



**Department of Animal Husbandry and
Dairy Science
Mahatma Phule Krishi Vidyapeeth
Rahuri-413 722, Dist. Ahmednagar (MS)**



Doctoral Programme in Dairy Science

Course Layout

Minimum Credit Requirements

Sr. No.	Subject	Minimum credit(s)
1.	Major	18
2.	Minor	08
3.	Supporting	06
4.	Seminar	02
5.	Research	45
	Total Credits	79
	Compulsory Non Credit Courses	06

Sr. No.	Course Number	Course Title	Credits
A) Major subjects (Min.18 credits)			
1	DSC – 601	Advances in Milk and Milk Products Technology	3 = 2 + 1
2	DSC – 602	Advances in Dairy Microbiology	3 = 2 + 1
3	DSC – 603	Advances in Dairy Processing	3 = 2 + 1
4	DSC – 604	Advances in Chemistry of Milk Processing	3 = 2 + 1
5	DSC – 605	Recent Trends in Value Added Dairy Products and Byproducts	3 = 2 + 1
6	DSC- 608	Research and Development Management in Dairy Industry	3= 3+0
B) Minor Subjects (Min. 08 credits)			
1	AH- 601	Advances in Livestock Production and Management	3 = 2 + 1
2	DSC – 606	Recent Advances in Sensory Evaluation	1 = 1 + 0
3	DSC - 607	Advances in Dairy Food Packaging	2 = 1 + 1
4	AH – 610	Advances in Quality Control of Livestock Products	2 = 2 + 0

C) Supporting Subjects (Min. 06 credits)			
1	FST-611	Advances in Food Biotechnology	3 =2+1
2	STAT-601	Design of Experiments for Plant Sciences	3 = 2+1
D) Seminar (02 credits)			
1	DSC - 691	Doctoral Seminar –I	1=0+1
2	DSC-692	Doctoral Seminar –II	1=0+1
E) Doctoral Research (45 credits)			
1	Thesis- 699		45=0+45
F) Non Credit Compulsory Courses			
1	PGS-501	Library and Information Services	1=0+1
2	PGS-504	Basic Concepts in Laboratory Techniques	1=0+1
3	PGS-502	Technical Writing and Communication Skills	1=0+1
4	PGS-503	Intellectual Property and its Management In Agriculture	1=0+1
5	PGS-505 (e-course)	Agriculture Research, Research Ethics and Rural Development Programmes	1 =1+0
6	PGS-506 (e-course)	Disaster Management	1 =1+0

Course Contents

A) Major Subjects:

Course No. DSC 601

Course Title: Advances in Milk and Milk Product Technology

Course Credits: 2+1=3

Theory:

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Globalization: Meaning, mode of action, functioning, draft guidelines	2	6
2	Initiatives from Indian context, private, public sector	2	6
3	Enforcement of rules / regulations in general and dairy sector in particular	2	6
4	Requirements to become a global member in relation to Indian dairy sector	1	3
5	SWOT analysis of Indian dairy industry in globalization context	2	6
6	Scope for India to become a global leader in dairy sector	2	6
7	Impact of globalization on Indian dairy sector present scenario and future perspectives	2	6
8	Genesis of milk grid and benefits to producers and consumers	2	7
9	Role of various organizations in milk grid. Functioning and impact of milk grid on dairy industry	2	6
10	Principles and practices of hygienic handling of milk- on farm, storage, transport, processing, after process storage and marketing	1	3
11	Role of end user in hygienic handling of finished milk and milk products	2	6
12	Advanced techniques in handling of milk and milk products	1	3
13	Advancements in cream separation	4	13
14	Review of innovative technique in hygienic milk	1	3
15	Innovative techniques in dairy product manufacturing- evaporated, concentrated, heat-acid coagulated, fermented, frozen	3	10
16	Review in development of newer dairy products	3	10

Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Various innovative techniques and its applications in dairy product manufacturing and quality assessment	12	75
2	Manufacture of new dairy products	4	25

