



Foreword

Dairy sector has socio-economically significant role in the development of rural and urban India. It is growing manifolds after successful implementation of operation flood, 1970. Similarly, change with liberalization of Indian economy has opened up many opportunities to the Dairy sector. Milk is the largest commodity of animal husbandry sector in India, both in terms of quantity and value. Milk production may touch 180 million tonne by 2030 with a per capita consumption of around 390 ml at an estimated population of 153 billion. Only, 35 % of total milk production, in India, is processed. Out of which 13 % is processed by large scale dairy plant/organized sector, while 22 % by unorganized sectors and remaining milk is consumed as liquid milk by household (CII, 2009; Singh and Datta, 2010).

Looking at this scenario, it appears that large quantity of milk in the market is consumed raw rather than processed for milk products. This is due to lack of processing plants and trained manpower. It is quoted by CII, 2009 that branding of milk products in Dairy sector may climb up to 30% by 2030. To pursue this demand oriented supply, India has to work hard in Dairy sector. It requires long term strategic planning and trained manpower.

At present 19 ICAR institution/universities are offering dairy education programmes such as B. Tech (Dairy Technology), IDD (Dairy Technology) etc. These institutions produce less than 300 dairy graduates every year. It is estimated that by the year of 2020 estimated demand of dairy graduates will be 25000. This suggests that current numbers of dairy colleges may not have capacity to supply trained manpower to fulfil future need. To accomplish the plausible demand, many cooperatives and other non government agencies (NGOs) should come forward to start colleges to produce trained manpower.

Albeit, it is well and good to get trained manpower from other agencies, at the same time it is also needed to have Regulations for quality assurance. As per Kamdhenu University Act, 2009, all the activities related with Veterinary, Dairy or Fisheries sectors in Gujarat State should be under Kamdhenu University only. Therefore University has prepared "Regulations" for Affiliation of College of Dairy Science to Kamdhenu University, 2015, aiming with supply of quality manpower from their affiliated colleges.

I hope these Regulations shall be a good guide to prepare a proposal for starting a Dairy Science College affiliated to Kamdhenu University.

M. C. Varshneya
(Vice Chancellor)

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Introduction

Kamdhenu University has been established by Government of Gujarat under the Kamdhenu University Act, 2009, for education and development of Veterinary, Dairy and Fisheries and allied sciences in the State. As demand of trained manpower in the field of Dairy Technology has been increased, many non governmental agencies and co-operatives have come forward with the idea of opening institutions to generate workforce for the Dairy industry.

To regulate those institutions and maintain quality and standard of education in Dairy Technology, Kamdhenu University has decided to prescribe Regulations with following in view:

Vision

- Provide excellent and skilled human recourse in Dairy industry equipped with technological innovative attitude and entrepreneurial orientation.

Mission

- To regulate the standards and quality in Dairy education.
- To mould individuals into future quality human resource and entrepreneurs in the area of Dairy education.
- To review and check the quality of B.Tech (DT) programme run by the colleges under Kamdhenu University.

Objectives

- To judge standards of instruction program and the teaching facilities of affiliated Dairy Technology Institution of Kamdhenu University.
- To regulate affiliated institution as per prescribed Rules and Regulations.
- To maintain quality of education of Dairy Science in the jurisdictions of Kamdhenu University.

**KAMDHENU UNIVERSITY
GANDHINAGAR**

**REGULATIONS FOR AFFILIATION OF COLLEGE OF DAIRY SCIENCE TO
KAMDHENU UNIVERSITY, 2015**

1. Short Title, Extent and Commencement:
 - (i) These Regulations shall be called "**Regulations for Affiliation of College of Dairy Science to Kamdhenu University, 2015**".
 - (ii) These shall extend to all institutions which intend to affiliate or are affiliated (annual provisional) for B-Tech (Dairy Technology) programme with this University located anywhere within the jurisdiction of the University i.e., the whole of the state of Gujarat.
 - (iii) These Regulations will be effective from the date of notification and shall also apply to the institution under the process of affiliation and those institution accorded affiliation provisionally to Kamdhenu University.
2. Definitions - In these Regulations, unless the context otherwise requires:
 - a) The words and expressions shall be the same as defined in the Kamdhenu University Act, 2009.
 - b) "Institute" or "Institution" means an institution or organisation registered under the appropriate laws of State i.e. Societies Registration Act, 1860, Bombay Public Trust Act, 1950 etc. or a Company incorporated under the Companies Act, 2013 (Act No. 18 of 2013) as amended from time to time or the State/Central Government institutions and/or a College which has been accorded provisional affiliation to impart education leading to graduation in Dairy Science.
 - c) "Affiliation" means affiliation (provisional or permanent) accorded to a College, whether private or public, by whatever name called, with respect to specific academic programmes;
 - d) "College" means for the purpose of these Regulations, an institution affiliated to the University and providing Bachelor of Technology in Dairy Technology.
 - e) "Principal" means head of an Affiliated College or Institution of Dairy Science.

- f) “Teacher” means for the purpose of these Regulations, a person, known by any rank, appointed/hired by the Affiliated Institution for the purpose of imparting instruction;

3. Applicability:

These regulations shall apply to all those institutes as defined in regulation no. 2(b).

4. General Regulations and Procedure for Affiliation:

- (i) The institute desirous to start a College of Dairy Science shall apply to the Registrar in the prescribed Application Form (Appendix-I), which shall be made available at a charge of Rs. 10,000/ (Rupees Ten thousand only) in the form of Demand Draft drawn in favour of University account to be intimated by University before 31st March of the year preceding the year from which affiliation is intended to take effect. Late applications shall not be considered.
- (ii) The applicant shall have proven financial capabilities of annual turnover of minimum Rs. Two crore as evident from last three year's balance sheet certified by Chartered Accountant.
- (iii) The applicant shall have its own buildings and land with undisputed ownership and possession of the buildings and/or land proposed for starting a College of Dairy Science.
- (iv) The applicants shall have corpus funds of minimum Rs. One crore and shall have minimum 35 acres of contiguous land or as prescribed by the Indian Council of Agricultural Research (ICAR) under its clear title exclusively for the College of Dairy Science. Documentary evidences and affidavits shall be produced in this regards at the time of application. The affiliation shall not be granted for rented facilities.
- (v) The Institute shall have infrastructure and other facilities for the purpose of teaching and practicals as per the Annexure I.
- (vi) The application received by the Registrar shall be scrutinised by the Scrutiny Committee consisting of following members.
1. Dean of Dairy Faculty of Kamdhenu University - Chairman
 2. Two experts to be nominated by Vice Chancellor

3. One representative of Director of Animal Husbandry not below the rank of Joint Director

4. Registrar – Member Secretary

The above said committee shall strictly scrutinise the application in the light of above said clauses of these Regulations and recommend for further necessary actions.

(vii) Having found satisfactory report of the scrutiny committee, the Registrar on the recommendation of the Scrutiny Committee, shall inform the institute to pay non refundable processing fees of Rs. 1,50,000/- (Rupees One Lac Fifty Thousand only) in the form of Demand Draft drawn in favour of University account intimated by University.

(viii) On receipt of the processing fees, the University shall constitute an inspection committee consisting of following members which shall visit the institution and will present its inspection report to the University.

1. Dean of Dairy Faculty of Kamdhenu University - Chairman

2. Two experts to be nominated by Vice Chancellor

3. One representative of Director of Animal Husbandry not below the rank of Deputy Director

4. Executive Engineer of the University or his representative not below the rank of Deputy Engineer

5. Deputy Registrar - Secretary

(ix) The inspection committee appointed shall visit the institute and inspect all the documents, premises, financial capabilities, available infrastructures, academic and technical capabilities and other facilities of the institution. The institution shall, besides producing evidences of adequate financial capabilities as provided in the sub rule (iv) shall furnish a bank guarantee of an amount equivalent to six months' salary of teaching and non-teaching staff or a minimum of Rs. One crore only, whichever is higher, in favour of the University before provisional affiliation is granted.

(x) The inspection committee shall submit its report to the Registrar within two months from the date of receipt of non refundable fees along with the requirements mentioned in sub rule (ix). The report shall be placed in the

Academic Council in the next meeting for necessary recommendation to the Board of Management of the University.

- (xi) On approval of the Board of Management, the trustee/society shall obtain "No Objection Certificate" from State Government, which shall be obtained separately by the trust/institution.
- (xii) The Board of Management shall accord provisional affiliation for one year or reject the application with reasons in writing which shall be conveyed to the applicant by the Registrar. On approval of the provisional affiliation by the Board, the Institute shall have to remit a non refundable one time affiliation fees of Rs. 50 lacs (Rupees Fifty lacs only) in the form of Demand Draft in favour of University account intimated by University before the beginning of common admission process by the University, failing which the institute will not be permitted to start the academic programme for that year.
- (xiii) The renewal of affiliation in subsequent years shall be accorded by the Board of Management on recommendation of the Academic Council and inspection committee as prescribed in sub rule (ix) on receipt of application for renewal from the institute. The inspection committee for renewal of affiliation shall visit the institution before 30th April of that year on receipt of non refundable inspection fee of Rs. 1,50,000/- (Rupees One Lakh Fifty thousand only) by 31st March every year. The fees for visit of inspection committee shall have to be remitted for each such visit of inspection committee. The amount of fees may be revised by University without notice.
- (xiv) Any institution whose application for affiliation has been rejected, may apply afresh as per the procedure laid down here in these Regulations.

5. Admission, Fee Structure and Examinations:

- (i) The admission procedure for degree course shall be as provided in the Regulations for the Award of Bachelor of Technology in Dairy Technology (B. Tech) of the Kamdhenu University.
- (ii) The Institute shall compulsorily participate in centralized admission system and in no case admit students directly on its own.
- (iii) The intake capacity for of an institute affiliated course shall be initially 40 students which may be increased up to maximum of 60 students per year on

recommendations of the inspection committee and on approval by the Academic Council.

- (iv) Management quota seats will be as per regulations for the award of Bachelor of Technology in Dairy Technology of Kamdhenu University.
- (v) The institution may issue advertisements for promotional purpose but in no case shall issue any advertisement for admission pertaining to concerned academic year.
- (vi) The Institute may charge fees to the students as prescribed by the Kamdhenu University from time to time except management quota seats.
- (vii) The entire process of conduct of final/end term examinations, evaluation and related issues for the degree course shall be under the direct control and supervision of the Kamdhenu University.

6. Award of the Degree:

After successful completion of the course, the degree certificates (provisional or otherwise) shall be issued to the students by the Kamdhenu University only.

7. Faculty and Support Staff:

The strength of the teaching as well as supporting staff shall be such as provided in Annexure-I.

8. Recruitment of Staff:

- (i) The qualification of teaching and other technical staff shall be recruited as per the recruitment regulations prescribed by the University.
- (ii) For recruitment of the Principal of the Institution, selection committee which shall include representative of the University nominated by the Vice-Chancellor.
- (iii) In case of recruitment of a member of the teaching staff of the Institution, a representative of the University nominated by the Vice-Chancellor and the Principal of that Institution shall be members.

9. The institute may provide residential accommodation to the Principal and other members of the teaching staff in or near the Institution.

10. University shall not be responsible for any kind of delay in granting affiliation.

11. The provisionally affiliated institute which completes five years shall then apply for permanent affiliation to the University.
12. Regulations for Permanent Affiliation:
 - a. Eligibility Criteria for granting Permanent affiliation:
 - (i) The Institution shall have completed at least five years of satisfactory performance after getting first provisional affiliation and attained the academic and administrative standards as prescribed by the University from time to time.
 - (ii) The Institution must have completed all necessary infrastructure prescribed under the regulations as stipulated from time to time.
 - (iii) All the teaching and non-teaching staff is appointed on regular/permanent basis on scale of pay as per ICAR/Government.
 - (iv) The affiliated Institution shall furnish such reports, returns and other information as the Board, after consulting the Academic Council, may require enabling it to judge the efficiency of the College or the institution.
 - b. Procedure for Granting Permanent Affiliation
 - (i) Institution which wishes to get permanent affiliation shall apply to the University any time after completing five years of provisional affiliation in the prescribed proforma.
 - (ii) The procedure for according permanent affiliation, the proforma for application and inspection fees shall be the same as for granting provisional affiliation given in the regulations.
 - (iii) If the University decides not to recommend for granting permanent affiliation to the Institution for reasons, to be recorded in writing, of its failure to meet the conditions / requirements for getting such affiliation, the Institution may apply again as and when it fulfils the conditions / requirements subsequently, but not earlier than six months from the date of rejection of its earlier application.
13. The institute which is accorded provisional affiliation is authorized to mention the status in the form of “Provisionally Affiliated to Kamdhenu University” on their signboards, letterheads, properties and other such documents.
14. Till a College/Institute is permanently affiliated to the University as provided in these regulations, the College/Institute shall not be authorized to declare its status anywhere as “Affiliated to Kamdhenu University”.

15. The affiliation granted under these regulations is non-transferable.
16. Every affiliated/recognized institution shall comply with the provisions of the Kamdhenu University Act, 2009 (specifically Section 46 to 52 Ch. VIII), and its Statutes, Regulations, minimum standards and norms as amended from time to time. If any affiliated/recognized institution contravenes then,
 - (i) The rights conferred on such college or institution by the affiliation or recognition shall stand withdrawn from the date of such contravention and such college or institution shall cease to be an affiliated College or recognised institution.
 - (ii) The rights conferred on an institution by recognition may be withdrawn or suspended for any period if the institution fails/has failed to observe any of the conditions of its recognition or the institution has conducted in a manner which is prejudicial to the interest of education.
17. The decision of the University for granting or not granting provisional or permanent affiliation to any institution shall be final.
18. The standards of the institute granted permanent affiliation shall be reviewed every five year by Kamdhenu University by the procedures and norms of the inspection prescribed hereinabove.

Annexure-I

Minimum Standards and Norms for Affiliation of College of Dairy Science to Kamdhenu University

1. Divisions/Section: Five Departments and One Section

Sr No	Departments
1	Dairy Technology
2	Dairy Engineering
3	Dairy Chemistry
4	Dairy Microbiology
5	Dairy Trade and Dairy Business Management
	Sections
1	Pilot Dairy Unit cum Business Process Development Centre

2. Medium of Instruction: English

3. Minimum Intake

Degree	Course	Intake Capacity
B. Tech.	Dairy Technology	40

4. Land Requirement

Main building and hostels: 10 Acres

Field area: 25 Acres

Play grounds: From common facility of the institute

Total: 35 Acres

5. Manpower Requirements of Principal's Office

Designation	No. of position
Principal	1
A. Establishment	

PA to Dean	1
Administrative Officer	1
Assistant Comptroller/Assistant Accounts Officer	1
Superintendent	1
Steno/Computer operator	1
Assistant	1
Operator (Audio Visual)	1
Attendants/Messengers	1
Clerk (LDC)	1
Electrician	1
Store Keeper	1
Driver	1
B. Dairy Plant and Business Incubation Centre and Laboratories	
Manager, Pilot plant/ Business Incubation Centre	1
Laboratory Technician for the college	6
Plant Supervisors/Technical Assistants (Dairy Processing-10, Refrigeration-2, Electrical-2)	14
Plant Operators (Processing-6, Boiler-2 Refrigeration-2,)	10
Mechanical Draftsman	1
Jr.Mechanic/wireman	1
Fitter	1
Steno/PA	1
Assistant	1
Computer operator	2
LDC	1
Attendants	2
C. Library	

Assistant Librarian	1
Library Assistants	1
Clerks	1
Shelf Assistants	1
D. Students Welfare (To be provided by the University as Central Facility)	
E. Hostel Staff for Two Hostels	
Warden	1+1
Clerks	1
Attendants	2
Security, Sanitation and Landscaping	To be outsourced

6. Faculty Requirements for the Departments

Division/Section	Faculty			Total
	Professor**	Associate Professor	Assistant Professor	
Dairy Technology	1	1	4	6
Dairy Engineering	1	1	4	6
Dairy Chemistry	1	1	2	4
Dairy Microbiology	1	1	2	4
Dairy Business Management	0	1	2	3
Total	4	5	14	23

* One each in Dairy Economics and Dairy Extension; Supporting subjects will be taught by other faculty in the College.

