COURSE STRUCTURE AND SYLLABI

B. TECH. (DAIRY TECHNOLOGY)

2022-2023

Centurion UNIVERSITY

Shaping Lives...
Empowering Communities...

DEPARTMENT OF DAIRY TECHNOLOGY
SCHOOL OF AGRICULTURAL AND BIOENGINEERING
CENTURION UNIVERSITY OF TECHNOLOGY & MANAGEMENT
ODISHA -761211, INDIA
www.cutm.ac.in

SCHOOL OF AGRICULTURAL AND BIOENGINEERING

(GROUP A)

B. TECH PROGRAMME (DAIRY TECHNOLOGY)

CHOICE BASED CREDIT SYSTEM

http://courseware.cutm.ac.in/

BASKET STRUCTURE

Basket	Basket Category		Minimum Credits	Scope
I.	Foundation Courses in Sciences		17	Choice
II.	Foundation Courses in Humanities & Management. [A: 6 credit (choice), B: 6 credit (Compulsory)]		12	Choice
III.	Smart Stack		25	Core
IV.	Foundation Courses in Engineering	IV.A	26	Core
	Core Dairy Technology Courses	IV.B	64	Core
	Summer Training (02)	IV.C	6	Core
V.	Domain /Skill/Internship/Minor Project		30	Choice
		Total Credits	**180**	

BASKET I

Basket I: Foundation Courses in Sciences
(Total Credits: 17)

Sl. No.	Area	Code	Course	Credits (T+Pr+Pj)
1.	Mathematics (5)	CUTM1001	Differential Equations and Linear Algebra	3 (2+0+1)
2.		CUTM1002	Laplace and Fourier Transforms	3 (2+ 0+1)
3.		CUTM1003	Complex Analysis, Numerical Methods	3 (2+0+1)
4.		CUTM1004	Discrete Mathematics	3 (2+0+1)
5.		CUTM1005	Probability & Statistics	3 (2+0+1)
6.		CUTM1010	Environmental Studies	2 (0+0+2)
7.	Physics (2)	CUTM1006	Mechanics for Engineers	3 (2+1+0)
8.		CUTM1007	Optics and Optical Fibres	3 (2+1+0)
9.	Chemistry (2)	CUTM1008	Applied Analytical Chemistry	3 (2+1+0)
10.		CUTM1009	Applied Engineering Materials	3 (2+0+1)

BASKET II

Basket II (Humanities and Management)
(Total Credits: 12; A: 6 credit (Choice); B: 6 credit Compulsory)

	Area	Code	Course	Credits (T+Pr+Pj)
A	Management	CUTM1011	Optimization Techniques	2 (0+2+0)
		CUTM1012	Engineering Economics and Costing	3 (2+0+1)
		CUTM1013	Project Management	3 (2+0+1)
A	Sustainable	CUTM1014	Gender, Human Rights and Ethics	3 (2 +0+1)
		CUTM1015	Climate Change, Sustainability and Organization	3 (2+0+1)
B	Job readiness	CUTM1016	Job Readiness	6 (0+6+0)

BASKET III

Basket III (Smart Stack: Compulsory for all branch of Engineering) (Total Credits: 25)

Sl. No.	Code	Course	Credits (T+Pr+Pj)
1.	CUTM1017	Industrial IOT and Automation	6 (3+2+1)
2.	CUTM1018	Data Analysis and Visualization using Python	4 (0+1+3)
3.	CUTM1019	Machine Learning using Python	4 (1+2+1)
4.	CUTM1020	Robotic Automation with ROS and C++	4 (1+2+1)
5.	CUTM1021	Design Thinking	2 (0+0+2)
6.	CUTM1022	System Integration with DYMOLA	2 (0+0+2)
7.	CUTM1023	Smart Engineering Project (G2M)	3 (0+0+3)
		Total Credits	**5 + 7 + 13 = 25**

BASKET IV.A

Basket IVA (Foundation Courses in Engineering)
(Total Credits: 24)