Suggested Readings:

1. Sukumar De (2006) Outlines of Dairy Technology. Oxford Univ. Press, New Delhi.
2. Henderson, J.L. (1971) Fluid milk industry. The AV Publ. Co. Inc. Westport Connecticut.
3. Robinson, R.K. (1986) Modern Dairy Technology Vol. 1. Elsevier Applied Science, London.
4. Harper W.J. and Hall C.W. (1981) Dairy Technology and Engineering.
5. Aneja R.P., Mathur, B.N; Chandan R.C. and Banerjee A.K. (2002) Technology of Indian Milk Product.
6. Dilip Shah (1987) Milk Pricing and Marketing practices, Maricheemalee Prakashan, Surat
7. Selected articles from journals

Course No. DSC 602**Course Title: Advances in Dairy Microbiology****Course Credits: 2+1=3****Theory:**

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Bacterial growth – Meaning, reproduction of bacteria, methods\	2	6
2	Bacterial growth phases	1	3
3	Factors affecting bacterial growth – nutrition, temperature, oxygen etc.	3	10
4	Continuous culture – concept, techniques, necessity	1	3
5	Microbial genetics – functions of various cell component related to microbial genetics	2	6
6	Concept of genetic modification in relation to micro- organisms	1	3
7	Various techniques in gene modifications - recombination, transformation, transduction ,conjugation etc	1	3
8	Plasmids – Introduction and it's Genetic importance	1	3
9	Role of plasmid in genetic modifications, especially in dairy starters	1	3
10	Phenomenon and types of fermentation by lactic acid bacteria.	2	6
11	Different metabolic pathways in relation to desirable fermentation by LAB	2	7
12	Novel techniques in starter propagation and preservations	2	7

13	Recent developments in cheese ripening	1	3
14	Microbial origin Bio-preservatives- Meaning and role	1	3
15	Production of microbial origin bio-preservatives	1	3
16	Characteristics of microbial origin bio-preservatives	1	3
17	Current trends in food safety in general and dairy products in particular	1	3
18	Requirements for dairy food safety	1	3
19	New emerging pathogens in milk and milk products	2	7
20	Recent technology in control of food borne pathogenesis	1	3
21	Concepts in dairy food quality managements	1	3
22	Concept of single cell Biomass	1	3
23	Micro- organisms considered for obtaining biomass as a food	1	3
24	Production, processing, storage and application of single cell biomass	1	3

Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Study of LAB growth phases by cultural activity – Total count, acidity development, production of flavour compounds etc.	4	25
2	Study of various factors affecting growth of lactic acid bacteria-temperature, moisture content, oxygen, nutritional requirements, antagonistic substance, period of incubation	4	25
3	Studies on flavour compound production by LAB	2	13
4	Preservation of starter culture – liquid form, freezing	2	13
5	Application of bio- preservatives for shelf-life extension for dairy products	2	12
6	Production of single cell proteins	2	12

Suggested Readings:

1. Yadav J.S; Grover S. and Batish V.K. (1993) A comprehensive Dairy Microbiology. Metropolitan. Metropolitan, New Delhi (India) 110 002.
2. Foster, E.M. (1958) Dairy microbiology, Macmillan & co. Ltd; London.
3. Robinson, R.K. (1991) Dairy Microbiology Vol. I, The microbiology of milk, Applied Science publisher, London.
4. Robinson, R.K. (1981) Dairy Microbiology Vol. II – The microbiology of milk products, Applied Science publisher, London.
5. Elmer. H. Marth and Same, S.L. Applied Dairy Microbiology, 2nd ed., Steele Mared Dekkar, Inc. New York.
6. Richardson Gary H. Standard methods for the examination of Dairy Products,

- 15th ed. American Public health Association, Washinnton D.C.
7. Marvin L. Speck, Compendium of methods for the microbiological examination of food. 2nd Edn., American public health Association, Washington. D.C.
8. Harison W.F. and M E Mc Canee (1976) Laboratory methods in feed and Dairy Microbiology, Acd. Press, London
9. Selected articles from journals