** If Professor is not available, Associate Professor will be recruited.

7. Administrative and Supporting Staff for Divisions/Section

Sr. No	Division /Section	Steno/PA/ Computer Operator (9300-34800 + GP 4200)	Assistant (5200-20200 +GP 2800)	Attendant/ Messenger (5200-20200 +GP 2800)	Clerk (9300-34800 +GP 4200)	Laboratory Assistant/Attendant (5200-20200+ GP 2800)
1	Dairy Technology	2	1*	1	1	1
2	Dairy Engineering	2	-	1	1	1
3	Dairy Chemistry	2	1**	1	1	1
4	Dairy Microbiology	2	-	1	1	1
5	Dairy Business Management	2	-	1	1	1
	Total	10	2	5	5	5

* For Dairy Technology ** For Dairy Chemistry, Microbiology & Business Management

8. Central/Division/Section Laboratories (as per requirements of the teaching and research work of the college)

Division /Section	Laboratory
Dairy Technology	Product Development Laboratory Product Characterization and Rheology Packaging Laboratory Sensory Evaluation Laboratory Central Instruments Laboratory Food Technology Laboratory
Dairy Engineering	Bioprocess Engineering Laboratory Fluid Mechanics Laboratory Heat Transfer Laboratory Refrigeration and Air Conditioning Food Engineering Laboratory Thermodynamics Laboratory

	Electrical Laboratory Instrumentation and Control Laboratory Dairy Engineering Workshop
Dairy Chemistry	Dairy Food Analysis Laboratory
Dairy Microbiology	Dairy Food Quality and Safety Laboratory
Dairy Business Management	Computer Laboratory Audio-Visual Laboratory Language Laboratory

9. Floor Space Requirements

Central Facilities

Sr. No.	Details	Number of Rooms	Dimensions
1	Dean office	1	30
2	PA room	1	25
3	Committee room with video conferencing facility	1	80
4	Administrative officer room	1	80
6	Examination hall	1	60
7	Evaluation room	1	60
8	Faculty room	1	60
9	Placement cell	1	50
10	Smart Lecture rooms	5	80 each
11	Auditorium (Optional)	1	100
12	Library/Book bank	1	100
13	Multipurpose room	1	60
14	Laboratories	6	80 each
15	Hostels	2	4000 each
16	Generator Shed	1	60
17	Toxic chemical storage and	1	50

	waste unit		
18	Canteen	1	1000
19	Toilets	-	Adequate
20	Parking space	As per requirement	Adequate
21	Vehicles:		
	Office car	1	Adequate
	Staff car/Jeep	1	
	Bus	1	
	Pick-up van	As per need	

10. Division/Section

Sr. No.	Details	No. of rooms	Dimensions (Sq ft)
1	Office of the Head of Division	5 One for each division	30
2	Administrative staff	05 One for every Division	60
3	Faculty room	26	20
5	Committee room cum library	05 (one for every Division)	30
6	Smart lecture cum seminar room	05 (one for every Division)	Seating capacity - 50 each
Laboratories (no. of laboratories as per ICAR)			
7	Dairy Technology	5	80
8	Dairy Engineering	9	80
9	Dairy Chemistry	4	80
10	Dairy Microbiology	3	80
11	Dairy Business Management	4	80

11: Library:

Due provision is made or shall be made for a library. The library facility with reading room will be mandatory and should be a part of the main College building with computers, internet and reprographic services.

The library must be possessing required multiple copies of the text books covering all the subjects of the course syllabus besides reference books, journals, periodicals, newspapers

etc. The minimum number of books in the library should be 1500 (excluding literature and general purpose books). An indicative list of the books is given in Annexure 1-B.

12. Dairy Plant and Business Incubation Centre

Detail	Space requirements
Raw Milk receiving Dock, Milk storage tank room, Milk Processing Hall, Cheese Room, Milk Condensing & Drying Plant room, Cheese Drying & Curing room, Milk Cold Store, Ice Cream Hardening Room, Dispatch Dock, Milk Bottling / Pouch Filling Room, Food processing section, Boiler House, Refrigeration & Ice Bank, System room, Store room – Products, Store room – chemicals & accessories, Sales Counter, Office of the Head of the Department, Offices for the Teaching Staff - Assistant professor, Associate Professor, Offices for the Technical Staff – Boiler Attendant, Refrigeration Attendant, Fitter, Office for the Ministerial Staff & Driver, Wash rooms– Staff & Students (both for Male & Female)	As per need

SYLLABUS

SEMESTER-WISE DISTRIBUTION OF B. TECH. (DT) COURSES

APPROVED IN ACADEMIC COUNCIL-(2013-14)

Sr. No.	Course No.	Course Title	Credits
FIRST SEMESTER			
1	DBM-1101	Dairy Development	1(1+0)
2	DBM-1102	Milk Production Management	2(1+1)
3	DBM-1103	Applied Mathematics	2(2+0)
4	DBM-1104	English	3(2+1)
5	DC-1101	Organic Chemistry	3(2+1)
6	DE-1101	Engineering Drawing	2(0+2)
7	DE-1102	Fluid Mechanics	3(2+1)
8	DE-1103	Workshop Practice	2(1+1)
9	DM-1101	Fundamentals of Microbiology	4(2+2)
10	NSS	National Social Scheme	1(0+1)
	Total		24(14+10)
SECOND SEMESTER			
1	DBM-1205	Economic Analysis	2(2+0)
2	DBM-1206	Industrial Statistics	3(2+1)
3	DC-1202	Chemistry of Milk	3(2+1)
4	DE-1204	Heat & Mass Transfer	3(2+1)
5	DE-1205	Thermodynamics	3(2+1)
6	DM-1202	Introductory Dairy Microbiology	3(2+1)
7	DT-1201	Market Milk	5(3+2)
8	DT-1202	Traditional Dairy Products	3(2+1)

9	NSS	National Social Scheme	1(0+1)
	Total		26(17+09)
THIRD SEMESTER			
1	DBM-2107	Computer Programming	3(1+2)
2	DC-2103	Physical Chemistry of milk	3(2+1)
3	DC-2104	Biochemistry	3(2+1)
4	DE-2106	Electrical Engineering	3(2+1)
5	DE-2107	Refrigeration & air-conditioning	3(2+1)
6	DM-2103	Microbiology of Dairy Products	3(2+1)
7	DT-2103	Fat Rich Dairy Products	4(3+1)
8	DT-2104	Ice-cream and Frozen desserts	4(2+2)
9	NSS	National Social Scheme	1(0+1)
	Total		27(16+11)
FOURTH SEMESTER			
1	DBM-2208	Financial Management	3(2+1)
2	DC-2205	Chemistry of Dairy Products	3(2+1)
3	DE-2208	Dairy Engineering	3(2+1)
4	DE-2209	Instrumentation and process control	3(2+1)
5	DM-2204	Starter Cultures & Fermented Milk Products	4(2+2)
6	DM-2205	Dairy Biotechnology	3(2+1)
7	DT-2205	Packaging of Dairy Products	3(2+1)
8	DT-2206	Cheese and Fermented Milks Technology	5(3+2)
9	NSS	National Social Scheme	1(0+1)
	Total		27(17+10)

FIFTH SEMESTER			
1	DBM-3109	Cost Accounting	2(2+0)
2	DC-3106	Chemical Quality Assurance	3(2+1)
3	DC-3107	Environmental Studies	3(2+1)
4	DE-3110	Dairy Process Engineering	4(3+1)
5	DE-3111	Principles of Dairy Machine Design	3(2+1)
6	DM-3106	Quality and Safety Monitoring in Dairy Industry	3(2+1)
7	DT-3107	Condensed and Dried Milks	5(3+2)
8	DT-3108	By-products Technology	4(3+1)
	Total		27(19+08)
SIXTH SEMESTER			
1	DBM-3210	IT in Dairy Industry	2(1+1)
2	DBM-3211	Operation Research	2(2+0)
3	DC-3208	Food Chemistry	3(2+1)
4	DE-3212	Food Engineering	3(2+1)
5	DE-3213	Dairy Plant Design and Layout	3(2+1)
6	DM-3207	Food & Industrial Microbiology	3(2+1)
7	DT-3209	Food Technology	4(3+1)
8	DT-3210	Judging of Dairy Products	3(2+1)
9	DT-3211	Dairy Plant Management and Pollution Control	3(2+1)
	Total		26(18+08)
SEVENTH SEMESTER			
1	DBM-4112	Communication Skill and Entrepreneurship Development	2(2+0)

2	DBM-4113	Dairy Extension Education	1(1+0)
3	DP-4101	Dairy Plant Operations and Management–I (Experiential Learning)	25 (5+20)
	Total		28(08+20)
EIGHTH SEMESTER			
1	DBM-4214	Marketing Management and International Trade	2(2+0)
2	DC-4209	Human Nutrition	1(1+0)
3	DP-4202	Dairy Plant Operations and Management–II (Experiential Learning)	25 (5+20)
	Total		28(08+20)

I. DAIRY ENGINEERING

1. DE-1101: Engineering Drawing:

2(0+2)

Practical: Drawing of lines, types of lines; lettering and dimensioning: types of lettering and types of dimensioning; Drawing of scales: Plain scale, diagonal scale, comparative scale and Vernier scale; Drawing of projections: Orthographic projections, methods of projections. Drawing of sectional views; Drawing of screw threads: Types of threads and terminologies used in it, Screw fastening, types of nuts, types of bolts, stud, locking arrangements for nuts and Foundation bolt; Drawing of rivets and riveted joints, forms of rivet heads, types of riveted joints, failure of riveted joints; Drawing of welded joints: Forms of welds, location and dimensions of welds; Drawing of keys: cotter joint, pin joints, types of keys, types of cotter joints, pin joints; Drawing of shaft couplings: Rigid couplings, loose couplings, flexible couplings, universal coupling; Drawing of shaft bearings: Journal bearings, pivot bearings, collar bearings.

2. DE-1102: Fluid Mechanics:

3(2+1)

Theory: Units and dimensions; Properties of fluids: Compressible and non compressible fluids, Surface tension, capillarity; Static pressure of liquids: Hydraulic pressure, absolute and gauge pressure, pressure head of a liquid, Pressure on vertical rectangular surfaces; Pressure measuring devices: simple-, differential-, micro-, inclined- manometer, mechanical gauges, Piezometer; Floating bodies: Archimedes principle, stability of floating bodies, Equilibrium of floating bodies, Metacentric height; Fluid flow: Classification, steady, uniform and non uniform flow, Laminar and turbulent; Continuity equation, Bernoulli's theorem and its applications; Flow through pipes: Loss of head, determination of pipe diameter, Determination of discharge, friction factor, critical velocity; Flow through orifices, mouthpieces, notches and weirs, Vena contract, hydraulic coefficients, discharge losses, Time for emptying a tank; Loss of head due to contraction, enlargement at entrance and exit of pipe, External and internal mouthpieces, types of notches, rectangular and triangular notches, rectangular weirs; Venturi-meters, pitot tube, Rota-meter, Water level point gauge, hook gauge; Dimensional analysis: Buckingham's theorem, application to fluid flow phenomena; Froude Number, Reynolds number, Weber number and hydraulic similitude; Pumps: Classification, reciprocating, centrifugal pump, Pressure variation, work efficiency, Types of chambers, selection and sizing.

Practical: Study of different tools and fittings; Plotting flow rate versus pressure drop with U-tube manometer; Verification of Bernoulli's theorem; Determination of discharge coefficient for venturi, Orifice, V-Notch; Verification of emptying time formula for a tank; Determination of critical Reynolds number by Reynolds' apparatus; Study of reciprocating, centrifugal and gear pump; Calibration of Rota meter and flow meter; Study of different types of valves; Determination of head losses in fluid flow; Problems on following topics: Pressure, capillarity and surface tension Floating bodies, Liquid flow, venture-meter, orifice, weir, flow through pipes, pumps.

3. DE- 1103: Workshop Practice

2 (1+1)

Theory: Introduction to workshop practice, safety, care and precautions in workshop; Wood working tools and their use, Carpentry and pattern making; Mould material and their applications; Heat treatment processes: hardening, tempering, annealing, normalizing etc.; Metal cutting, Soldering & Brazing, Electric arc welding, Gas welding; Smithy and forging operations, tools and equipment. The bench: Flat surface filing, Chipping, Scraping, Marking out, Drilling and Screwing; Use of jigs and fixtures in production; Introduction to following machine tools: (a) Lathe (b) Milling machine (c) Shaper and planer (d) Drilling and boring machines (e) Grinder (f) CNC machines.

Practical: Simple exercises in Filing and Fitting, Chipping and Hack-sawing, Chiselling, Tapping and Smithy practice; Simple exercises in Arc, Gas, & Argon welding; Simple exercises in Soldering, Brazing, Basic joints in carpentry.

4. DE-1204: Heat and Mass Transfer

3(2+1)

Theory: Basic heat transfer process, thermal conductivity, convective film coefficient, Stefan Boltzmann's constant and equivalent radiation coefficient, Overall heat transfer coefficient, physical properties related to heat transfer; Working principles and application of various instruments for measuring temperature; One dimensional steady state conduction: Theory of heat conduction, Fourier's law, Derivation of Fourier's equation in Cartesian coordinates, linear heat flow through slab, cylinder and sphere. Heat flow through slab, cylinder and sphere with non-uniform thermal conductivity, Concept of electrical analogy and its application for thermal circuits, Heat transfer through composite walls and insulated pipelines; One dimensional steady state heat conduction with heat generation: Heat flow through slab, hollow sphere and cylinder with uniform heat generation, Development of equations of temperature distribution with different boundary conditions; 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, Effectiveness and efficiency of the FINS; Introduction to unsteady state heat conduction; Convection: Forced and free convection, use of dimensional analysis for correlating variables affecting convection heat transfer, Concept of Nusselt number, Prandtl number, Reynolds number, Grashoff number, some important empirical relations used for determination of heat transfer coefficient; Heat Exchangers: General discussion, fouling factors, jacketed kettles, LMTD, parallel and counter flow heat exchangers, Shell and tube and plate heat exchangers, Heat exchanger design, Application of different types of heat exchangers in dairy and food industry; Fick's Law of diffusion, steady state diffusion of gases and liquids through solids, Equi-molal diffusion, Mass transfer coefficient and problems on mass transfer.

