and Row Publishers, New York |

FE-235 FOOD PROCESSING EQUIPMENTS – I 3 (2+1)

Theory

No. of Units	Topics	No. of Lectures
1	Material handling : Material handling machines and conveyors	2
2	Pretreatment unit operations : Cleaning, Dehulling and Dehusking, Sorting & Grading	2
3	Peeling and Forming	2
4	Size reduction and separation	2
5	Agitation and Mixing	2
6	-do-	2
7	Engineering properties of Food materials: Its significance in equipment design, processing and handling of food products	2
8	Hygienic design of Food processing equipment. Sanitary requirement,	2

	Sanitary pipes and fittings	
9	Rheology and texture of food materials: Concept of rheology, elastic, plastic and viscous behaviour, methods of texture evaluation, subjective and objective measurements	3
10	Methods of texture evaluation, subjective and objective measurements	2
11	Evaporation : Principles of evaporation, types and selection of evaporators, mass and energy balance. Design of single and multiple effect evaporators, recompression heat and mass recovery and vacuum creating devices.	3
12	Drying : Principles of drying, drying rate kinetics, Classification, mass and energy balance. Different types of dryers and components - roller, spray, tray, fluidized bed etc	3
13	Thermal processing: Blanching, Pasturization and Sterilization - principles, different methods and equipments. Processing in containers, process time, T-evaluation, Design of batch and continuous sterilization	3
	Total	30

Practicals

No. of Units	Topics	No. of Experiments
1.	Study of Instron and its working	2
2	Studies on the sorting and grading of food materials	2
3	Determine flow parameters of Newtonian, non newtonian food products by : Capillary tube viscometer, Hakke's viscometer, Rotational viscometer and Falling Ball viscometer	3
4	Study of evaporator, dryer, sterilizer	2
5	Design problems on evaporators	2
6	Design problems on Dryers	2
7	Numerical problem on Thermo bacteriology (D, Z, & F)	2
	Total	15

REFERENCE BOOKS

- | | | |
|---|---|------------------------------------|
| 1 | Unit operations of chemical Engineering | Mc Cabe Smith & Harriott |
| 2 | Food Engineering operation | Brennan, Butters, Cowell and Lilly |
| 3 | Process Heat Transfer | Kern |

Theory

No. of Units	Topics	No. of Lectures
1	Introduction to subject, Packaging situations in World, India, need of packaging, plastic consumption/use in World, India etc. Package requirements, package functions, Hazards acting on package during transportation, Storage and atmospheric package, labeling laws	5
2	Package Materials: classification packages, paper as package material its manufacture, types, advantages corrugated and paper board boxes etc. Glass as package material, Manufacture, Advantages, disadvantages. Metal as package material-manufacture, Advantages, disadvantages, Aluminum as package material,. Its advantages and disadvantages, plastic as package material classification of polymers, properties of each plastics, uses of each plastics, chemistry of each plastic such as polyethylene, Polypropylene, polystyrene, polycarbonate, PVC, PVDC, Cellulose acetate, Nylon etc.	10
3	Lamination Coating and Aseptic packaging Lamination, need of lamination, types, properties, advantages & disadvantages of each type Coating on paper & films, types of coatings. Need of coating, methods of coatings. Aseptic packaging-Need, Advantaged, process, comparison of conventional & aseptic packaging, system of aseptic packaging and materials used in aseptic packaging. Machineries used in Packing foods	5
4	Packaging of Specific Foods Packaging of specific foods with its properties, Like bread, Biscuits, Coffee, Milk powder, egg powder, carbonated beverages. Snack foods etc.	5
5	Mechanical and functional tests on Package Various mechanical and functional testes perform in laboratories on package boxes and package materials	5
	Total	30

Practicals

No. of Units	Topics	No. of Experiments
1	Classification of various packages bared on material and rigidity	1
2	Measurement of thickness of paper, paper boards	1
3	Measurement of water absorption of paper, paper boards	1
4	Measurement of bursting strength of paper of paper boards	1

5	Measurement Tear resistance of papers	1
6	Measurement of puncture resistance of paper and paperboard	2
7	Measurement of tensile strength of paper of paper boards	1
8	Determination of gas transmission rate of package films	1
9	Determination of WVTR of films	2
10	Determination of coating on package materials	1
11	Identification of plastic films	1
12	Prepackaging practices followed for packing fruits and vegetables	2
	Total	15

REFERENCE BOOKS

Handbook of Package Engineering	Joseph F. Hanlon
Fundamentals of Packaging	F.A. Paine
Food Packaging	Sacharow and Griffin
Principles of Food Packaging	R. Heiss
Flexible Packaging of Foods	A.L. Brody
Food Packaging and Preservation	M. Mathouthi

FE-247 FOOD PROCESSING EQUIPMENTS- II 3 (2+1)