Sl. No.	Course Code	Name of Course	Credits (T+Pr+Pj)
1.	CUTM1089	Fluid Mechanics with FVM	3 (2+1+0)
2.	CUTM1711	Fundamentals of Microbiology/General Microbiology	4 (3+1+0)
3.	CUTM1312	Biochemistry/Fundamentals of Plant Biochemistry	3 (2+1+0)
4.	CUTM1088	Thermodynamics	3 (2+1+0)
5.	CUTM1525	Heat and Mass Transfer	4 (2+1+1)
6.	CUTM1057	Basic Electrical Engineering	2 (1+1+0)
7.	CUTM1074	Design of Structures	4 (1+3+0)
8.	CUTM1143	Dairy and Food Engineering	3 (2+0+1)
		Total Credits	**26 (15+9+2)**

BASKET IV.B

Basket IV.B (Core Dairy Technology Courses)
(Total Credits: 64)

Sl. No.	Course Code	Name of Course	Credits (T+P+PJ)
1.	CUTM1144	Milk Production Management and Dairy Development	3 (2+1+0)
2.	CUTM1145	Physical Chemistry of Milk	3 (2+1+0)
3.	CUTM1146	Market Milk	3 (2+1+0)
4.	CUTM1147	Traditional Indian Dairy Products	3 (2+1+0)
5.	CUTM1148	Microbiology of Fluid Milk	3 (2+1+0)
6.	CUTM1149	Chemistry of Milk	3 (2+1+0)
7.	CUTM1150	Fat Rich Dairy Products	3 (2+1+0)
8.	CUTM1151	Microbiology of Dairy Products	2 (1+1+0)
9.	CUTM1152	Dairy Process Engineering	3 (2+0+1)
10.	CUTM1153	Starter Cultures and Fermented Milk Products	3 (2+1+0)
11.	CUTM1154	Condensed & Dried Milks	3 (2+0+1)
12.	CUTM1155	Quality and Safety Monitoring in Dairy Industry	3 (2+0+1)
13.	CUTM1156	Ice-cream & Frozen Desserts	3 (2+0+1)
14.	CUTM1157	Chemistry of Dairy Products	3 (2+1+0)
15.	CUTM1158	Cheese Technology	3 (2+0+1)
16.	CUTM1159	By Products Technology	3 (2+0+1)
17.	CUTM1160	Packaging of Dairy Products	3 (2+0+1)

18.	CUTM1161	Chemical Quality Assurance	2 (1+0+1)
19.	CUTM1162	Dairy Plant Design and Layout	2 (1+0+1)
20.	CUTM1163	Food and Industrial Microbiology	3 (2+0+1)
21.	CUTM1164	Sensory Evaluation of Dairy Products	3 (2+1+0)
22.	CUTM1165	Dairy Plant Management	2 (1+0+1)
23.	CUTM1166	Waste Disposal and Pollution Abatement	2 (1+0+1)
		Total Credits	**64 (41+11+12)**

BASKET IV. C

Basket IV.C (Core-Summer Trainings)
(Total Credits: 6)

Basket	Basket Category		Credits (T+Pr+Pj)
CUTM1939	Summer Training-I	IV.C	3 (0+0+3)
CUTM1940	Summer Training-II	IV.C	3 (0+0+3)
		Total	**6 (0+0+6)**

BASKET V

Basket V (Domain, Skills, Internship, Projects: Choice Based)
(Total Credits: 30)

Basket	Basket Category		Credits (T+Pr+Pj)
V	Skill Course	Choice	4 (0+0+4)
	Domain Course	Choice	28 (3+15+10)
	Value added Course	Entrepreneurship Development and Industrial Consultancy (Non-Gradial)	2 (2+0+0)
		Financial Management and Cost Accounting (Non-Gradial)	3 (2+0+1)
		Total	**32 (3+15+14)**

BASKET-I

Foundation Courses in Sciences
(Total Credits: 17)

1.	CUTM1001	Differential Equations and Linear Algebra	3 (2+0+1)

Course Objectives

- Introduce students to how to solve linear Differential Equations with different methods.
- To solve the system of linear equations appearing in the problems of electrical engineering, mechanical engineering etc.
- To use Eigen values and Eigen vectors in Control theory, vibration analysis, electric circuits, advanced dynamics problems.
- Introduce students how to solve first order and second order differential equations

Course Outcomes

Upon successful completion of this course, students will be able to:

- Understand the importance of linear functions in mathematics.
- Solve systems of linear equations using Gauss- elimination to reduce to echelon form.
- Learn fundamental concepts of ODE theories and where and how such equations arise in applications to scientific and engineering problems.
- Be competent in solving linear/non-linear 1st & higher order ODEs using analytical methods to obtain their exact solutions