Practical: Determination of thermal conductivity: milk, solid dairy & food products; Determination of overall heat transfer coefficient of: Shell and tube, plate heat exchangers and Jacketed kettle used in Dairy & Food Industry; Studies on heat transfer through extended surfaces, Studies on temperature distribution and heat transfer in HTST pasteurizer, Design problems on heat exchangers, Study of various types of heat exchangers, Design problems on Heat and Mass Transfer.

5. DE-1205: Thermodynamics

3(2+1)

Theory: Basic concepts: systems, processes, cycles, energy, The zeroth Law of Thermodynamics: Ideal gases, Equation of state, Compression and expansion of gases; The first Law of Thermodynamics: Internal energy, enthalpy; The second Law of Thermodynamics: Thermodynamic temperature scale, Carnot cycle, entropy, reversibility, availability; Air Cycles: Otto, Diesel, dual efficiencies, Plotting the cycles on various thermodynamic planes viz., p-V, T-S, p-h diagram; etc.; IC Engines: Two stroke and four stroke cycles, construction, injection and ignition of fuel, Performance of IC engines; Fuels: Chemical properties, air for combustion, Calorific value and its determination, Burners, firing of fuels, Renewable energy sources; Properties of steam: Wet, dry saturated, superheated steam, Use of steam tables and Molier charts; Steam generators: Fire tube boilers, Water tube boilers, Boiler mountings and Boiler accessories; Draught: Natural, forced, fan, jet, Measurement of Height of chimney, Condensers, Layout of pipeline and expansion joints, Boiler trial Codes, Indian Boiler Regulation acts; Air Compressors: Reciprocating, Single and two stage air compressors.

Practical: Application of thermodynamics in engineering problems; Study of two stroke engine and four stroke engines, Performance tests on IC engines; Determination of dryness fraction of steam, To study the boiler installed in Model Plant, Water softening plant, Lancashire boiler, Locomotive boiler, Babcock & Wilcox boiler, Electrode boiler, Boiler mounting and steam line layout and steam traps; Visit to sugar mill/rice mill or plant with steam utilization, Study of Solar water heater and biogas plants and appliances.

6. DE-2106: Electrical Engineering

3(2+1)

Theory: Alternating current fundamentals: Electromagnetic induction magnitude of induced E.M.F., Alternating current, R.M.S. value and average value of an alternating current, Phase relations and vector representation; A.C. series and parallel circuits, Concept of resonance, poly-phase alternating current circuits, three phase concept, Star and delta connections, star delta transformation, Energy measurement; Transformers: Fundamental of transformer, Theory, vector diagram without load and with load, Losses, voltage regulation and efficiency of transformer, auto-transformer; Alternators: Elementary Principles, Construction and different types of alternators, E.M.F. in alternators, circuit breakers; Induction motors: Fundamental principles, production of rotating fields, construction, Rotor winding: squirrel cage and phase wound rotors, Analysis of current and torque, starting of induction motors, Motor housing, selection of motor and its controls; D.C. Machines: Construction and operation of D.C. generator, Types of generators, various characteristics of generator, D.C. motors: torque-speed characteristics of D.C. motors, Starting and speed control of D.C. motors; Electric Power Economics: Maximum demand charge, Load factor and power factor correction; Measuring Instruments: Classification of instruments, Elements of a generalized measurement system, static and dynamic characteristics.

Practical: Study of voltage resonance in L.C.R. circuits at constant frequency: (a) Star connection study of voltage and current relation (b) Delta connection study of voltage and current relation; Measurement of power in three phase circuit: (a) For balanced loads (b) For unbalanced loads, by wattmeter and energy meters; Polarity test, no load test, efficiency and regulation test of single phase; Voltage and current relation in a three phase transformer of various kinds of primary and secondary connection systems; Starting of induction motor by the following starters: (i) D.O.L. (ii) Manual star-delta (iii) Automatic star-delta (iv) Manual auto-transformer; Starting of slip-ring induction motor by normal and automatic rotor

starters; Test on three phase induction motor, determination of efficiency, line current, speed, slip, power factor at various outputs; Determination relation between the induced armature voltage and speed of separately excited D.C. generator, Magnetization characteristic of D.C. generator; Study the starter connection and starting reversing and adjusting speed of a D.C. motor; Study of various measuring instruments.

7. DE-2107: Refrigeration and Air Conditioning

3(2+1)

Theory: Basic refrigeration cycles and concepts: Standard rating refrigerating machines, Elementary vapour compression refrigeration cycle with reciprocating, rotary and centrifugal compressors; Theoretical vapour compression cycle, Departure from theoretical vapour compression cycle, representation on T-S and p-h diagrams, Mathematical analysis of vapour compression refrigeration system; Refrigerants: Primary and secondary refrigerants, common refrigerants (Ammonia, Freon), Brine, their properties and comparison; Multiple evaporator and compressor systems: Applications, One compressor systems, dual compression, comparison of system, Control of multiple evaporator system, Working and mathematical analysis of above systems; Refrigeration equipments: Compressor, Condenser, evaporator, Cooling tower, spray pond, Basic elements of design, Construction, operation and maintenance, balancing of different components of the system; Refrigeration Controls: Low side and high side float valves, capillary tube, thermostatic expansion valve, automatic expansion valve, solenoid valve, High pressure and low pressure cut-outs, thermostat, overload protector, common defects and remedies; Refrigeration Piping: Purpose, materials, joint and fittings, water and brine pipe size selection; Absorption Refrigeration Systems: Simple vapour absorption refrigeration systems, Practical absorption system, Refrigerant absorbent combinations Absorption cycle analysis; Psychrometry: definition, properties of air-vapour mixtures, Psychrometric charts, Processes involving air vapour mixtures, Dehumidification, humidifiers, Humidity measurements, humidity control, Wet bulb, dry bulb temperature dew point temperature; Cooling load calculations: Types of loads, design conditions for air cooling, air conditioning loads; Cold storage: Types of cold storage, Types of loads in cold storage, Construction of cold storage; Insulating materials and vapour barriers.

Practical: Study of tools used in installation of a refrigeration plant including charging and detection of leaks; Study of different parts and learn the operation of bulk milk cooler; Study of different parts and learn the operation of a refrigeration plant/ice plant using ammonia refrigerant; Study of different parts and learn the operation of a vapour absorption refrigeration plant; Dismantling and assemble an open compressor and a sealed unit; Study different parts and refrigeration controls of the following (a) Refrigerator (b) Water cooler (c) Deep Freezer (d) Compare their cooling coils and other systems; To find out the rating (cooling rate) at different suction temperatures (temperature differences) and air handling capacity of the air cooling unit; Plotting the practical refrigeration cycle on a pressure enthalpy diagram and to compare it with a theoretical refrigeration cycle; Study different parts and operation of a (a) Air washer, (b) Room cooler, (a) Air conditioner, (d) Chemical dehumidifiers, (e) Cooling; Plotting of psychrometric process: Sensible heating & cooling, Dehumidification & cooling and heating & humidification; Study of different humidity indicating, recording and controlling devices; Problems on cold storage; Visit to cold storage.

8. DE-2208: Dairy Engineering

3(2+1)

Theory: Sanitization: Materials and sanitary features of the dairy equipment; Sanitary pipes and fittings, standard glass piping, plastic tubing, fittings and gaskets, installation, care and maintenance of pipes & fittings; Description, working and maintenance of can washers, bottle washers; Factors affecting washing operations, power requirements of can the bottle washers, CIP cleaning and designing of system; Mechanical Separation: Fundamentals involved in separation, Sedimentation, Principles involved in filtration, Types, rates of filtration, pressure drop calculations, Gravity setting, principles of centrifugal separation, different types of centrifuges, Application in Dairy Industry, clarifiers, tri processors, cream separator, self de-sludging centrifuge, Bactofuge, care and maintenance of separators and clarifiers; Homogenization: Classification, single stage and two stage homogenizer pumps, power requirement, care and maintenance of homogenizers, aseptic homogenizers; Pasteurization: Batch, flash and continuous (HTST) pasteurizers, Flow diversion valve, Pasteurizer control, Care and maintenance of pasteurizers; Different type of sterilizers, in bottle sterilizers, autoclaves, continuous sterilization plant, UHT sterilization, Aseptic packaging and equipment, Care and maintenance of Sterilizers, Filling Operation: Principles and working of different types of bottle filters and capping machine, pouch filling machine (Prepack and aseptic filling bulk handling system, care and maintenance; Mixing and agitation: Theory and purpose of mixing, Equipments used for mixing solids, liquids and gases, Different types of stirrers, paddles and agitators, Power consumption of mixer impeller, selection of mixing equipment in dairy industry, mixing pumps.

Practical: To study: S.S. Pipes and fitting, gasket materials and S.S. milk pumps, Milk tanker and milk storage tanks, Can washer and bottles washer, C.I.P. Cleaning equipment, Homogenizers, Batch and Continuous pasteurizers, Different controls on pasteurizer, Different sterilizers, Pouch filling machine, Different types of agitators, Bottle filling and Capping machine, Determination of the rate of filtration and settling, Visit to a dairy plant.

9. DE-2209: Instrumentation and Process Control:

3(2+1)

Theory: Absolute and secondary instruments, Types of secondary instruments, Essentials of indicating instruments, Constructional details of indicating instruments, Principle of induction type instruments shaded pole method and two pole methods, compensation for frequency and temperature errors. Induction type voltmeter, Ammeter, advantage and disadvantages, induction type single phase watt hour meter, their errors and remedies, Numerical, wattmeter, power-factor meter, etc.; Characteristics of Instruments and Measuring Systems: Elements of generalized measuring system, static calibration, accuracy, sensitivity, reproducibility, static errors, dead zone, drift in measuring instruments, Analog and digital representation of signals, Factors influencing the choice of transducers, Mechanical Input Transducers, Level, Pressure, Flow, Velocity and Humidity Resistive, Capacitive and Inductive, Dielectric system for humidity measurements, Temperature Transducers : Resistive, inductive, capacitive and thermoelectric transducer, Magnetic Transducers: Systems based on induction and magnetic effects on moving charges, Transducers based on permeability variation.

Practical: Preparation and calibration of thermocouple; study the construction and working of Bourdon pressure gauge; Study the mechanism of pH meter and its electrodes; Study a pressure transducer; Study a Proximity sensor; Study of the different parts and working of Rota-meter; Study the different parts and working of pressure switch; Study the different

parts of an indicating instrument; Study the different parts and their working of single phase induction type watt hour meter; Visit to a microprocessor controlled dairy plant.

10. DE-3110: Dairy Process Engineering:

4 (3+1)

Theory: Evaporation: Basic principles of evaporators, construction and operation, Different types of evaporators used in dairy industry, Calculation of heat transfer area and water requirement of condensers, Basic concepts of multiple effect evaporators, Operations and various feeding systems, Economy of operation, Thermo processor and MVR system, Care and maintenance of evaporators; Drying: Introduction to principle of drying, Equilibrium moisture constant, bound and unbound moisture, Rate of drying constant and falling rate, Effect of Shrinkage, Classification of dryers spray and drum dryers, spray drying, etc., air heating systems, Atomization and feeding systems; Factors affecting bulk density of power, spray dryer controls, Theory of solid gas separation, cyclone separators, Bag Filters, Care and Maintenance of drum and spray dryers; Fluidization: Mechanisms of fluidization characteristics of gas fluidization systems, Minimum Porosity, Bed Weight, Pressure drop in fluidized bed, Application of fluidization in drying, Batch fluidization, Fluidized bed dryers; Mechanization and equipment used in manufacture of indigenous dairy products, Butter and Ghee making machine, Ice cream and Cheese making equipments; Packaging machines for milk & milk products, Membrane Processing : Ultra filtration, Reverse Osmosis and electro dialysis, Materials for membrane construction, Ultra filtration of milk, Effect of milk constituents on operation, membranes for electro dialysis.

Practical: Study of construction and operation of: Vacuum pan, Double effect evaporator, Spray dryer, Vacuum and atmospheric drum dryers; Study and operation of Butter, Ghee, Ice cream and cheese making equipments; Study the Reverse Osmosis and Ultra filtration system; Design problems on Double effect evaporator and Vacuum pan; Visit to a milk product plant.

11. DE-3111: Principles of Dairy Machine Design

3(2+1)

Theory: Basic concepts in Statics and Dynamics, Force Systems, Equilibrium condition, friction, Law of friction, Second moments of inertia, Parallel axis theorem; Dynamics: Equation of motion, Translation and rotation of a Rigid body, work and mechanics of materials, Stress, Axial Load classification, Strain, Hooke's law, stress strain diagram, Poisson's Ratio, Shearing Stresses, Torsion, Torsion formula, Angle to Twist of circular members, Power transmission, shear force and bending moments, Shear in Beams, Bending Moment in beams, Pure bending of beams, Flexural stress shearing stresses in beams relations between shear and bending moment, Torsional and flexural loads; Machine Design: Procedures, Specification, strength, design factor, factor of safety selection of factor of safety, Materials and properties, Static strength, ductility, hardness, fatigue, designing for fatigue conditions, Theories of failure, Stresses in elementary machine parts, design of shaft, Design of a drive system, Design of length and thickness of belt; Bearing: Journal and Antifriction bearings, Selection of ball, tapered roller and thrust bearing, Springs: helical and leaf springs, Energy stored in springs, Design and selection of springs.

Practical: Engineering Statics & Dynamics; Work and Energy, Linear and Angular Momentum, Stress strain diagram evaluation of elastic constants, Power transmission, Shear force and bending moment diagrams, Flexural stresses, Shearing stresses in Beans, Fits and tolerances, Design stresses in elementary machine parts, Design of shafts, axles keys Springs, Couplings, Bearing.

12. DE-3212: Food Engineering

3(2+1)

Theory: Rheology of processed food, properties of fluid foods, Rheological method, Measurement of rheological parameters, properties of granular food and powders, Properties of solids foods, Viscoelastic models, Measurement of food texture; Food Freezing: Thermal properties of frozen foods, Prediction of freezing rates, Plank's equation, Neumann problem and Tao solution, Design of food freezing equipment, Air blast freezers, Plate freezers and immersion freezers, storage of frozen foods; Food dehydration: Estimation of drying time for food products, constant rate period and falling rate period dehydration, Diffusion controlled falling rate period, Use of heat and mass balanced in analysis of continuous dryers, fixed tray dehydration, cabinet drying, tunnel drying; Freeze Dehydration : Heat and mass transfer, Calculation of drying times, Industrial freeze drying; Equipment for pulping, Fruit juice extraction, blanching, De-hulling, Size reduction and distillation.

Practical: Study of rheological properties of foods, Study of freezers and freeze dryers, Design problems on batch freezers, Design problems for continuous freezers, Design problems on dryer, Visit to cold storage, Visit to food processing plant.