Course No. DSC 603
Course Title: Advances in Dairy Processing
Course Credits: 2+1=3

Theory:

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Quality milk: Meaning/Definition in respect of nutrition, microbial, adulteration etc	1	3
2	principles involved in production of high quality milk	1	3
3	Requirements for production and processing of milk	1	3
4	Improvement in production and processing practices to achieve high quality standards	2	6
5	Recent advances in cooling/ chilling and thereby preservation of milk	2	6
6	Recent advances in thermal processing of milk, UHT, sterilization Bacto- therm etc	3	10
7	Effect of processing on microbial status of milk. i.e. Chilling/ cooling, thermal treatments, Bacto-therm treatment	3	10
8	Effect of processing on physical properties of milk. i.e. Chillig/ cooling, thermal treatments, Bacto-therm	3	9
9	Effect o processing on chemical properties of milk – cooling/ chilling, thermal, Bacto-therms	3	10
10	Effect of processing on nutritional status of milk	2	6
11	Role of membrane processing in dairy industry – RO, NF, UF, MF etc	2	6
12	Role of Bio – technological tools in dairy industry in relation to processing	3	9
13	Dairy waste – Meaning, problems, management and utilization	3	10
14	Advances in disposal of dairy waste /effluents	3	9

Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Determination of total plate count at production site	1	6
2	Determination of coliform count at production site	1	6
3	Determination of spore forming organisms at production site	1	6
4	Activation of LP system in raw milk	2	13
5	Effect of LP - treatment on major milk constituents	2	13
6	Application of sterilization treatment to milk	1	6
7	Effect of sterilization on milk constituent	2	13
8	Effect of homogenization on total microbial count	1	6
9	Performance study of membrane filter in relation to Microbial count	1	6
10	Effect of bio preservative on quality of milk	1	6
11	Design and layout of modern dairy processing plant	2	13
12	Visit to study the various activities in modern dairy plant	1	6

Suggested Readings:

1. Sukumar, De. (2005) Outline of Dairy Technology. Oxford Univ. Press, New Delhi
2. Bhandari, V., (2001) Ice cream Manufacture and Technology. Tala Me Graw-Hillpublishing Co,Ltd, New Delhi.
3. Arbuckle, W.S., (1972) Ice Cream, A,VI publication, Westpord.Aulhor, La Grange
linoisHall, C.W. and Hedrick. T.ly (1971) Drying of milk and milk products, AVI publishing Co, Weeport.
4. Saugu, K.P.S (2002) Dairy Processing Technology
5. Selected articles from journals

Course No. DSC 604**Course Title: Advances in chemistry of milk processing****Course Credits: 2+1=3****Theory:**

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Methods of heat treatments : Boiling, pasteurization, sterilization and their purpose in relation to milk	1	3
2	Heat induced changes in milk and milk constituents	1	3
3	Heating and interactions between various milk components	5	16
4	Inactivation of milk enzymes during processing	1	3
5	Milk protein system in concentrated milk as influenced by heat treatment.	2	6

6	Scope, importance and use of artificial sweeteners in dairy foods	2	6
7	Milk fat replacers, comparison between milk fat and fat replacer	1	3
8	Scope and use of milk fat replacers in dairy foods	2	6
9	Physico- chemical changes in milk fat globule membrane due to homogenization and its consequences in product manufacture	3	10
10	Cold agglutination – meaning, principle involved	1	3
11	Mechanism of cold agglutination and its consequences in dairy processing	2	6
12	Enzymatic coagulation of milk by specific and non specific enzymes	3	10
13	Bioactive peptide – meaning, importance, role in human nutrition and health	3	10
14	Various bio peptides – chemical structure	2	6
15	Manufacture techniques of bio-peptides	1	3
16	Application of bio-peptides	2	6

Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Utilization of various artificial sweeteners in the indigenous milk sweets.	10	62
2	Milk structure before and after homogenization treatment	3	19
3	Application of chromatographic tools to characterize bio-metabolites in milk	3	19

Suggested Readings:

1. Wong, N.P; Jenness, R; Keeney, M. and Elemer, H.M. (1988) Fundamental of dairy chemistry 3rd ed Van Nostrand Reinhold co. New York, USA
2. Walstra, P and Jenness, R; (1984) Dairy Chemistry and Physics. John Wiley and sons, New York, USA
3. Fox, P.F; (1982) Development in Dairy Chemistry- 2 Lipids Applied Science publisher London and New York.
4. Fox, P.F; and Mewamy PLH; (1997) Dairy Chemistry & Biochemistry Applied science publication, London.
5. H.A. McKenzie; (1971) Milk Proteins Vol. I & II, Academic press New York.
7. Selected articles from journals.

Course No. DSC 605**Course Title: Recent trends in value added dairy products and by-Products****Course Credits: 2+1=3****Theory:**

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Value addition in dairy products - concept, meaning, scope	1	3
2	Current trends in utilization of food additive- with specific purpose	2	6
3	purpose based categorization of food additive. Colour, flavour, stabilizer, emulsifier, plasticizer, sweetener, fibers, nutrition, enrichment etc	7	22
4	Value added dairy products- fruits, cereals, vegetables, herbals, spices, nuts, Condiments etc.	16	51
5	Minerals and vitamins fortified milk products	1	3
6	Application of antioxidant in fat rich products	1	3
7	Functional / formulated foods – meaning, purpose and types	1	3
8	Neutraceuticals – meaning, purpose, types	1	3
9	Recent development in dairy by product utilization	2	6

Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Manufacture of value added products in laboratory based on fruits, vegetables, cereals, herbals, spices etc.	8	50
2	Evaluation of value added dairy products for its physico-chemical and sensory quality	4	25
3	Keeping quality of value added dairy products	4	25

Suggested Readings:

1. Anonymous, (1998) Lecture Compendium Dairy Technol. NDRI, Karnal.
2. Achaya K.T. and Rangappa S.K. (1973), Indian Dairy products.
3. Gould G.W., (1995), Advances in traditional dairy products.
4. Sukumar De, (1990), Out line of Dairy Technology. Oxford Publ. New Delhi.
5. Renner, E. and Abd E.L. Salam M.H. (1991), Application of Ultrafiltration in the Dairy
6. Cheryen, Munir, (1990), Ultrafiltration and microfiltration Hand book. Technomic Publishing House.
7. Aneja R.P; Mathura, B.N; Chandan R.C and Banerjee A.K. (2002) Technology of Indian Milk Product.
8. Selected articles from journals.

DSC-608**Course Title: Research and development management in dairy industry****Credits :- 3+0= 3****Theory:**

Sr. No.	Name of Topic	No. of lecture	Weightage Marks
1	Current status of R & D in dairy processing in India.	2	4
2	Current status of R & D in dairy processing abroad.	2	4
3	Resource management :- management of financial and human resources in dairy industries.	2	4
4	Structure and design of R & D organization.	2	4
5	Analysis of organization behaviour :- 9 Transactional analysis.	1	2
6	Personal Management :- Topology analysis, individual and the organization, team building, human behaviour at work, motivation.	4	8
7	Management of R & D runctions	1	2
8	Criterion for selection of R & D projects & technology development process	4	8
9	Techniques for monitoring R & D runctions.	2	4
10	Patenting laws:	1	2
11	Indian patenting act /international protocols for technology transter	2	4
12	Transter of technology fzom lab to plant	2	4
13	Hazardus analysis & critical control point (HACCP)	3	7
14	General management practices (GMP/GHP) in dairy processing.	3	6
15	ISO : 14001	1	2
16	Total quality management practices in dairy industry (TQM)	3	7
17	Six sigma concept in dairy processing	4	9
18	Project proposal writing for research funding	2	4
19	Development of feasibility and technical reports for dariy plant establishment	3	7
20	Report writing of projects	2	4
21	Evaluation of report writing projects.	2	4