Module-I:

- First order linear differential equations and its applications
- **Project-1:** Some applications of differential equations in RL-RC electrical circuit problems

Module-II:

- Second order linear homogeneous differential equations (Real roots, Real equal roots, Complex conjugate roots) and its applications.
- **Project-2:** RLC Circuit, Pendulum

Module-III:

- Second order linear non-homogeneous differential equations, finding particular integral consisting of exponential, trigonometric (Sine, cosine) using inverse operator method
- **Project-3:** Simple mass-spring system, Damped vibration system

Module-IV:

- Basic concepts of a matrices, solution of linear system of equations by Gauss elimination method, linearly independent and dependent of a vector, rank of a matrix.
- **Project 4:** Report on finding the traffic flow in the net of one-way streets

Module-V:

- Determinants and Cramer's Rule, Fundamental theorem of linear system of equations.

Module-VI:

- Eigen values and Eigen vectors of a matrix.
- **Project 5:** (i) Find the limit states of the Markov process model.
  (ii)Find the growth rate in the Leslie model

Module-VII:

- Symmetric, Skew-Symmetric, Orthogonal Matrices and Properties
- **Project 6:** To make a report to show that the product of two orthogonal matrices is orthogonal, and so is the inverse of an orthogonal matrix. What does this mean in terms of rotations?

Text Books:

- Advanced engineering mathematics by Erwin Kreyszig, 8th edition [Chapter-6 (6.1-6.6), Chapter-7 (7.1,7.2)]
- Higher Engineering by B.V. Ramana [Chapter-8(8.1,8.2,8.9,8.10,8.21), Chapter-9 (9.2,9.3,9.5)]

Reference Books:

- J. Sinha Roy and S. Padhy, A Course of Ordinary and Partial Differential Equations, Kalyani Publishers, New Delhi.
- G.B. Thomas, M.D. Weir, J.R. Hass, Thomas' Calculus, Pearson Publication.
- R.G. Bartle, D.R. Sherbert, Introduction to Real Analysis, Wiley Publication

Courseware link:
http://courseware.cutm.ac.in/courses/differential-equations-and-linear-algebra/

2.	CUTM1002	Laplace and Fourier Transforms	3 (2+0+1)

Course Objectives

- To describe the ideas of Fourier and Laplace Transforms and indicate their applications in the fields such as application of PDE, Digital Signal Processing, Image Processing, Theory of wave equations, Differential Equations and many others.
- To use Fourier series for solving boundary value problems appearing in scientific & engineering problems.

Course Outcomes

Upon successful completion of this course, students will be able to:

- Solve differential equations with initial conditions using Laplace transform.
- Evaluate the Fourier transform of a continuous function and be familiar with its basic properties.

Module-I

- Laplace Transforms, Properties of Laplace transforms, Unit step function.
- **Project-1:** Make a short draft of properties of Laplace transform from memory. Then compare your notes with the text and write a report of 2-3 pages on these operations and their significance in applications.

Module-II:

- Second shifting theorem, Laplace transforms of Derivatives and Integrals.
- **Project-2:** Find the Laplace transform of the following functions.

Module-III:

- Derivatives and Integrals of Transforms, Inverse Laplace transform.
- **Project-3:** Application of Unit step function (RC- Circuit to a single square wave).

Module-IV:

- Solution of differential equations by using Laplace transform.
- **Project-4:** Find the solution of differential equation by using Laplace Transform.

Module-V:

- Periodic function, Fourier series, Fourier series expansion of an arbitrary period, Half range expansions.
- **Project-5:** Find the Fourier series expansion of a 2-pi periodic function.

Module-VI:

- Complex form of Fourier series, Fourier Integrals, Different forms of Fourier Integral.
- **Project-6:** Find the Fourier sine and cosine integral of the following functions.

Module-VII:

- Fourier Transforms, Fourier sine and cosine Transforms.

Text Book:

- E. Kreyszig, Advanced Engineering Mathematics, John Willey & Sons Inc-8th Edition.Chapters:5(5.1 to 5.4(without Dirac's delta function)), 10(10.1,10.4 and 10.7-10.9(definitions only, no proofs)).
- Higher Engineering Mathematics by B.V..Ramana, Tata McGraw-Hill Education India, Inc-8th Edition

Reference Text Book:

- Advanced Engineering Mathematics by P.V.O' Neil Publisher: Thomson
- Mathematical Methods by Potter & Goldberg; Publisher: PHI.