13. DE-3213: Dairy Plant Design and Layout

3(2+1)

Theory: Introduction of Dairy Plant design and layout, Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site, Dairy building planning, Process schedule, basis of dairy layout, importance of planning, principles of dairy layout, Space requirements for dairy plants, estimation of service requirements including peak load consideration, General points of considerations for designing dairy plant, floor plant types of layouts, service accommodation, single or multilevel design, Arrangement of different sections in dairy, sitting the process sections, utility/service sections, offices and workshop, Arrangement of equipment, milk piping, material handling in dairies, Common problems, office layouts flexibility. Development and presentation of layout, model planning, use of planning table in developing plot plant and detailed layout; Choice of building construction materials, floors, general requirement of dairy floor finishes, floors for different section of dairy, Foundations, walls doors and windows, Drains and drain layout for small and large dairies; Ventilation, fly control, mold prevention, illumination in dairy plants.

Practical: Building symbols and convention layouts for small, medium and large size dairies, Isometric presentation of piping, Design and layout of: Milk collection/chilling centre; Fluid milk plant (small, medium and large); Single product dairy (i) Cheese, (ii) ice cream, (iii) butter and (iv) ghee; Composite dairy plant.

II. DAIRY MICROBIOLOGY

1. DM-1101: Fundamentals of Microbiology

4(2+2)

Theory: Microbiology and microbes: Place of microbiology in living world and its sub-division: scope of microbiology. History and development of microbiology: cell theory: contributions of Leeuwenhoek, Pasteur and Koch & others. The microscope as tool for the study of microbiology: Principles of microscopy: Light Microscopy (Bright field, dark field, phase contrast, fluorescence) & electron microscopy: preparation and staining of specimens: staining techniques. Microbial taxonomy: principles: numerical taxonomy: major characteristics used in taxonomy: classification according to Bergey's manual of systematic bacteriology. The Cell: Structure and functions of prokaryotic & eukaryotic cells: difference between prokaryotes and eukaryotes. Microbial growth and nutrition: the growth curve: factors affecting growth of microorganisms, estimation of bacterial growth: bacteriostatic and bactericidal agents: the common nutrient requirements and nutritional types of microorganisms. Bacterial genetics: DNA as the genetic material: structure of DNA: bacterial mutations (spontaneous and induced): genetic recombination- (transformation, transduction, conjugation). Micro flora of air, soil and water: methods for controlling microorganisms in air & water: water as carrier of pathogens.

Practical: General instruction for microbiological laboratory. Microscope- simple and compound. Microbiological equipments: autoclave, hot air oven, incubator, centrifuge, colorimeter, laminar airflow, membrane filter. Aseptic techniques in microbiology. Staining Techniques: Simple staining, Negative staining and differential staining (gram staining, spore staining and acid fast staining). Motility of microorganisms by hanging drop technique. Measurement of microorganisms by micrometry. Media: Types and preparation of commonly used growth media, liquid and solid. Isolation techniques for microorganisms: Streak, spread & pour plate. Enumeration of microorganisms in air and soil. Enumeration of microorganisms in water: total viable count, coliform (MPN).

2. DM-1202: Introductory Dairy Microbiology

3(2+1)

Theory: Microorganisms associated with raw milk: morphological and biochemical characteristics of important groups and their classification: significance of different groups of bacteria i.e. psychrotrophs, mesophiles, thermotolerants, and thermophiles in milk. Hygienic milk production system: microbial quality of milk produced under organized v/s unorganized milk sector in India and comparison with developed countries: sources of entry of microorganisms:

Good Hygiene Practices (GHP) during milk production operations. Microbiological changes in bulk refrigerated raw milk: Impact of various stages like milking, chilling, storage and transportation on microbial quality of milk with special reference to psychrotrophic organisms:

Direct and indirect rapid techniques for assessment of microbial quality of milk. Microbial

interactions (Synergism, antibiosis, metabiosis, mutualism, commensalism). Role of microorganisms in spoilage of milk: souring, curdling, bitty cream, proteolysis, lipolysis: abnormal flavors and discoloration. Mastitis milk: Processing and public health significance, organisms causing mastitis, somatic cells secreted in milk, detection of somatic cell count (SCC) and organisms causing mastitis in milk. Milk as a vehicle of pathogens: Food infection, intoxication and toxic infection caused by milk borne pathogens like *E. coli*, *Salmonella typhi*, *Staphylococcus aureus*, *Bacillus cereus* etc. Antimicrobial substances in milk: immunoglobulin, lactoferin, lysozymes, LP systems etc. Microbiology of heat treated milks: Microflora of pasteurized milk, sterilized/UHT milk, TDT, TDP, Z- value, spoilage aspects.

Practical: Morphological examination of common dairy organism (size and shape, arrangement and sporulation). Identification of common yeasts and molds encountered in dairy products. Microbiological examination of raw milk by DMC. Dye reduction tests- (MBRT, RRT), SPC, Coliform count for microbiological examination of raw and pasteurized milk. Biochemical characteristics of important dairy microorganisms. Enumeration of psychrotrophic, thermophilic, thermoduric and spore forming bacteria in milk. Detection of mastitis milks, pH, SLST, somatic cell count, chloride content, Hotis test, CAMP test. Detection and estimation of coliforms: presumptive test, rapid coliform count, IMVIC test. Detection of important pathogens using selective media: *E. coli*, *Staphylococcus aureus* *Salmonella* and *Bacillus cereus*.

3. DM 2103: Microbiology of Dairy Products

3(2+1)

Theory: Microbiology of cream: types of microorganisms and sources: microbial defects, standards and controlling measures: problems in pasteurized and sterilized cream. Microbiological changes during the manufacture and storage of butter: factors affecting microbial growth and microbiological standards for butter. Microbiology of condensed and evaporated milks: types of organisms surviving during manufacture and storage: microbial defects and control measures. Microbiology of dried milks: microflora of roller and spray dried whole and skim milk powder and infant foods: factors influencing microflora of dried milks and infant foods. Microbiology of ice-cream and frozen desserts: microbial quality of ingredient and standards: incidence and implications of enteropathogens in ice-cream and their control. Microbiology of indigenous milk products: khoa, chhana, paneer, shrikhand, microbiological defects of indigenous products. Microbiology of packaging materials.

Practical: Microbiological examination of cream (raw and pasteurized): standard plate count, lipolytic count, coliform count, direct microscopic count and dye reduction tests. Microbiological examination of butter (salted and unsalted): standard plate count, lipolytic count, coliform count, psychrotrophic count and yeast and mold count. Microbiological examination of condensed milk: standard plate count, coliform count, anaerobic count, yeast and mold counts, thermoduric and thermophilic counts. Microbiological examination of dried milks: standard plate count, thermoduric and thermophilic counts. Microbiological examination of ice-cream: standard plate count, coliform count, staphylococcal count and detection of salmonella. Microbiological

examination of khoa: standard plate count, coliform count, staphylococcal count, yeast and mold count. Microbiological examination of paneer and shrikhand: spore count, coliform count, yeast and mold count and staphylococcal count. Microbiological examination of packaging materials: standard plate count, spore count, yeast and mold count. Microbiological analysis of casein and dried whey.

4. DM-2204: Starter Cultures and Fermented Milk Products

4(2+2)

Theory: Introduction of starter cultures & their importance in dairy industry, classification of Lactic Acid Bacteria: Metabolism of Lactic Acid Bacteria and diacetyl production, production of antibacterial substances by lactic starter cultures. Mixed and define strain starter culture: propagation of starter cultures: factors affecting their propagation: starter concentrates- direct bulk and direct vat starter cultures: starter distillates. Quality and activity of starter cultures: defects in starters and their control: starter failures: antibiotic residues, sanitizers and bacteriophages. Preservation of starter cultures: freezing and freeze-drying: factors affecting the survival of cultures during preservation. Role of starter cultures in the preparation of various fermented milks: classification of fermented milks. Microbiology of dahi and yoghurt: different types of dahi and yoghurt, preparation, defects and their control. Nutritional and therapeutic significance of fermented milks. Kefir and Kumiss: origin and characteristics, microbiology of Kefir grains. Microbiology of other fermented milks such as Bugarian milk, cultured buttermilk, kishk and Yakult: their significance. Concept of probiotic starters and their application in probiotic dairy food.

Practical: Testing for purity of starter cultures: gram's staining, catalase test: creatine test. Starter activity tests: dye reduction tests, Horrall-Elliker test, Whitehead and Cox test. Preparation of single and mixed starter cultures: homo fermentation and hetrofermentation separately and also in combinations. Maintenance and preservation of starter cultures- Freeze drying techniques demonstration. Preparation of concentrated starter - freeze dried and frozen types. Effect of physical factors on dairy starter: temperature, pH, salt, sugar. Testing milk for the presence of inhibitory substance using *B. stearothermophilus* and *S. thermophilus* as indicator organisms. Effect of antibiotic residues in milk on starter activity. Associative growth of microorganisms in milk. Detection of bacteriophages in cheese whey. Preparation and evaluation of quality and grading of Dahi, Yoghurt, cultured butter milk, acidophilus milk and Kumiss. Microbiological analysis of processed cheese- Total spore count & Anaerobic spore count. Microbiological analysis at different stages of manufacture of (storage and ripening) hard varieties of cheese- such as Cheddar cheese.

5. DM-2205: Dairy Biotechnology

3(2+1)

Theory: Definition, scope and historical development of biotechnology, achievement and future application: structure of DNA and RNA: DNA replication, protein synthesis, genetic code, mutations: Vectors, cloning strategies in bacteria and animals, DNA technology. Protoplast fusion & Tissue culture in dairy cultures. Application of biotechnology in food and dairy industry, dairy effluents. Genetic manipulation of dairy starters for improved

attributes of commercial value. Dairy enzymes and whole cell immobilization. Ethical issues related to use of genetically modified foods.

Practical: Isolation of plasmid and genomic DNA from bacteria (*E. coli*, lactic acid bacteria) Agarose gel electrophoresis of DNA fragments). Restriction analysis of DNA. Curing of plasmids. Preparation of competent cell. Conjugal transfer in *E. coli* cells. Transformation of *E. coli* by calcium chloride treatment/electroporation. Demonstration of protoplast fusion, PCR technique. Visit to a biotechnology lab.

6. DM-3106: Quality and Safety Monitoring in Dairy Industry

3(2+1)

Theory: Current awareness on quality and safety of dairy foods: consumer awareness and their demands for safe foods: role of Codex Alimentarius Commission (CAC) in harmonization of international standards: quality (ISO 9001:2000) and food safety (HACCP) system and their application during milk production and processing. National and international food regulatory standards: BIS, PF A, ICMSF, IDF etc., their role in the formulation of standards for controlling the quality and safety of dairy foods. Rapid assessment of dairy food for microbial and non-microbial contaminants: Enumeration principles in detection of predominant spoilage organisms, pathogens and indicator organisms like, *E. coli*, *Salmonella*, *Shigella*, *Staphylococcus aureus*, *Bacillus cereus* and non microbial contaminants like antibiotic residues, aflatoxin, pesticides other inhibitors etc from dairy foods, their detection and control measures. Microbial quality of water and environmental hygiene in dairy plant: chlorination of dairy water supply, quality of air. Personnel hygiene, treatment and disposal of waste water and effluents: setting up of a microbiological/pathogen lab in a dairy plant and its safety concern. Dairy products borne infections and intoxications and of public health significance: Microbial toxins in dairy products (other than aflatoxins) and their significance in public health.

Practical: Evaluation of common sanitizing agents used in dairy plants by a) suspension b) capacity test. Microbiological tests for assessing equipment and personnel hygiene by swab and rinse methods. Detection of faecal and non- faecal coliforms and faecal streptococci in dairy plant. Detection and enumeration of different pathogenic bacteria in dairy products: *Staphylococcus aureus*, *Bacillus cereus*, *Salmonella* and *Shigella*. Bacteriological analysis of dairy water for: a) total viable counts b) coliform counts (MPN).

7. DM- 3207: Food and Industrial Microbiology

3(2+1)

Theory: Food Microbiology: Basic aspects and scope of food microbiology. Intrinsic and extrinsic factors that affect microbial growth in food. Microbial spoilage of fruits, fruit juices, vegetables, cereals, meat, poultry, sea foods, carbonated soft drinks, canned foods: control of spoilage. Food preservation: physical methods: chemical preservatives and natural antimicrobial compounds, biology based preservation system. Industrial Microbiology: Fermentation processes: the range, components and types (submerged, surface and solid state fermentation): criteria for selection of industrially important microorganisms: media for industrial and inoculums development: downstream processing

of fermented products. Fermenters: types, functions, design and control: chemostat and turbidostat. Microorganism and processes involved in the production of industrial alcohol, organic acids (citric lactic), enzymes (protease, lipase and rennet), vitamin (B-12), antibiotic (nisin).

Practical: Microbiological examination of fresh and canned fruits/ vegetables/ juices: flour and bread, eggs and meat. Design and control of a tabletop and 10 litre lab fermenter (Demonstration). Isolation of psychrophile, salt and sugar tolerant microorganisms from foods. Production of lactic acid from whey. Production of nisin and assaying the antimicrobial activity of the culture. Production of ethyl alcohol from molasses and whey by yeasts. Production of fermented whey beverages.

III. DAIRY TECHNOLOGY

1. DT -1201: Market Milk

5(3+2)

Theory: Market milk industry in India and abroad: Distinctive features of tropical dairying as compared to those of the tropical climate of developed countries. Collection and transportation of milk; a) Organization of milk collection routes b) Practices for collection of milk, reservation at farm, refrigeration, natural microbial inhibitors, lactoperoxidase system. Reception and treatment (pre-processing steps) of milk in the dairy plant: a) Reception, chilling, clarification and storage: General practices b) Homogenisation: Definition, pre-treatments, theories, synchronization of homogenizer with operation of pasteurizer (HTST) c) Effect of homogenization on physical properties of milk. d) Bactofugation: Theory and microbiology; Thermal processing of milk: a) Principles of thermal processing: kinetics of microbial destruction, thermal death curve, Arrhenius equation, D value, Z value, F_0 value, Q_{10} value b) Factors affecting thermal destruction of micro-organisms c) Definition and description of processes: Pasteurization, thermization, sterilization, UHT Processing d) Product control in market milk plant e) Defects in market milk f) Manufacture of special milks: toned, doubled toned, reconstituted, recombined, flavoured, homogenized vitaminised and sweet acidophilus milk g) Manufacture of sterilized milk h) Distribution systems for market milk; Quality and safety aspects in dairy food chain, good manufacturing practices (GMP) in dairy processing, UHT processing of milk: a) Relevance of UHT processing in the tropical climate b) UHT plants: Description; Direct, Indirect, with upstream and downstream homogenization, third generation UHT plants c) Aseptic packaging, types and systems of packaging, sterilizing packages, filling systems d) Technical control in the UHT plant, Training of personnel, Plant hygiene e) Shelf life of UHT milk and tests for UHT milk, Nutritive value of milk, Effect of heat processing on nutritive value, Efficiency of plant operation: product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency, Maintaining plant hygiene & HACCP.

Practical: Familiarization with equipments for reception of milk in plant; Pre-treatments: Chilling, clarification, filtration, Standardization and numericals relating to it; Cream separation: parts of separator and the process; Operation of LTLT, HTST pasteurizer, laboratory steriliser; Sampling and chemical examination of pasteurized, sterilized and UHT processed milk; Preparation of special milks; toned, double toned, standardised, flavoured, sterilised; Cleaning of storage tanks, cream separators, HTST plants; manual cleaning and CIP; Assessment of homogenisation efficiency in milk; Strength of common detergents and sanitizers used in market milk plant.