Theory

No. of Units	Topics	No. of Lectures
1	Mechanical separations : Centrifugation : liquid-liquid centrifugation, liquid- solid centrifugation, clarifiers, de sludging and decanting machines	3
2	Filtration : Principles involved in filtration. Pressure and vacuum filtration	3
3	Expression : batch and continuous type	3
4	Baking, Roasting and Frying equipment	3
5	Extraction and Leaching, Crystallization and Distillation : Basic principles involved	3
6	Membrane processes : Ultra filtration, Reverse osmosis	3
7	Electro dialysis, Pre-evaporation and micro filtration	3
8	Microwave and Dielectric & Infrared heating : Physical parameters. Heat transfer phenomenon. Equipment and application	3
9	Irradiation - Principle and its equipments	3
10	Blending and pulverization equipments	3

	Total	30
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Practicals

No. of Units	Topics	No. of Experiments
1	Lab demonstration on state of water	2
2	Demonstration of equilibrium sorption isotherms	2
3	Study of centrifugal separators	2
4	Study of ultra filtration equipments	2
5	Study of microwave oven, infrared moisture meter and universal moisture meter	2
6	Visit to Bakery Plant	1
7	Study of size reduction machineries	2
8	Study of size reduction machineries	2
	Total	15

REFERENCE BOOKS

- | | |
|------------------------------------|------------------------------------|
| 1 Food Engineering operation | Brennan, Butters, Cowell and Lilly |
| 2 Introduction to Food Engineering | Heldman D.R. and Singh R.P. |
| 3 Fundamentals of Food Engineering | Charm S.E. |

FE-358 REFRIGERATION ENGINEERING 3 (2+1) AND COLD CHAIN

Theory

No. of Units	Topics	No. of Lectures
1	Definition of refrigeration and air conditioning, necessity of refrigeration and air conditioning. History of refrigeration	3
2	Refrigerants, definition, classification, nomenclature, methane and ethane series. Desirable properties of refrigerants- physical, chemical, safety, thermodynamic and economical. Azeotropes	4
3	Components of vapour compression refrigeration system, evaporator, compressor, condenser and expansion valve	4
4	Ice manufacture, principles of ice production, different systems Treatment of water for making ice, Brines, Freezing tanks, ice cans, air agitation, quality of ice	4

5	Applications of refrigeration in different food products – fruit and vegetable products, meat products, fish, poultry products, dairy products etc	4
6	Food Freezing: Freezing systems: indirect contact systems, plate freezers, air blast freezers, and freezers for liquid foods. Direct contact systems, air blast immersion, frozen food properties, density, thermal conductivity enthalpy, apparent specific heat and thermal diffusivity, freezing time, factors influencing freezing time, freezing rate, thawing time	6
7	Frozen food storage: Quality changes in foods during frozen storage	5
Total		30

Practicals

No. of Units	Topics	No. of Experiments
1	Standard refrigeration symbols	1
2	To study vapour compression refrigeration system	1
3	Solving problems on cooling load calculations / Refrigeration load	3
4	To study the properties and performance characteristics of some commonly used refrigerants	2
5	To study the components of the refrigeration system	3
6	Freezing of foods by different methods	3
7	Determination of freezing time of a food material	2
Total		15

REFERENCE BOOKS

Refrigeration and air-conditioning Manohar Prasad
Introduction to Food Engineering R. P. Singh and D. R. Heldman
A course in Refrigeration and air conditioning S.C. Arora and S. Domkundwar

FE-359 BIOCHEMICAL ENGINEERING 3 (2+1)

Theory

No. of Units	Topics	No. of Lectures
1	Biochemical Engineering and their scope: Definition, necessity, value engineering, good manufacturing practices. Standard operating procedures, good laboratory practices	2

2	History of Biochemical Engineering: Theory of scientists Pfizer, Alexander Fleming Salman Waksmen. Instrumentation and their control, physical and chemical parameters.	1
3	Role of biochemical engineering in development of modern fermentor: Scale up, management of cellular process, design, operation and their problems	3
4	Basis for biochemical engineering in fermentation industry: Unit operation, unit process, process design, chemical reaction kinetics, process variables, biochemical properties, process control	3
5	Kinetics of microbial growth and death: Definition, fermentation kinetics rate of cell synthesis, product formation and effect of environment. Types of kinetics, Batch and continuous type, control measures	2
6	Simple enzyme kinetics: Simple kinetics model for enzyme substrate interaction. Derive the equation of Michelin Menton, for reaction rate, product formation, calculation of Km and V max values	3
7	Complex enzyme kinetics: Oxidation – reduction form of enzymes, observed apparent rate constant, factors affecting the inhibition, competitive, non competitive inhibition, substrate interaction	3
8	Kinetics pattern of various fermentations: Classification of kinetics pattern, as per different scientists, simple, simultaneous, consecutive, stepwise, complex reactions and their examples	3
9	Media and air sterilization: Definition, thermal death time, media heat sterilization, advantages of continuous sterilization.	2
10	Aeration and agitation	3
11	Product recovery of different process: Mass transfer resistance, extraction, leaching, drying and evaporation, sorption and storage, permeability law	2
12	Product formation for value added products using bioconversions techniques Production of single cell protein, alcohol, raw material for required for product formation, production of antibiotics, economic process, utilization of damaged grain through bioconversion, present mode of utilization and their nutritional value	3
	Total	30