Courseware link:

http://courseware.cutm.ac.in/courses/laplace-and-fourier-transforms/

3.	CUTM1003	Complex Analysis & Numerical Methods	3 (2+0+1)

Course Objectives

- To understand about Complex variables and complex functions.
- To acquire the skill of evaluating contour integrals using Cauchy's integral formula and Cauchy's integral theorem.
- To understand the limitations of analytical methods and the need for numerical methods and the ability to apply these numerical methods to obtain the approximate solutions to engineering and mathematical problems.

Course Outcomes

Upon successful completion of this course, students will be able to :

- To get equipped with the understanding of the fundamental concepts of functions of a complex variable along with the concepts of analyticity, Cauchy-Riemann relations and harmonic functions.
- Evaluate complex contour integrals applying the Cauchy integral theorem, Cauchy integral formula.
- Derive a variety of numerical methods for finding out solutions of various mathematical problems arising in roots of linear and non-linear equations, solving differential equations with initial conditions and Evaluating real definite integrals.

Module I (T-3 hrs-P-0-hrs-P-0 hrs)

- Complex numbers, Algebra of complex numbers, Modulus and argument, Functions of a complex variable.

Module II (T-4 hrs-P-0 hrs-P-2 hrs)

- Analytic functions, Cauchy-Riemann equations (Without Proof), Harmonic and Conjugate harmonic functions.

Project-1: Verification of Cauchy-Riemann equations for complex functions in Cartesian form and Polar form

Module III (T-3 hrs-P-0 hrs-P-2 hrs)

- Complex integrals, Cauchy's Integral Theorem (Without Proof), Cauchy's Integral Formula (Without Proof), Cauchy's Integral Formula for higher order derivatives (Without Proof).

Project-2: Evaluation of contour integrals using Cauchy's Integral Formula

Module – IV (T-2 hrs-P-0 hrs-P-2 hrs)

- Interpolation, Lagrange interpolation polynomial.

Project-3: Finding out the value of a given function at an interior point on an unequal interval using Lagrange interpolation polynomial

Module V (T-3 hrs-P-0 hrs-P-2 hrs)

- Forward and backward difference operators, Newton's forward and backward difference Interpolation formulae.

Project-4: Finding out the value of a given function at an interior point on an equal interval using Newton's forward and backward difference interpolation formulae

Module VI (T-2 hrs-P-0 hrs-P 2 hrs)

- Numerical Integration, Trapizoidal rule, Simpson's one third rule.

Project-5: Evaluation of real definite integrals using Trapizoidal rule and Simpson's one third rule

Module VII (T-3 hrs-P-0 hrs-P-2 hrs)

- Runge-Kutta 2^{nd} & 4^{th} order methods.

Project-6: Finding out Numerical solutions of differential equations using Runge-Kutta 2^{nd} & 4^{th} order methods

Text Book

- Advanced Engineering Mathematics by E. Kreyszig Publisher: Johnwilley & Sons Inc-8th Edition Chapters: 12 (12.1 to 12.4), 13 (13.1 to 13.4)
- Advanced Engineering Mathematics by E. Kreyszig Publisher: John Willey & Sons

Inc-8th Edition Chapters: 17 (17.3, 17.5), 19 (19.1)

Reference Books:

- Advanced Engineering Mathematics by P.V. O'Neil Publisher: Thomson
- Fundamentals of Complex Analysis (with Applications to Engineering and Science) by E.B. Saff & A.D. Snider Publisher: Pearson
- Numerical Methods for Scientific and Engineering Computation by M. K. Jain, S. R. K. Iyengar & R.K. Jain; New Age International Publishers.
- Introductory Methods of Numerical Analysis by S.S. Sastry; Third Edition, Prentice Hall India.

Courseware link:

http://courseware.cutm.ac.in/courses/complex-analysis-numerical-methods/

4.	CUTM1004	Discrete Mathematics	3 (2-0-1)

Course Objectives

- To understand mathematical reasoning in order to read, comprehend and construct Mathematical arguments as well as to solve problems, occurred in the development of programming languages.
- To work with discrete structures such as graphs to study the structure of the world wide web, to model a computer network and to find the shortest path between two places in a transportation network.