2. DT -1202: Traditional Dairy Products

3(2+1)

Theory: Status and significance of traditional milk products in India. Khoa: Classification of types, standards methods of manufacture and preservation factors affecting yield of khoa. Physico-chemical changes during manufacture and storage of khoa. Mechanization in manufacture of khoa. Confectioneries made from Khoa-Burfi, peda, Milk cake, Kalakhand, Gulabjamun and their compositional profile and manufacture practices. Rabri and Basundi: Product identification, process description, factors affecting yield physico-chemical changes during manufacture. Channa: Product description, Standards method of manufacture, packaging and preservation. Chhana based sweets: Rasogolla, Sandesh, Rasmalai.

Mechanization of manufacturing process. Paneer: Product description standards method of manufacture packaging and preservation. Physico-chemical changes during manufacture and storage. Mechanization of paneer manufacturing/packaging process. Shrikhand: Chakka-product description, standards method of manufacture, small scale and industrial, packaging and preservation aspects. Shrikhand-save as chakka. Physico-chemical changes and quality assurance during manufacture and storage. Sandesh: Product description method of manufacture and packaging process. Misti dahi: Product description method of manufacture and packaging process. Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. Biopreservative principles in enhancing the self-life of indigenous milk products including active packaging.

Practical: Preparation of khoa from cow, buffalo and concentrated milk. Analysis of khoa, chhana and paneer for total solids, moisture, fat and acidity. Preparation of kheer. Preparation of chhana from cow and buffalo milk and mixed milk. Preparation of paneer from cow and buffalo milk and mixed milk. Preparation of misti dahi, chhaka and shrikhand. Preparation of khoa and chhana based sweets. Field trip

3. DT-2103: Fat-Rich Dairy Products

4(3+1)

Theory: Status of fat-rich dairy products in India and abroad. Cream: a) Definition & Legal standards, efficiency of cream separation and factors affecting it: control of fat concentration in cream. b) Planning and operating a cream production unit) neutralization, standardization, pasteurization and cooling of cream. c) Preparation and properties of different types of cream: table cream, sterilized cream, whipped cream, plastic cream, frozen cream and chip-dips (cultured cream), UHT processing of cream. Defects, factors affecting quality of cream: ripening of cream e) Packaging storage and distribution, defects (non-microbial) in cream and their prevention.

Butter: a) Introduction to the butter making process: theory of churning, Legal standards. b) Technology of Butter manufacture, Batch and continuous methods. Over-run in butter: control of fat loses in butter-milk: packaging and storage: transportation: defects in butter: theology of butter: uses of butter. Butter making equipment: Construction, operation, care and maintenance of cream separators, coolers and vacreator, factory butter churn and continuous butter making machine. Special butters and related products: a) Manufacture, packaging, storage and properties of whey butter, flavoured butter, whipped butter, renovated butter / fractionated and polyunsaturated milk fat products, vegetable oil-blended products and low-fat spreads. b) Manufacture, packaging, storage and characteristics of margarine of different types. Ghee and butter oil: a) Methods of ghee making-batch and industrial processes, innovations in ghee production, procedure, packaging and preservation of ghee: utilization of substandard milk. b) Ghee: Composition and changes during manufacture fat constants.

Practical: Standardization, neutralization, pasteurization and cooling of cream. Preparation of sterilized cream. Study of construction and cooperation of the power operated butter churn and butter packaging machine. Preparation of cooking butter by the hand-operated churn. Preparation of desi butter. Manufacture of table butter using the power-driven churn. Preparation of ghee from cream and butter. Study and operation of continuous ghee plant.

4. DT-2104: Ice-Cream and Frozen Desserts

4(2+2)

Theory: History, development and status of ice-cream industry, History, development and status of ice-cream industry, Definition, classification and composition of ice-cream and other frozen desserts, Stabilizers and emulsifiers-their classification, properties and role in quality of ice-cream, Technological aspects of ice-cream manufacture, Thermodynamics of freezing and calculation of refrigeration loads. Types of freezers, refrigeration control/instrumentation. Hygiene, cleaning and sanitation of ice cream plant. Effect of process treatments on the physico-chemical properties of ice-cream mixes and ice-cream, Processing and freezing of ice-cream mix and control of over run, Packaging, hardening, storage and shipping of ice-cream, Defects in ice cream, their causes and prevention, Physico-chemical properties of ice-cream and compositional standards. Microenvironment in ice cream, critical process factors & their impact on entry of pathogen in ice cream, their survival during storage, food poisoning outbreaks, food safety & legal standards. Recent advances in ice-cream industry and plant management. Technology for preparation of dried ice-cream milk mix and Nutritive value of ice-cream.

Practical: Calculation of standardization of ice-cream mixes. Manufacture of plain and fruit flavoured ice-cream. Manufacture of chocolate, fruit and nut ice-cream. Preparation of sherbets/ices. Preparation of soft served and filled ice-cream. Manufacture of kulfi. Study of continuous and batch type freezers. Manufacture of ice-cream by continuous process. Compositional analysis of ice-cream. Field trip.

5. DT -2205: Packaging of Dairy Products

3(2+1)

Theory: Introduction, Importance of Packaging, History of Package Development, Packaging materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board), Glass, Metal, Plastics, Foils and laminates, retort pouches, Package forms, Legal requirements of packaging materials and product information. Packaging of milk and dairy products such as pasteurized milk, UHT -sterilized milk, aseptic packaging, fat rich products- ghee and butter, coagulated and desiccated indigenous dairy products and their sweetmeades, concentrated and dried milks including baby foods. Modern Packaging Techniques: Vacuum Packaging, Modified atmosphere packaging (MAP), Eco-friendly packaging, Principles and methods of package sterilization, Coding and Labelling of Food packages, Aseptic Packaging (AP), Scope of AP and pre-requisite conditions for AP. Description of equipments (including aseptic tank) and machines- Micro-processor controlled systems employed for AP, Package conditions and quality assurance aspects of AP. Disposal of waste package materials, Packaging Systems.

Practical: Identification of packaging materials, Flame Hot wire test, testing of papers/paperboards: Percentage moisture, Grease resistance, Water absorptiveness, grammage, Tearing resistance, Bursting strength. Testing of glass bottle - resistance to thermal shock. Testing of plastics and laminates - Thickness, Water vapour transmission rate (WVTR), Grease resistance. Packaging of different dairy products by using prepak and vacuum packaging machines.

6. DT -2206: Cheese and Fermented Milk Technology

5(3+2)

Theory: Origin and history of development of cheese manufacture, status and scope in India and abroad. Definition, standards and classification of cheese. Milk quality in relation to cheese making. Treatment of milk: Physical and chemical. Cheese additives and preservatives. Role of starter culture in relation to cheese quality. Rennet preparation and properties, rennet substitutes. Action of rennet on milk in relation to cheese making. Manufacture of different varieties of cheese: Cheddar, Gouda, Swiss, Mozzarella, Cottage. Role of milk constituents and changes during manufacture and ripening in cheese. Factors affecting yield of cheese. Packing, storage and distribution of cheese. Accelerated ripening of cheese. Manufacture of processed cheese, cheese spread and processed cheese foods. Defects in cheese, their causes and prevention, Mechanization and automation in cheese processing. Microbiological critical control of cheese cold store.

Practical: Familiarization with equipments, accessories and standardization numericals. Study of factors affecting rennet action. Manufacture of Cheddar cheese. Manufacture of Gouda cheese. Manufacture of Mozzarella cheese. Manufacture of Swiss cheese. Manufacture of Cottage cheese. Manufacture of Processed cheese. Manufacture of Processed cheese spread. Manufacture of processed cheese food. Analysis of cheese: proximate composition. Determination of ripening index. Visit to cheese factory.

7. DT -3107: Condensed and Dried Milks

5(3+2)

Theory: History, status and scope in India and abroad, Definition and legal standards: Condensed milk, sweetened condensed milk and evaporated milk. Manufacturing techniques for evaporated milk including pilot sterilization test, sweetened condensed milk and recombined sweetened condensed milk. Grading and quality of raw milk for condensed and evaporated milk, Physico-chemical changes taking place during manufacture of condensed milk, Heat stability of milk and condensed milk, Physico-chemical properties of condensed milk and role of stabilizers in the stability of condensed milk, Defects in condensed milks, their causes and prevention., Recent advances with reference to freeze concentration and membrane concentration,

Dried Milks: History and status in India and abroad, Grading and quality of raw milk for dried milks, Manufacture of skim milk powder (SMP), whole milk powders and heat classified powders, Physico-chemical changes taking place during manufacture of dried milks, Physical properties of dried milks, Defects in dried milk during manufacture and storage, their causes and prevention, PFA, BIS and International Standards for dried milk, Manufacture of infant foods, malted milk foods and other formulated dried products. Management of condensed and dried milk industry.

Practical: Manufacture of plain concentrated milks. Chemicals examination of concentrated and dried milks for moisture, T.S., Fat, lactose, sucrose, bulk density, solubility index, etc. Manufacture of SCM and EM. Concentration of milk by membrane processing. Manufacturing of SMP by spray drying / roller drying. Manufacture of instant milk powder. Visit to drying plant.

8. DT-3108: By Products Technology

4(3+1)

Theory: Status, availability and utilization of dairy by-products in India and Abroad. Associated economic and pollution problems. Physico chemical characteristics of whey, butter milk and ghee residue, By-products from skim milk: a) Casein: types of commercial casein, their specifications, manufacturing processes with basic principles involved. b) Industrial and food uses of caseins c) Manufacture of sodium and calcium caseinates their physico-chemical and functional properties and food applications d) Manufacture of casein hydrolysates and its industrial application e) Co-precipitates: types, their specifications, manufacturing processes with basic principles involved, functional properties and food applications. Whey processing: a) Fermented products from whey, b) Beverages from whey c) Deproteinized and demineralized whey d) Condensed whey e) Dried whey, types and their specification, manufacturing techniques. f) Utilization of whey products. Whey protein concentrates: a) Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates b) Functional properties and food applications of WPC. Lactose: methods for the industrial production of lactose, refining of lactose, uses of lactose and hydrolysis of lactose. Butter milk processing: a) Condensed butter milk b) Dried butter milk c) Utilization of butter milk products Ghee residue. Composition, processing and utilization. Nutritional characteristics of by products.

Practical: Manufacture of edible casein from cow and buffalo milk. Manufacture of rennet casein. Manufacture of sodium caseinate. Manufacture of calcium caseinate. Manufacture of co-precipitate. Chemical analysis of whey, buttermilk, casein and co-precipitates. Isolation of whey proteins by cold precipitation technique. Manufacture of whey proteins, concentration by ultra filtration process. Manufacture of whey drinks. Manufacture of dried whey. Manufacture of lactose. Chemical analysis of whey protein concentrates and lactose. Incorporation of whey protein concentrates in processed cheese foods. Manufacture of coffee whitener.

9. DT -3209: Food Technology

4(3+1)

Theory: Status of food processing industries in India and abroad, magnitude and inter-dependence of dairy and food industry, prospects for future growth in India. Harvesting, transportation and storage of fruits and vegetables. Post harvest processing of fruits and vegetables. Peeling, sizing, blanching, Canning of fruits and vegetables, Drying and freezing of fruits and vegetables. Juice processing- General steps in juice processing, role of enzymes in fruit Juice extraction, equipments and methods of fruit juice extraction, preservation of fruit juices, fruit juice clarification, concentration of fruit juices, fruit juice powders. Fruit juice processing: Orange and tangerine, Lemon and lime juice, Apple juice, Grape juice, Nectars, pulpy juices, tropical blends, Vegetable juices. Jam, Jelly, Marmalade, Pectin: chemistry technology. Fruits and vegetable preserves, Glazed, Crystallized fruits. Tomato base products: Juice, puree, paste, sauce, ketchup. Pickles: Principle of pickling, technology of pickles. Beverages - Classification, scope, carbonated non-alcoholic beverages and its manufacture. Fruit beverages and drinks, additives for fruit based beverages. Coffee: Production practices, structure of coffee/cherry, Coffee processing including roasting, grinding, brewing extraction, dehydration, aromatization, instant coffee. Tea-Tea leaf processing, green, red, yellow, instant tea. Technology of confectionery foods- Candies, Chewing gums and bubble gums, Toffees, Caramels, Standards of confectionery products. Chocolate products: Cocoa bean processing, chocolate liquor, Standards of confectionery products. Functional foods: Introduction, Phytochemicals, Milk ingredients as nutraceuticals, fiber-rich food products etc.

Practical: Manufacture of toffees and caramels, testing the efficacy of blanching process, Drying of fruits and vegetables. Preparation of fruit based drinks and beverages: Ready-to-serve drink, Nectar, Squash, Whey-fruit based beverages. Manufacture of fruit jam.

Manufacture of fruit jelly. Manufacture of chocolate confections. Manufacture of tomato ketchup/tomato sauce. Manufacture of soups. Manufacture of fruit preserve. Manufacture of candied fruits. Manufacture of fruit bar. Manufacture of pickles.

10. DT-3210: Judging of Dairy Products

3(2+1)

Theory: Introduction, definition and importance of sensory evaluation in relation: to consumer acceptability and economic aspects: factors affecting food acceptance. Terminology related to sensory evaluation. Design and requirements of sensory evaluation laboratory. Basic principles: Senses and sensory perception, Physiology of sensory organs, Classification of tastes and odours, threshold value factors affecting senses, visual, auditory, tactile and other responses. Fundamental rules for scoring and grading of milk and milk products. Procedure: Types of tests - difference tests (Paired comparison, due-trio, triangle) ranking, scoring, Hedonic scale and descriptive tests. Panel selection, screening and training of judges. Requirements of sensory evaluation, sampling procedures. Factors influencing sensory measurements. Milk: Classes of raw and processed milks, defects associated with them: milk score card and its use. Judging and grading of milk. Fermented milks: Desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka, shrikhand, lassi and other fermented drinks. Cream: Desirable attributes and defects in cream, Score card for cream, Judging and grading of different types of cream. Butter: Specific requirements of high grade butter, undesirable attributes of butter, butter score-card, sensory evaluation of butter. Ghee: Grades of ghee, special requirements of quality ghee, defects in ghee, sensory evaluation of ghee. Frozen dairy products: Desirable and undesirable characteristics of frozen dairy products. Sensory evaluation of ice cream, kulfi and milk sherbets. Cheese: Quality attributes of some common cheese varieties and their defects, score card for cheese. Sensory evaluation and grading for cheddar, cottage and other varieties of cheeses. Dried dairy products: Desirable and undesirable characteristic of dried milks. Judging and grading of dry milk products. Concentrated milks: Desirable attributes and defects. Judging and grading of evaporated and condensed milk. Heat desiccated Indian milk products: Desirable and undesirable characteristics. Sensory evaluation of khoa and khoa based sweets. Acid coagulated Indian milk products: desirable and undesirable characteristics. Sensory evaluation of paneer, chhana and chhana based sweets. Consumer acceptance studies: Objectives, Methods, types or questionnaires, development of questionnaires, comparison of laboratory testing and Consumers studies, limitations. Interrelationship between sensory properties of dairy products and various instrumental and physico-chemical tests. Preparation of milk and milk products with defects, techniques for simulation.