Suggested Readings:

1. Selected articles from journal
2. Dairy India 2007. P. R. Gupta, Priyadarshni Publisher

B) Minor Subjects

Course No. DSC 606

Course Title: Recent Advances in sensory evaluation of dairy products

Course Credits: 1+0=1

Theory:

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Introduction and importance of sensory evaluation of dairy products	1	6
2	Modern concepts of sensory evaluation	1	6
3	Facilities – sensory laboratory, other supplies- electricity, water, aeration	1	6
4	Equipments for sensory evaluation, its availability, function	2	13
5	Physico- chemical aspects of judging based on products and sensory organs Various sensory tests	4	26
6	Consumers acceptance tests – purpose, training, application etc.	3	10
7	Role of various sensory evaluation techniques- advantages and disadvantages	2	6
8	Analysis of numerical data and interpretation	1	6
9	Computer application in sensory evaluation	1	6

Suggested Readings:

1. Judging dairy products, J.A. Nelson and G.M.Trout (1981) AVI Pub. Co.
2. Quality control in food Industry. Vol 1, S.M. Hersehedoerfer (1967) Acd.Press
3. Quality control in food Industry. A. Kremmer and B.A. Trigg (1970), AVI Pub. Co.
4. Glossary of general terms for sensory evaluation of foods, Part I and II : ISI
5. Guide for sensory evaluation for foods, : ISI
6. Selected articles from journals.

Course No. DSC 607

Course Title: Advances in dairy food packaging

Course Credits: 1+1= 2

Theory:

Sr. No.	Name of Topic	No. of Lectures	Weightage (Marks)
1	Review of existing system of packaging of milk and milk products	3	19
2	Methods of packaging- aseptic, modified atmospheric packaging Shrink packaging, retort pouch, micro- waveable, biodegradable packaging edible packaging, active packaging	7	44
3	Identification of gaps and remedies in adoption of current packaging system for milk and milk products	4	25

4	Sources of toxic materials in packaging and migration of toxins in to food material	2	12
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Practical:

Sr. No.	Title of Practical	No. of Practical	Weightage (Marks)
1	Collection of different packaging materials available in market for milk and milk Products	3	19
2	Determination of thickness, GSM, grease resistance, bursting strength, WVTR, puncture resistance, tearing of packaging material	8	50
3	Estimation of shelf life of various packaging material /system	3	19
4	Demonstration of vacuum packaging for milk and milk products	2	6

Suggested Readings:

1. Principles of Package developments (1972). Roger C Griffin and Stanley Sacharrin
2. Handbook of package material (1976). Stanley Sacharrin
3. Principles of food packaging (1976). S. Sac row and R.C. Griffin
4. New monograph on UHT milk (1981). IDF Bulletin No. 133
5. Plastics in packaging (1988). Indian Institute of Packaging
6. Packaging of food products (1988). Indian Institute of Packaging
7. BIS specification on packaging material
8. Selected articles from journals.

Course No. AH 601

Course Title: Advances in Livestock Production and Management

Course Credit: 2+1 = 3

Theory:

Sr. No.	Name of Topic	No. of Lectures	Weightage (%)
1	Present status of dairy farming in India,	1	3
2	Global scenario and reasons for the same	1	3
3	Avenues for progress.	1	3
4	Advances in housing management of dairy cattle in various agro climatic zones of India	2	7
5	Advances in housing management of buffaloes in various agro climatic zones of India	1	3
6	Advances in housing management of sheep in various agro	2	7