Practicals

No. of Units	Topics	No. of Experiments
1	Instrumentation and their control in fermentation industry -physical parameter	2
2	Instrumentation and their control in fermentation industry – chemical parameter, metabolic parameters and biosensors in food industry	2

3	To study the different parts of 30 lit. laboratory and 1 lakh lit. capacity fermentors	1
4	Comparative study of one lakh liter laboratory fermentor	1
5	To study the thermal stability of peroxides enzyme in potato	1
6	To assess the amylase activity from given foods sample	1
7	To measure the microbial growth after (fermentation thermal death time)	1
8	To study the mass transfer of solution by dialysis process	1
9	To study the time temperature relationship for destruction of microorganisms	1
10	To study the ethyl alcohol production through bioconversion	2
11	To study the vitamin production through bioconversion	1
12	Visit to Distillery Plant	1
Total		15

REFERENCE BOOKS

Biochemical Engineering Shuichi Alba, Arthur E. Humphrey and
Nancy F. Millis
Biochemical Engineering Fundamentals Bailer J.E. and Ollis D.F.

FE-3510 INSTRUMENTATION AND 3 (2+1) PROCESS CONTROL

Theory

No. of Units	Topics	No. of Lectures
1	Introduction, definition, recorders and monitors, panel boards	3
2	General characteristics of instruments, static and dynamic characteristics	4
3	Temperature and temp. scales, various types of thermometers - mercury-in-glass, bimetallic, pressure-spring thermometers, thermo couples, resistance thermometers and pyrometers	5
4	Pressure and pressure scales, manometers, pressure elements differential pressure	4
5	Liquid level measurement, different methods of liquid level measurement	4
6	Flow measurement, kinds of flow, rate of flow, total flow differential pressure meters, variable area meters	4
7	Transmission, pneumatic and electrical	3
8	Control elements, control actions, pneumatic and electrical control systems	3

	Total	30
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Practicals

No. of Units	Topics	No. of Experiments
1	To study instrumentation symbols	1
2	Measurement of temperature by different thermometers.	1
3	Measurement of pressure by 'U' tube manometer, (inclined tube manometer)	2
4	Measurement of liquid level in the tank with the help of Bob and tape	2
5	Determination of relative humidity by wet and dry bulb thermometer	2
6	Measurement of velocity of fluid by using venturimeter/orifice meter/pilot tube	2
7.	Measurement of RPM of an electric motor by Tachometer	2
8	Measurement of wind velocity by anemometer	1
9	Measurement of intensity of sun shine by sunshine recorders	2
	Total	15

REFERENCE BOOKS

- | | |
|---|----------------------------|
| 1 Instrumentation | F.W. Kirk and N.R. Rimboi. |
| 2 Industrial instrumentation fundamentals | Austin E. Fjribance |
| 3 Process instruments and controls Handbook | Considine |

FE-3611 FOOD PLANT DESIGN AND LAYOUT 3 (1+2)

Theory

No. of Units	Topics	No. of Lectures
1	Overall design of an enterprise : Plant design, sales planning for plant design	1
2	Strength of material – engineering materials, material science, use of various metals, including plastic, glass, etc in food industry, selection and specification – material design, concepts and manufacturing of various equipments and machineries for food processing plant	2
3	Plant Location, levels of Plant location. Location of layout : location factors, plant site selection. Location theory and models, industrial buildings and grounds	2
4	Classification of Dairy and Food Plants, farm level collection and chilling centre, space requirement	1

5	Preparation of a Plant Layout : Plant Layout problem, importance, objectives, classical types of layouts.	2
6	Evaluation of Plant Layout. Advantages of good layout. Organizing for Plant Layout, Data forms	1
7	Common Problems in Plant Layout and Process scheduling	1
8	Siting of Process sections, Equipment selection and capacity determination	2
9	Arrangement of process, and service equipment. Estimation of Services and Utilities	1
10	Office layout, line balancing, Flexibility. Practical Layouts	1
11	Maintenance of Food Plant Building, Illumination and ventilation, Cleaning and sanitization, painting and colour coding, Fly and insect control	1
	Total	15

Practicals

No. of Units	Topics	No. of Experiments
1	Preparation of project report	3
2	Preparation of feasibility report	2
3	Layout of Food storage wares and godowns	2
4	Layout and design of cold storage	3
5	Layout of preprocessing house	2
6	Layout of Milk and Milk product plants	3
7	Bakery and related product plant	3
8	Fruits processing plants	3
9	Vegetable processing plants	2
10	Layout of multi-product and composite food Plants	3
11	Waste treatment and management of food plant	3
12	Visit to Fruit and Vegetables processing plant	1
	Total	30

REFERENCE BOOKS

Milk Plant Layout
Plant Layout and Design
Engineering for Dairy and
Food Products

H.S. Hall (1963). FAO Pub., Rome
James M. Moore (1962), Mac Millan, New York
A.W. Faral (1980). Rebert E., Kriger
Pub Co., New York