Practical: Determination of threshold value for basic tastes. Determination of threshold value for various odours. Selection of judging panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests. Judging of milk and cream. Judging of butter and ghee. Judging of condensed and evaporated milk. Judging of milk powders Judging of cheese and related products. Judging of frozen products. Judging of khoa and khoa-based sweets. Judging of chhana & chhana based sweets. Judging of dahi and fermented dairy products.

11. DT -3211: Dairy Plant Management and Pollution Control

2(1+1)

Theory: Production Management. Definition, Function and structure of Production Management, Production planning & Control, Work study and measurement motion and time study, Plant Operations. Efficiency factors losses, Financial and Managerial efficiency Provision for Industrial Legislation in India, particularly in dairy industry, personal management. Manpower planning, recruitment, training, transfer, promotions policies, job specifications, job evaluation, job enhancement, job enrichment, MBO, working conditions. Safety hazards, hazards prevention security for plant machinery and the employees, plant

maintenance. Prevention & Break-down maintenance spare parts inventory, tools & lubricants etc. Food hygiene, personnel hygiene, plant hygiene, water quality etc. Cleaning and Sanitation - different type of cleaning and sanitizing agents. Effluent treatment: Type, degree and treatment of waste.

Practical: Flow process charts of different milk products. Identification of steps of material losses on Dairy plants. Identification of hazardous processes and equipments, safety and precautions. Identification and uses of common lubricants. Waste utilisation processes. Various treatments in waste disposal. Analysis of cleaning agents and sanitizers. Reports and records maintenance of dairy plant. Operational precautions. CIP cleaning.

1. DP-4101: Dairy Plant Operations and Management-I **25(5+20)**

(Experiential Learning)

Imparting capabilities of mid level managerial jobs through on job training experience in a commercial Dairy Plant. Training to the students to handle various aspects of scheduling, processing, maintaining, product accounting and operational efficiencies of all the major equipments and process encountered in the Dairy Plant. This includes training as per the different models proposed by the Dairy Plant.

Operational and Evaluation modalities as per the details provided in the rules and regulations for B. Tech. (D.T.) course(s) of studies.

2. DP-4202: Dairy Plant Operations and Management-II **25(5+20)**

(Experiential Learning)

Imparting capabilities of mid level managerial jobs through on job training experience in a commercial Dairy Plant. Training to the students to handle various aspects of scheduling, processing, maintaining, product accounting and operational efficiencies of all the major equipments and process encountered in the Dairy Plant. This includes training as per the different models proposed by the Dairy Plant.

Operational and Evaluation modalities as per the details provided in the rules and regulations for B. Tech. (D.T.) course(s) of studies.

IV. DAIRY CHEMISTRY

(1) DC-1101: Organic Chemistry

3(2+1)

Theory: Hydrogen bonding: Concepts of hydrogen bonding inter and intra molecular hydrogen bonding in alcohol, carboxylic acids and other molecule. Hydrophobic interactions: Elementary idea of hydrophobicity and its importance in the structure of proteins. Alcohols: Important properties of mono, di and trihydric alcohols (Glycol and Glycerol). Aldehydes and Ketone: Reactions of aldehydes and ketones. Importance of carbonyl compounds in food flavors. Carboxylic acids: Ionization constant and strength of carboxylic acids. Important reactions of carboxylic acid, Derivatives: Esters, Amides, Lactones their preparation and reactions. Amines: Basic character of amines, important reactions. Phenols: Acidic character of phenols and effect of nuclear substituents on it. Reactions in phenols. Substituted carboxylic acid: important reactions of halogen substituted, Keto and Hydroxy acids. Zwitter ion forms, its properties viz. melting point and volatility. Amino Acids and Peptides: Synthetic and natural amino acids. General properties of amino acids. Definition and classification of proteins. Primary, secondary, tertiary and quaternary structure of Proteins. Carbohydrates: Definition, Classification and isomerism. Derivation of structure of Glucose, open chain and ring structure, evidences for ring structure stereochemistry and stability of anomers. Reactions of monosaccharides. Fatty acids and Lipids: Definition and classification. Important reaction of fatty acids (saturated and unsaturated), Structure and properties of Neutral lipids, phospholipids and cholesterol.

Practical: Systematic identification of Organic Compounds: Aliphatic and Aromatic character, unsaturation, Detection of elements (Nitrogen, Sulphur and Halogens), Detection of functional groups (Alcoholic, Phenolic, Carboxylic, Carbonyl, Aldehyde, Ketonic esters, Amino, Amide, Nitro etc.). Preparation of derivatives: Dinitrophenylhydrazone, Oxime and Osazone. Qualitative test for Amino Acids and Proteins: Biuret test, Million's test, Nitroprusside Test, Ninhydrin test, Xanthoproteic test, Hopkin's cole reaction. Detection of Carbohydrates (reducing & non reducing sugars) by: Molisch / Orcinol / Resorcinol / Silver mirror test. Detection of lipids and phospholipids

(2) DC-1202: Chemistry of Milk

3(2+1)

Theory: Definition and structure of milk, Constituents and gross composition of milk, factors affecting composition of milk, Preservatives, neutralizers and adulterants in milk and their detection. Nomenclature and classification of milk proteins, Casein: Isolation, fractionation and chemical composition, physicochemical properties of casein, Whey proteins: Preparation of total whey proteins: α -lactalbumin and β -lactoglobulin. Properties of α -lactalbumin and β -lactoglobulin, immunoglobulins and other minor milk proteins and non protein nitrogen constituents of milk, Hydrolysis and denaturation of milk proteins Under different physical and chemical environments, Estimation of milk proteins using different physical and chemical methods, Importance of genetic polymorphism of milk proteins, Milk enzymes with special reference to lipases, Xanthine oxidase, phosphatases, proteases and lactoperoxidase, Milk carbohydrates their status and importance. Physical and chemical properties of lactose, Sugar amine condensation, amadori re-arrangement, production of hydroxy methyl furfural (HMF), Processing related degradation of lactose, Definition,

general composition and classification of milk lipids. Nomenclature and general structure of glycerides, factors affecting the fatty acid composition. Milk phospholipids and their role in milk products, Unsaponifiable matter and fat soluble vitamins, Milk Salts: Minerals in milk (a) major minerals (b) Trace elements, physical equilibria among the milk salts and Milk contact surfaces and metallic contamination.

Practical: Sampling techniques for chemical examination of milk. Determination of pH and titratable acidity of milk. Determination of fat in milk by different methods. Determination of total solids and solids-not-fat in milk. Determination of total milk proteins by Kjeldahl method. Determination of casein, whey proteins and NPN in milk. Estimation of alkaline phosphatase and lipase in milk. Determination of lactose in milk. Determination of ash in milk. Determination of phosphorus and calcium in milk. Determination of chloride in milk. Determination of temporary and permanent hardness of water. Estimation of available chlorine from bleaching powder.

(3) DC-2103: Physical Chemistry of Milk

3(2+1)

Theory: Constituents and gross composition of milk of different species and breeds of milk animals, Colloidal State: Distinction between true and colloidal solution, lipophilic & lyophobic solutions, properties of colloidal system. Gels: their formation and properties. Milk as a colloidal system and its stability. Elementary idea about emulsion. Density: Density and specific gravity, pycnometer method, hydrometer lactometer. Density and specific gravity of milk, effect of various processing variables on the density and specific gravity of milk. Liquid State: Surface tension, surface energy, interfacial tension. Surface tension of mixtures. Surface tension of milk and the factors affecting it. Viscosity: Definition of viscosity, Newtonian and Non-Newtonian liquids, Stokes Law, influence of temperature and concentration of solute on viscosity. Viscosity of milk, evaporated milk and condensed milk. Refractive index. Colligative Properties of Dilute Solution: Vapour pressure, Raoult's Law, Depression of freezing point, Elevation of boiling point. Freezing point and boiling point of milk. Osmosis and Osmotic pressure. Interrelation of colligative properties.

Aqueous solution of Electrolytes: Electrolytes: nonelectrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrausch Law, Electrical conductance of milk. Ionic Equilibria: Dissociation of water, ionic product of water, concept of pH and pOH and their scale. Acids and bases: Bronsted-Lewis concepts of acids and bases, dissociation constants of acids and bases. Salt, their hydrolysis. Buffer solutions. Derivation of Henderson - Hasselbalch equation and its application, buffer capacity and buffer index, milk as a buffer system. Equilibrium of electrolytes. pH indicators. Oxidation-Reduction: Redox potential, Nernst equation, electrochemical cells. Hydrogen, glass and calomel electrodes. Redox system of milk. Nuclear Chemistry: The nature of isotopes, radio isotopes. Half life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclides in milk & milk products. Molecular Spectroscopy: The spectrum of electromagnetic radiation, the laws of Lambert and Beer, visible, and ultraviolet Spectroscopy. Mention of mass, NMR spectroscopy.

Practical: Determination of density and specific gravity of milk using pycnometer, hydrometer and lactometer. Determination of viscosity of milk using Ostwald viscometer/pipette. Determination of surface tension of milk using Stalagmometer/Capillary. Interfacial tension between water-oil phase. Determination of freezing point of milk. Preparation of buffer solutions. Electrometrically determination of pH of buffer solution and milk. Determination of acidity of milk electrometrically/titrimetrically. Determination of

electrical conductance of milk. Determination of redox potential of milk. Coagulation of milk using electrolytes. Determination of refractive index of skim milk and whey. Titration of amino acid in the presence and absence of formaldehyde. Determination of PKa_1 , PKa_2 and PI. Verification of Lambert Beer Law.

(4) DC-2104: Biochemistry

3(2+1)

Theory: Enzymes: Ribozymes, isozymes, allosteric enzymes, zymogens, regulatory enzymes, Classification and mechanism of enzyme action, Factors affecting rate of enzyme catalyzed reaction, enzyme inhibition, Co enzymes and cofactors, immobilization of enzymes. Nucleic acids: Structure and function, definition and composition. Structure of RNA & DNA. Bioenergetics. Anabolism and Catabolism of carbohydrates, lipids and proteins. Vitamins and Hormones: Structure & functions, general description. Relationship between vitamins and hormones in terms of their biological role. Elementary knowledge of milk synthesis in mammary gland.

Practical: Estimation of alkaline phosphatase and the effect of temperature and pH on its activity. Estimation of catalase and the effect of temperature and pH on its activity. Determination of the Michaelis constant of an enzyme. Estimation of RNA by colorimetric method. Estimation of DNA by colorimetric method. Measurement of proteolysis, lipolysis and amylase activity. Estimation of vitamin A in ghee. Estimation of ascorbic acid in milk. Estimation of vitamin D in milk. Estimation of proteins by Lowry's method, Biuret method. Estimation of lipids and lipid analysis by TLC. Estimation of cholesterol in milk. Estimation of denaturation of proteins in heated milk by dye binding method. Estimation of HMF content in food.

(5) DC-2205: Chemistry of Dairy Products

3(2+1)

Theory: Chemical composition and legal standards of milk products, Chemistry of creaming and factors affecting the same. Ripening and neutralization of cream. Theories of churning and factors affecting the same. Structure and rheology. Butter colour and its chemistry, Ghee: Physico-chemical changes during manufacture, flavour compounds and their chemistry. Oxidative and hydrolytic deterioration, antioxidants, Process induced changes in milk: Cooling, freezing, heating, homogenization and irradiation, Physico-chemical changes in milk constituents during manufacture of khoa, chhana, rabri, kulfi and their keeping quality, Chemistry of cheese - milk clotting enzymes from various sources, enzymatic coagulation of milk, physico-chemical changes during ripening, Milk powder: structure and properties, changes during storage. Lactose crystallization and its effect on casein and fat. Characteristics of infant foods, Condensed and evaporated milk: Lactose crystallization, browning, gelation, salt balance, heat stability etc, Ice - cream: properties of ice -cream mix, stability, chemistry of stabilizers, emulsifiers, Physico- chemical changes while manufacturing of fermented milks.

Practical: Analysis of cream: determination of acidity and fat in cream, Analysis of butter: fat, moisture, salt, curd and acidity, Analysis of ghee: determination of moisture, physico-chemical constants: RM and Polenske value, acid value, refractive index, saponification number, iodine value and peroxide value, Analysis of cheese: sampling, moisture, fat, salt, protein and acidity, Analysis of milk powders: moisture, fat, ash, solubility, acidity and bulk density, Analysis of condensed and evaporated milk : sampling, protein, ash, sucrose and acidity, Analysis of ice- cream: sampling, total solids, fat, sucrose and protein, Analysis of khoa and paneer/chhana : sampling, moisture, fat and

(6) DC-3106: Chemical Quality Assurance**3(2+1)**

Theory: Importance of chemical quality control in dairy industry: setting up quality control laboratories and testing facilities: mobile testing laboratories. Sampling procedures: labelling of samples for analysis: choice of analytical tests for milk and milk products for chemical analysis: instrumental methods of analysis. Calibration of dairy glassware including butyrometer, pipettes, burettes, hydrometers, lactometers and freezing point thermometer. Preparation and standardization of reagents required in the analysis of milk and milk products. Application of PFA, AGMARK, BIS and codex related to dairy products for the quality control of milk and milk products. Preservatives, neutralizers and adulterants in milk and milk products and their detection. Accreditation of analytical laboratories: Hazard analysis and critical control points (HACCP). Prediction of shelf life behavior of milk and milk products. Milk contact surfaces, metallic contamination, environmental contaminants such as pesticides, antibiotics, heavy metals in dairy products: methods of estimation. Soft and hard water, temporary and permanent hardness, softening of hard water.

Practical: Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers. Preparation and standardization of dairy reagents such as acids, alkalies, sodium thiosulfate, silver nitrate, fehling's, EDTA solutions etc. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Chemical analysis of permissible additives used in milk and milk products. Chemical analysis of detergents and sanitizers. Preparation and testing of Gerber sulphuric acid used in fat determination. Testing the amyl alcohol used for fat determination. Analysis of market samples of milk and milk products. Visit to PFA/Agmark Laboratories.

(7) DC-3107: Environmental Studies**3(2+1)**

Theory: Environmental Science: An introduction, Ecosystem: kinds, structure, characteristics, functioning, Biochemical cycles, Natural resources and their managements, Environmental pollution, Air pollution, Water pollution, Solid waste pollution, Noise pollution, Soil pollution, Radioactive pollution, Food processing industry waste and its management, Management of urban waste water, Recycling of organic waste, Recycling of factory effluent, Control of environmental pollution through law, Composting of biological waste and Sewage, uses of water disposal effluent treatment, microbial examination.

Practical: Environment and its analysis, Water quality parameters, collection of sample for pollution study, Determination of pH/acidity/alkalinity from sample, Estimation of dissolved oxygen, Estimation of BOD, Estimation of COD, Estimation of nitrates, Estimation of phosphates, Estimation of pollutant elements, Estimation of heavy/toxic elements, Estimation of lead mercury, Visit to industrial sewage disposal unit.