	climatic zones of India		
7	Advances in housing management of goat in various agro climatic zones of India	1	3
8	Management systems for cattle,	1	3
9	Management systems for buffaloes	1	3
10	Management systems for sheep	1	3
11	Management systems for goat.	1	3
12	Establishing Dairy Cattle Enterprise,	1	3
13	Characteristics of a successful dairy farm	1	3
14	Choice of the foundation stock.	1	3
15	Breeding Management	1	3
16	Problems associated with reproduction	1	3
17	Advances in Feeding Management of cattle in different stages	1	3
18	Advances in Feeding Management of buffalo in different stages	1	3
19	Advances in Feeding Management of sheep in different stages	1	3
20	Advances in Feeding Management of goat in different stages.	1	3
21	Management of high yielding animals.	1	3
22	Recent development in sheep and goat management and their relevance under Indian conditions,	2	7
23	Role of sheep husbandry in dry farming in India.	1	3
24	Present development programmes in sheep and goat production,	2	7
25	Advances in reproduction,	2	6
26	Metabolic disorders of high yielder	1	3
27	Advances in preventive measures for production related diseases.	1	3

Practical:

Sr. No.	Name of Topic	No. of Lectures	Weightage (%)
1	Advances in different farm structures on livestock farm	4	25
2	Atomization in feeding, milking and sanitation,	2	12
3	Least cost feed formulation,	4	25
4	Energy recycling through dairy farm waste	2	13
5	Computer application in dairy farm management	2	12
6	Visit to modern livestock farms	2	13

Suggested Readings:

Clarence HE. 2007. Dairy Cattle & Milk Production. Daya Publ. House.

Gupta JL 2006. Sheep Production and Mangement. CBS.

Thomas CK & Sastry NSR. 1991. Dairy Bovine Production. Kalyani.

Course No. AH 610**Course Title: Advances in Quality Control of Livestock Products****Course Credit: 2+0=2****Theory:**

Sr. No.	Name of Topic	No. of Lectures	Weightage (%)
1	Recent advances in quality control in dairy and meat industry with special reference to Total Quality management,	4	13
2	HACCP	1	3
3	Good manufacturing practices for manufacturing of quality and safe livestock products.	1	3
4	PFA and BIS standards, international standards organization (ISO 9000),	2	6
5	Product quality certification	1	3
6	International standards for milk powders	1	3
7	American Dairy Products Institute (ADPI) standards.	1	3
8	Rheology of milk products	1	3
9	Preservatives	1	3
10	Antioxidants, antibiotics and pesticides residue in milk	1	3
11	Advances in bacteriological and physico-chemical analysis of milk and milk products.	2	7
12	Importance of quality assurance of livestock products for domestic and export trade	2	7
13	Quality standards for meat	2	6
14	Effect of processing on nutritional and chemical qualities of meat products,	2	6
15	Sensory evaluation of meat products	2	6
16	Physicochemical and microbiological quality assessment and standards	2	6
17	Meat hygiene regulations in relation to slaughter houses and processing plants	2	7
18	International regulations	1	3
19	State, Municipal and other regulations pertaining to meat trade	1	3
20	Meat Food Products Order	1	3
21	Codex alimentarius commission.	1	3

Suggested Readings:

Selected articles from journals.

C) Supporting Subjects

1	FST-611	Advances in Food Biotechnology	3 =2+1
2	STAT-601	Design of experiments for plant sciences	3 = 2+1

D) Seminar

1	DSC - 691	Doctoral Seminar –I	1=0+1
2	DSC-692	Doctoral Seminar –II	1=0+1

E) Doctoral Research

1	Thesis- 699		45=0+45
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F) Compulsory Non Credit Courses

1	PGS-501	Library and Information Services	1=0+1
2	PGS-504	Basic Concepts in Laboratory Techniques	1=0+1
3	PGS-502	Technical Writing and Communication Skills	1=0+1
4	PGS-503	Intellectual Property and its Management in Agriculture	1=0+1
5	PGS-505 (e-course)	Agriculture Research, Research Ethics and Rural Development Programmes	1 = 1 + 0
6	PGS-506 (e-course)	Disaster Management	1 = 1 + 0