(8) DC-3208: Food Chemistry**3(2+1)**

Water: Water binding and chemical reactions mediated by water. Food Proteins: Classification, physicochemical properties, Reaction involved in processing, Reactions with alkali, Enzyme catalyzed reactions involving hydrolysis and proteolysis, Theories of formation of texturised proteins. Lipid: Reactions involved during deep frying of food viz., autoxidation of saturated acyl lipids and polymerization. Lipoprotein and membrane:

definition, classification and involvement in the formation of biological membranes. Unsaponifiable matter contents in various fats and oils. Edible fats and oils, classification and chemical composition. Carbohydrates: Legumes, jellies polysaccharide viz. linear, branched and modified. Properties and utilization of common polysaccharides, viz. cellulose, glycogen, hemicellulose and pectin. Enzymatic degradation of polysaccharides, viz. agar, alginate. Carrageenan gums and starch. Production of dextran and malto dextran. Food Enzymes: Hydrolases and lipases, utilization in food industry, effect of inhibitors, pH and temperature. Minerals in foods: Main Elements, trace elements in eggs, cereal and cereal products, vegetables and fruits. Aroma compounds in foods: Threshold value, off flavours. Food additives: Vitamins, amino acids, minerals. Aroma substance, flavour enhancers, monosodium glutamate, nucleotides. Sugar substitutes, sorbitol. Sweeteners- saccharin, cyclamate. Food colours. Antinutritional factors and Food contaminant: Toxic- trace elements, radio nuclides. Cereals and cereal products: Individual constituents like proteins, lipids, carbohydrates and vitamins in cereals flour and their relationship in dough making. Type of flours, bread making and nonbread making: chemical composition, influence of additives/minor ingredients on baking properties. Physical, chemical changes during baking. Legumes: Classification composition and physicochemical properties. Vegetables and fruits: Classification, general composition, chemical changes during ripening and storage. Jams, jellies and pickles: Classification, composition and preservation. Beverages: Classification, Coffee, Tea and Cocoa gradation, composition, chemical changes during processing, volatile compounds. Preservation of Foods: General principles of food preservation, chemical preservation, preservation through irradiation.

Practical: Determination of moisture, acidity and gluten content in flour. Determination of total ash and acid insoluble ash in flour. Determination of starch in flour. Determination of total nitrogen in cereal products. Determination of acidity and vitamin C in citrus fruits. Analysis of tomato ketchup for total solids, acidity, ash and salt. Determination of total sugar in tomato ketchup. Determination of total ash and alkalinity of soluble ash in tea. Determination of water extractives in tea leaves. Determination of presence of Chicory in coffee powder. Determination of reducing sugars in Jam. Determination of iron in infant foods.

(9) DC-4209: Human Nutrition

(1+0)

Theory: Theory and definition, Scope of Nutrition: Functions of the various nutrients in body. Digestion, absorption and assimilation of nutrients. Comparative requirements and nutritional requirement of different age groups (WHO and ICMR standard). Methods of evaluation of nutritive value of foods. Nutritional value of cow, buffalo and human milk. Milk intolerance: lactase deficiency and protein hyper sensitivity. Safety aspects of food additives. Toxic elements, radionuclides, pesticides and antibiotic residues in milk and milk products. Institutional feeding of workers. Planning and implementation of national food and nutrition policies and programme. Regulatory aspects of nutrition, IDF code on nutrition, nutrition facts under NLEA, Nutrient descriptors, serving size and nutritional claims.

V. DAIRY BUSINESS MANAGEMENT

1. DBM-1101: Dairy Development

1(1+0)

Theory: Socio-economic and geographical features of Indian dairying. Traditional Systems of cattle keeping, estimates of milk production, utilization and sale: cattle & buffalo population and its distribution: trends in population growth, annual milk production and per capita availability: productivity profile of indigenous dairy stock, industrial by-products of livestock industry. Five year plans and dairy development: resource inadequacy, post partition pressure: catalytic action of international aid: major aided dairy projects: public sector milk supply schemes: co-operative dairy organizations, Anand pattern and perspectives: milk products manufacture in private sector, import substitutions in dairy products. Strategy of cattle improvement: pioneering role military dairy farm: key village scheme and its limitations, intensive cattle development programme concept, approach and achievements. Public sector dairy schemes, Economic burden performance analysis, National Dairy Development Board-aim and objectives, policy orientation in dairy development. Operation Flood-I, II, III: programmes & Outlay, implementation, success, achievements, integrated infrastructure of milk production, improvements of dairy co-operative organization, Dairy development Corporations, Co-operative Dairy Federations, Self-reliance in dairy development, income & employment potential. Conversion of milk into products, utilization pattern indigenous & western products. Dairy problems and policies.

2. DBM-1102: Milk Production Management

2(1+1)

Theory: Introduction to Animal Husbandry. Distinguishing characteristics of Indian and exotic breeds of dairy animals and their performance. Breeding systems of dairy animals. General dairy farm practices- identification, dehorning, castration, exercising, grooming, weighing. Care of animals at calving and management of neonates. Management of lactating and dry cows and buffaloes. Methods of milking, milking procedure and practices for quality milk production. Dairy farm records and their maintenance. Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises. Common disease problems in dairy animals, their prevention and control. Feed nutrients required by animal body. Feed resources for milk production and their nutritive values. Digestive system of ruminants. Measures of feed energy.

Nutrients requirements for growth and milk production. Feeding standards. Structure and function of mammary system. Milk secretion and milk let-down. Male and female reproductive system. Estrus to reproductive cycle. Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. Artificial insemination and embryo transfer and their role in animal improvement. Introduction to biotechniques in dairy animal production.

Practical: Handling and restraining of dairy animals. External body parts and judging of cows and buffaloes. Feeding and management practices of calves. Identification of common feeds and fodders. Preparation of rations for adult animals. Milking of dairy animals and cleaning and sanitation of milking equipments. Identification of reproductive and digestive organs. Demonstration of semen collection, processing and artificial insemination.

3. DBM- 1103: Applied Mathematics

2(2+0)

Linear Algebra: Algebra of matrices, inverse, rank, system of linear equations, symmetric, skew-symmetric and orthogonal matrices. Hermitian, skew-Hermitian and unitary matrices, Eigen values and eigenvectors.

Calculus: Functions of single variable, limit, continuity and differentiability, Mean value theorems, Maxima and minima, Moment of Inertia. Taylor's series, Evaluation of definite and improper integrals, Functions of two variables, partial derivatives, maxima and minima, double and triple integrals and their applications, sequence and series, Fourier Series, Half range sine and cosine series.

Vector Calculus: Gradient, divergence and curl, vector identities, directional derivatives, line, surface and volume integrals, Stokes, Gauss and Green's theorems (without proofs) applications.

Ordinary Differential Equations: First order equation (linear and nonlinear), Second order, higher order linear differential equations with constant coefficients.

4. DBM- 1104 English

3(2+1)

Unit-1 Communication skills: Process, types and levels of communication. Technical communication and General Communication. Factors to be considered in technical communication. Barriers to effective communication. (Noise in oral and written communication) communication across cultures.

Unit-2 Note taking and Note making

Unit-3 Technical reports: Introduction, types of reports, structure of reports, objectives and characteristics of reports.

Unit-4 Technical Proposals: Definition, Purpose, Types, Characteristics, Structure, Style and appearance.

Practical

Unit- 1 Effective presentation strategies. Defining purpose, analysis of audience and locate, organizing contents. Preparing an outline of the presentation. Visual aids, nuances of delivery, Body language and effective presentation.

Unit-2 Group Discussions: Introduction, Group discussions as a part of the selection process, guidelines for group discussion. Role functions in group discussion.

Unit-3 Letter – Writing: Business Letters, Structure and types of a business letter, Letter of Inquiry, Letters of complaint, regret and adjustment.

Unit- 4 Effective Reading Skills: Purpose of reading, skimming and scanning. Tips for improving comprehension skills.

Unit- 5 Job application: Essential parts – Cover Letter and the ‘resume’. Types of ‘resumes’ (Curriculum Vitae) Chronological ‘resume’, functional ‘resume’.

Unit-6 Listening skills – Types of Listening Active Listening V/s Passive Listening Empathetic Listening. Traits of a good listener, Barriers in effective listening, Tips for effective listening.

5. DBM-1205: Economic Analysis

2(2+0)

Theory: Basic concepts-wants, goods, wealth, utility, consumption, demand and supply, Consumer behavior-law of diminishing marginal utility and equi-marginal utility, cardinal and ordinal utility approach for consumer's behaviors. Theory of demand-law of demand, demand schedule, demand function, determinates of demand, individual consumer demand and market demand, demand forecasting, elasticity of demand, price elasticity, income elasticity and cross elasticity, Consumer's surplus. Theory of production- concepts of firm and industry, basic factors of production and their role, production function for a single product, nature of production function, laws of returns. Concepts of costs-fixed and variable costs, short run and long run costs, average and marginal costs, economics and diseconomies of scale. Concept of market- types of market, pricing and output under different market situations, market price and normal price, price determination under perfect Competition, monopoly, oligopoly and monopolistic competition. National income - GDP, GNP, NNP, disposable personal Income, per capita income, inflation. Economic features and characteristics of dairy sector in India. Dairy development strategy with special emphasis in post- independence era and Operation Flood Programme

6. DBM- 1206: Industrial Statistics

3(2+1)

Theory: Definition and scope: sources of animal husbandry and dairy statistic. Measures of central tendency, Measures of dispersion. Moments skewness and kurtosis. Elementary notions of probability, Laws of addition and multiplication probability. Theoretical frequency distributions: Binomial distributions and applications, Poisson distribution and its applications, Normal distribution and its applications. Concepts of sampling methods- Simple random sampling, stratify random sampling, cluster sampling, systematic sampling. Introduction to testing of hypotheses, Tests of significance- Z, t₂, a, F tests, and their application in the field of dairying. Analysis of variance- One way and two way classification. Simple correlation coefficient and its test of significance, Line regression, rank correlation. Basic concepts of statistical quality control, Control charts for variables and attributes, Fundamental concepts of acceptance sampling plan.

Practical: Measures of central tendency. Measures of dispersion, Moments Skewness and Kurtosis. Filling of binomial and Poisson distribution. Selection of random sample. Application of 'Z' test for one and two sample problems. Application of 't' test for one and two sample problems. Application of Chi-square test and F-test. Correlation and regression. Rank correlation coefficient. Control chart for variables & attributes.

7. DBM-2107: Computer Programming

3(1+2)

Theory: Problem solving with computers, flowchart and algorithm development, Data types variables, constants, arithmetic and logical expressions, input/output statements, conditional statements, control structures, arrays, functions, structures, unions.

Practical: Understand different Components of Computer System. Write a C program to calculate volume of a prism having trapezoidal base. Write a program, which can input a positive integer (≤ 10000000) and print it in reverse order. For example 9875674 to 4765789. Write a program to calculate sum of squares of all odd integers between 17 to 335. Exclude integers divisible by 7. Ohm's law is $I=V/R$, Write a program to calculate I from given n sets of V and R. Write a program to generate the Cartesian coordinates of points (x,y) for the values of ranging from 0,5,10,15 ----- 90. title and label the output. Write a program to calculate the resultant focal length f, when f1 and f2 are placed in contact. Used formula is $f=(f1+f2)/(f1 \times f2)$. Compute for following pairs of focal lengths. f1 = 10,-8,-6,-1..... +8, + 1 0: f2= 0.5,-0.4,..... +0.4, +0.5 Write a program to sort an array of N elements in ascending order. Write a program to evaluate following series to calculate $\cos x$ $\cos x = 1 - \frac{x^2}{2!} + \frac{x^4}{4!} - \frac{x^6}{6!} + \dots$. Compare the calculated value with the one by using library function. Write a program which reads in indefinite number of Name, Marks1, Marks2, Marks3 from keyboard and store them in a file along with total marks, Percentage marks and Grade in a file.

8. DBM-2208: Financial Management

3 (2+1)

Theory: Introduction: Definition, scope and objectives of financial management. Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting. Double entry system of Book-Keeping. Preparation of Accounting Records: Journal, Purchases and Sales Book and Posting in Ledger, Cash Book. Preparation of Final Accounts and adjustments at the end of trading period. Preparation of Trial Balance Banking Transactions and Bank reconciliation statements. Statements of Financial Information: Accounting system: A source of financial statements, Classification of capital and revenue expenditure, Balance Sheet, Profit and Loss Account, Statement of changes in the financial position, funds flow statements, cash flow statement, uses of funds flow and cash flow statements in financial decision making. Nature and uses of financial analysis, Liquidity ratios, Leverage ratios, Activity ratios, Profitability ratios, Utility of Ratio analysis. Cost Volume - Profit analysis and operating leverage, Break-even analysis, Profit analysis and operating analysis, Utility of CVP analysis.

Capital Structure: C.S Planning, risk return trade off, financial leverage. Cost of capital: Management of cost of capital, cost of debt, debentures, preference share capital, equity

share capital & retained earnings, overall cost of capital. Investment decision: Time value of money, Net present value, Investment evaluation criteria, NPV method, Internal rate of return method, Profitability index method, Payback period method, Accounting rate of return method. Capital budgeting: Complex Investment Decisions: Investment timing & duration Investment decisions under inflation, Investment decisions under capital rationing. Project Report: Feasibility Report Valuation. Working capital management- Concept & determinants of working capital, Estimating working capital needs. Depreciation - Concept and method.

Practical: Preparation of Profit and Loss account. Preparation of Balance Sheet. Preparation of Cash flow statements. Preparation of Funds flow statements. Problems on Ratio analysis. Problems on Break-Even Analysis. Problems on Profit analysis. Problems on Operating Analysis. Problems on Financial leverage. Problems on Cost of Capital. Problems on Investment decisions. Problems on Capital budgeting

9. DBM-3109: Cost Accounting

2(2+0)

Theory: Introduction, Definition, Objectives, Common terms of Costing, Essentials of sound costing system. Different methods of costing, elements of cost: Labour- recording of time, idle time, methods of remunerating labour, Premium & Bonus Plans, Materials, Overheads. Cost classification: Direct and Indirect expenses, fixed and variable costs. Various methods of apportioning indirect expenses. Inventory Management: Planning, control and costing. Stores & storekeeping, scope & importance, purchase procedure, types of purchase, location of stores & materials, procedure for the movement of stores, different methods of pricing materials, store records. Cost Sheets- Different methods, Statement of cost and statement of profit estimates, Tenders or Quotations. Contract or Terminal costing. Process Costing: Process losses and inter- process profits, joint products and by products costing. Ascertainment of cost of milk production. Preparation of Cost Account Information for managerial decisions.

10. DBM-3210: IT in Dairy Industry

2(1+1)

Theory: Importance of Computerization and IT in dairy industries. Computers, Operating. Environments and Information Systems for various types of dairy Industries, Principles of communication. Role of Computer in Optimization. Introduction to Operation Research. A Computer Oriented Algorithmic approach: Queuing systems and waiting models, PERT CPS and CPM. Dairy Process Modeling and Simulation. Introduction to computers. Importance of computerization and IT in dairy Information systems for various types of dairy industries. Role of computers in dairy modeling and simulations to operation research. A computer oriented Algorithm approach: Queuing systems and waiting models. PERM and CPM. Introduction to Microsoft Access-Creation and management of data base, forms and reports.

Practical: Applications of MS Excel to solve the problems of dairy technology: Statistical quality control, Sensory evaluation of food. Use of word processing software for creating reports and presentation. Familiarization with the application of computer in dairy industries. Familiarization with software related to dairy industry. Visit to Industry and knowledge of computer application in the same

11. DBM-3211: Operation Research

2(2+0)

Theory: Introduction - Elementary concepts, objectives of operations research, Applications of OR in decision-making. Modelling in Operation Research. Linear Programming: Introduction, mathematical formulation of the problem, Graphical solution, Simplex technique for solving simple LP problems. Inventory Control - Introduction and general notations, Economic lot size models with known demand.

12. DBM-4112: Communication skill and Entrepreneurship Development

2(2+0)

Theory: Communication Skills: Structural and functional grammar: meaning and process of communication, Media of communication: listening and note taking, writing skills, oral presentation skills: field diary and lab record: indexing, footnote and bibliographic procedures.

Reading and comprehension of general and technical articles, precise writing, summarizing, abstracting: individual and group presentations, impromptu presentation, public speaking: Group discussion. Organizing seminars and conferences. Business and official correspondence, Memoranda, Report writing, Agenda and Minutes of Meetings Entrepreneurship Development: Assessing overall business environment in the Indian economy.

Overview of Indian social, political and economic systems and their implications for decision making by individual entrepreneurs. Globalization and the emerging business / entrepreneurial environment. Concept of entrepreneurship: entrepreneurial and managerial characteristics: managing an enterprise: motivation and entrepreneurship development: importance of planning, monitoring, evaluation and follow up: managing competition: entrepreneurship development programs: SWOT analysis, Generation, incubation and commercialization of ideas and innovations. Government schemes and incentives for promotion of entrepreneurship. Government policy on Small and Medium Enterprises (SMEs) / SSIs. Export and Import Policies relevant to horticulture sector. Venture capital. Contract farming and joint ventures, public-private partnerships. Overview of horti inputs industry. Characteristics of Indian horticultural processing and export industry. Social Responsibility of Business.

13. DBM-4113: Dairy Extension Education

1(1+0)

Theory: History, need definition, philosophy, principles, approaches and objectives of extension education, Teaching/learning process, Extension Teaching Methods, classification and selection of teaching methods. Nature and importance of communication. Key elements of communication. Importance of audiovisual aids in extension education and its classification. Steps for evaluation of extension programmes.

14. DBM-4214: Marketing Management and International Trade

2(2+0)

Theory: Concept of marketing: Functions of marketing: concepts of marketing management: scope of marketing management: marketing management. Process: concepts of marketing-mix, elements of marketing-mix. Market Structure and Consumer Buying Behaviour: Concept of market structure, marketing environment, micro and macro environments. Consumers buying behaviour, consumerism. Marketing Opportunities Analysis: Marketing research and marketing information systems: Market measurement- present and future demand: Market forecasting: market segmentation, targeting and positioning. Allocation and marketing resources. Marketing Planning Process. Product policy and planning: Product-mix: product line: product life cycle. New product development process. Product brand, packaging, services decisions. Marketing channel decisions. Retailing, wholesaling and distribution. Pricing Decisions. Price determination and pricing policy of milk products in organized and unorganized sectors of dairy industry. Promotion-mix decisions. Advertising: How advertising works: Deciding advertising objectives, advertising budget and advertising message: Media Planning: Personal Selling, Publicity: Sales Promotion. Food and Dairy Products Marketing. International Marketing and International Trade. Salient features of International Marketing. Composition & direction of Indian exports: International marketing environment: Deciding which & how to enter international market: Exports- Direct exports, indirect exports, Licensing, Joint Ventures, Direct investment & internationalization process, Deciding marketing Programme: Product, Promotion, Price, Distribution Channels. Deciding the Market Organization: World Trade Organization (WTO).

LIST OF EQUIPMENTS

1. Equipments required for Laboratories

Sr. No.	Name	Number
1	UV-Vis Spectrophotometer	02
2	Analytical balances	04
3	Electronic balances	04
4	Muffle furnace	02
5	Automatic titrator	01
6	Soxhlet instrument	01
7	Gerber centrifuge	02
8	pH meter	04
9	Autoclave	02
10	Laminar flow/Bio safety cabinet	02
11	BOD Incubator	02
12	Simple microscope	10
13	Simple oil immersion microscope	01
14	Hot air oven	01
15	Hot water bath	04
16	Serological bath	04
17	Centrifuge	02
18	Low temperature centrifuge	01
19	Pipette washer	02
20	Rotary shaker	01
21	Gas supply and burners	01
22	Standard assembly for titrimetric analysis with indicator	All items: 02 each

2. Packaging laboratory

Sr. No.	Name	Number
1	Weighing balance (Accuracy 0 ⁻³ .001 g)	02
2	Micrometre	04
3	Mullen Bursting strength tester	01
4	Mechanical drop tester	01

5	Compression strength tester	01
6	Smoothness or porosity tester	01
7	Cobb tester	01
8	Elmendorf tear tester	01
9	Water absorption tester	01
10	Head space analyser	01
11	Universal testing machine	01
Barrier testing instruments		
1	Oxygen	01
2	Carbon dioxide	01
3	Water vapour transmission tester	01

3. Pilot Plant cum Business Incubation Centre for Dairy and Food Processing

Sr. No.	Name	Number
1	Milk reception section	01
2	Liquid milk processing unit	01
3	Cream processing , butter and ghee Section	01
4	Powder reconstitution & milk poly pack section	01

4. The total production line to be developed for the Dairy Unit (10,000 LPD) is illustrated in the table below

Sr. No.	Product to be manufactured	Quantity of Milk
1	Liquid milk (Different qualities) of milk such as full cream, Standardized milk, Toned milk, double toned, milk as per the requirement by PDP	2,500 litres
2	Curd/Lassi/Chhach/Yoghurt	1000 litres
3	Paneer/Cheese/Shrikhand/Chhana (Production and Channa based sweets packaging)	1000 litres
4	Ice-cream (1000 litres mix)	1000 litres mix
5	By-Products: casein, caseinates, whey products, etc.	500 litres (only for practical purpose)

6	Heat desiccated products (Khoa, Khoa based sweets like Gulabjamun, Peda, Phirni, Rabri, Kurchan, Kheer, etc.)	500 litres (For practical purpose & also for marketing as per demand)
7	Fat rich products Butter, Ghee, etc.	Regular production from cream obtained from market milk industry

5. Major Common Pilot Plant Equipment:

Sr. No	Item	Numbers	Capacity
1	Milk Weighing Scale	1	0-100 kg
2	Bulk Cooling Tank	1	1000 L
3	Can Washer	1	5 cans/hr
4	HTST Plate Heat Exchanger	1	500 L/hr
5	Batch Pasteurizer	1	500 L
6	Homogenizer	1	500 L/hr
7	Milk Storage Tank	2	1000 L each
8	Milk Bottling Plant	1	10 bottles/min
9	Butter Churn	1	100 kg
10	Ghee Boiling Vat	1	100 kg
11	Ice cream Freezer - Batch	1	20 kg/batch
12	Cheese Vat	3	200 L each
13	Cheese Cutting Frame	3	1 X 3 ft size
14	Cheese Press	1	6 block
15	Milk Condensing Unit	1	40 kg water evaporation/hr

16	Spray Drying Unit	1	5-10 kg water evaporation/hr
17	Refrigeration Plant	1	10 Ton
18	Portable Weighing Scale	2	5 kg
19	Curd Mill	1	-
20	Cheese Hoop	6	20 kg size
21	Milk Cans	50	40 kg each
22	Auto Clave	1	-
23	Ice Water Plant	1	5 Ton
24	Cheese Block Cutter	1	-
25	Sieve for Shrikhand	2	-
26	Planetary Mixer	1	10 kg
27	Hand Bottle Filler	1	-
28	Can Scrubber Tank	1	-
29	Pouch Filling Machine	1	100 pouch/hr
30	Cream Separator	1	500 L/hr
31	Butter Trolley	1	50 kg
32	Wet Casein Grinder	1	5 kg/
33	Casein Shredder	1	5 kg
34	Casein Dryer	1	5 kg/batch
35	Bottle Sterilizer	1	40 bottles/batch
36	Khoa Kettle	1	10 kg/batch
37	Colloidal Mill	1	1 kg/min
38	Crown Capping Machine	1	Manual
39	Sugar Grinder	1	5 kg
40	Tin Seamer	1	Manual
41	UF Cum RO Unit	1	50 kg/hr

42	Crates For Milk Bottles	100	10 kg each
43	Deep Freezer	4	-
44	Gerber Centrifuge	2	24 tubes
45	BOD Incubator	2	-
46	Hot Air Oven	2	-
47	Hot Plate	1	-
48	Magnetic Stirrer	1	-
49	Colony Counter	1	-
50	Weight Box	1 set	100 g
51	Paraffin Bath	1	50 kg
52	Vacuum Packaging Machine	1	5 kg/batch
53	Milk Analyser	1	-
54	Ice Cream Freezer - Continuous Type	1	50 L/hr
55	Cooling Unit For Cheese Curing Room	1	2 tonnes
56	Candy Making Machine	1	50 candy/batch
57	Candy Moulds	10	24 x 100 ml
58	Vacuum Tray Dryer	1	-
59	Extruder	1	-
60	Ice Cream Cup Filling Machine	1	100 cups/hr
61	UHT Milk Sterilization Unit with Aseptic Packaging	1	100 L/hr
62	Tray sealing machine	1	-
63	Colloid Mill	1	-
64	Hammer mill	1	-
65	Planetary mixer	1	-
66	Pin mill	1	-
67	Homogenizer	1	-

68	Steam Jacketed Kettle	3	-
69	Refrigeration System For Ice Cream Hardening Room	1	2 tonnes
70	Processed Cheese Kettle	1	5 kg
71	Steam Boiler	2	500-1000 kg
72	Diesel power generator	1	125 KWA
73	Effluent Treatment Plant	1	-

6. Equipment for Dairy Engineering Division:

Sr. No.	Name	Number
1	Orifice and Mouthpiece apparatus	2
2	Pipe friction apparatus	1
3	Minor head loss apparatus	1
4	Flow through channel apparatus	1
5	Computerized centrifugal pump test rig	1
6	Rotameter	2
7	Water flow meters	2
8	Reynolds apparatus	1
9	Bernoulli's apparatus	1
10	Various types of pipe fittings and valves	02 set
11	Self priming pump	2
12	Monoblock pump set	2
13	Submersible pump	1
14	Powder conductivity meter	1
15	Computerized counter and parallel flow apparatus	1
16	Plate Heat Exchanger	1
17	Steam Jacketed kettle	1
18	Stefan Boltzmann Apparatus	1
19	Jacketed vats	2
20	Heat Transfer through composite wall	1
21	Heat Transfer through Natural Convention	1
22	Critical Heat Flux Apparatus	1

23	Heat Transfer through lagged pipe	1
24	Digital temperature indicators with probes	05 set
25	Multi Channel temperature indicator	2
26	Solar water heating system	1
27	Computerized refrigeration tutor	1
28	Computerized air conditioning tutor	1
29	Water cooler	1
30	Window AC	2
31	Split AC	2
32	Refrigerator	1
33	Models of sealed and open type compressor	01 set
34	Refrigeration plant controls such as thermostat, pressure switches, solenoid valves, expansion valves	01 set
35	Dessert cooler	2
36	Dehumidifier	1
37	Food Processor	1
38	Texture Analyzer	1
39	Laboratory scale freeze dryer	1
40	Try dryer	1
41	Texturometer	1
42	Juice extractors	1
43	Extruders	1
44	Sulfuring chamber	1
45	Blanching equipment	1
46	Clinching equipments	1
47	Jacketed kettle	1
48	Bomb calorimeter	1
49	Flue gas analyzer	1
50	Bucket calorimeter	1
51	Baby boiler	1
52	Models of boiler mountings and accessories.	01 set
53	IC Engine test rig	1
54	Steam flow meter	2
55	Water flow meter	2
56	Models of two stroke and four stroke engine	01 each

57	Different types of steam traps	02 set
58	Pipes and pipe fittings	As per the requirements
59	Oil and gas burners	01 each
60	Water softening plant	1
61	Boiler feed water pump	1
62	Digital clip-on-meters	2
63	Digital Energy analyzer	1
64	Power measuring instruments such as volt meter, ampere meter, energy meter, meger	05 set
65	Inverter	1
66	Induction Motors with starters	2
67	Variable Frequency Drive	2
68	Single phase Transformer, 2 kVA	2
69	Digital three phase Energy meter	2
70	Different types of starters such as direct on line starter, star delta starter, Auto-transformer starter etc.	02 set
71	Experimental set up for experiment in parallel & series connection, stair case wiring, tube light wiring, motor connection, speed measurement, demonstration of winding etc with necessary power, voltage, and current measuring devices.	02 set each
72	Hand tachometer	2
73	Non contact type tachometer	2
74	Soft starter	2
75	Air anemometer	1
76	Magnetic flow meter	2
77	Digital pocket type thermometers with different types of probes	5
78	Multi channel data logger	1
79	Various tutors/transducers such as Strain gauge, pressure, LVDT, Inductive, Photo cell, piezometer, etc.	01 set
80	Water Level controller	1
81	Pneumatic controller	1
82	PID controller temperature controller system	1
83	Digital Tachometer	1
84	Lux meter	1
85	Solar lighting system	2

86	Lathe Machine	1
87	CNC lathe	1
88	Grinding machine	1
89	Power saw	1
90	Drilling machine	1
91	Pipe bending machine	1
92	Electric welding machine	1
93	Portable welding machine	1
94	Gas welding set	1
95	Shear cutting machine	1
96	Threading machine	1
97	Universal wood working machine	1
98	Bench vice	20
99	Portable grinding machine	2
100	Shaping machine	1

7. Dairy Trade and Business Management Division:

Sr. No.	Name	Number
1	Desk top computers with LAN facility and Internet connection	20
2	Photocopier	3
3	Laser Printer	6
4	Colour Laser Printer	1
5	Softwares: SPSS/Metlab/Design expert	01 each with multiuse license
6	Indian patent database	1

LIST OF BOOKS

Indicative list of reference books for library:

Sr. No.	Title	Author
1.	Fundamental Food Microbiology	Ray, Bibek
2.	Microbiology Handbook Dairy Products	Fernandes, Rhea
3.	Basic Microbiology An illustrated Laboratory Manual	Khunita, B. K.
4.	Bergey's manual of Systematic Bacteriology Vol.3 : The Firmicutes	Boone, David R.
5.	Elements of Foods and Nutrition	Dowd, Mary T.
6.	Instant Bio Chemistry	Nagini, S.
7.	Bio Chemistry : International Student Version	Voet, Donald
8.	Principles of Food Chemistry	Demam, John M.
9.	Food Chemistry	Belitz, H. D.
10.	Food The Chemistry of Its Components	Covltate, T. P.
11.	Food Chemistry	Fennema, Owen R.
12.	Essentials of Cheese making	Upadhyay,K.G.
13.	Cost Accounting	Jawahar Lal
14.	Dairy Plant Management	Makwana, Ashish Keshavlal
15.	A Textbook of Organic Chemistry	Bansal,R.K.
16.	Milk Testing : A Laboratory Control of Milk	Davis, J.G.
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