Course Outcomes:

Upon successful completion of this course, the student will be able to:

- Apply the logical structure of proofs and work symbolically with connectives and quantifiers to produce logically valid, correct and clear arguments.
- Evaluate elementary mathematical arguments and identify fallacious reasoning
- Reformulate statements from common language to formal logic. Apply truth tables and the rules of propositional and predicate calculus.
- Model and solve real-world problems using graphs, both quantitatively and qualitatively.

Module-I (4 Hours)

- Propositional Logic, Connectives, Truth tables of compound propositions, Propositional Equivalence.

Project 1: Given the truth values of the propositions p and q, find the truth values of the conjunction, disjunction, implication, bi-implication, converse, contrapositive and inverse.

Module-II (3 Hours)

- Theory of inference, Predicates and Quantifiers, Rules of Inference.

Project 2: Build valid arguments of a given set of propositional logics and quantified statements using rules of inferences.

Module-III (3 Hours)

- Relations and its properties, Partial Ordering, POSET, Totally Ordered Set.

Project 3: Define the properties of a relation on a set using the matrix representation of that relation with examples.

Module-IV (3Hours)

- Hasse Diagram, Maximal & Minimal Elements of a Poset, Greatest & Least Elements of a Poset, Supremum & Infimum of a Poset, Lattice.

Project 4: Find a Topological Sort of a Poset.

Module-V (3 Hours)

- Introduction to Graph Theory, Graph Terminology and Special types of Graphs, Representation of Graphs.

Project 5: Describe how some special types of graphs such as bipartite, complete bipartite graphs are used in Job Assignment, Model, Local Area Networks and Parallel Processing.

Module-VI (3 Hours)

- Graph Isomorphism, Connectivity, Euler and Hamiltonian Graphs, Planar Graphs, Graph Coloring.

Project 6(i): Describe the scheduling of semester examination at a University and Frequency Assignments using Graph Coloring with examples. Find also their Chromatic numbers.

Project 6(ii): List out 10 pairs of Non-isomorphic graphs and explain the reason behind it.

Project 6(iii): List out all features ofEuler and Hamiltonian Graphs. Justify whether the given set of graphs are Euler and Hamiltonian. Construct a Gray Code where the code words are bit strings of length three.

Module-VII (4 Hours)

- Trees and their Properties, Spanning Trees, Minimum Spanning Trees, Kruskal's Algorithm.

Project 7: Find a minimum spanning tree in a given weighted graph using Kruskal's Algorithm.

Text Books:

- Discrete Mathematics and its Applications by K.H.Rosen, Publisher: TMH, Sixth Edition, 2009. Chapters: 1(1.1 ,1.2,1.3, 1.5); 7(7.1,7.6); 8(8.1 to8.5, 8.7, 8.8);9(9.1,9.4,9.5)

Reference Books:

- Discrete Mathematical Structures with Applications to Computer Science, J. P. Trembkay, Manohar, Tata MC Graw – Hill Edition 38th reprint, 2010.
- Discrete and Combinatorial Mathematics by R.P. Grimaldi Publisher: Pearson, 5th Edition, 2003.
- Discrete Mathematics and Applications by Thomas Koshy Publisher: Elsevier, 2004.
- Discrete Mathematical Structures by B. Kolman, R.C. Busby & S. Ross Publisher: PHI, 5th Edition, 2003.

Courseware link:
http://courseware.cutm.ac.in/courses/discrete-mathematics/

5.	CUTM1005	Probability and Statistics	3 (2+0+1)

Course Objectives

- To translate real-world problems into probability models
- To motivate students in an intrinsic interest in statistical thinking
- To apply probability and statistics in engineering and science like disease modeling, climate prediction and computer networks etc.

Course Outcomes

Upon successful completion of this course, students will be able to:

- Define and illustrate the concepts of sample space, events and compute the probability and conditional probability of events.
- Define, illustrate and apply the concepts of discrete and continuous random variables, the discrete and continuous probability distributions.
- Define, illustrate and apply the concept of the expectation to the mean, variance and covariance of random variables.
- Compute probabilities based on practical situations using the Binomial, Poisson and Normal distributions.

Module I:(3 hrs+2 hrs)

- Sample spaces and events; axiomatic definition of probability; Axioms of Probabilities

Project-1: A Report on Application of probability to control the flow of traffic through a highway system, a telephone interchange, or a computer processor

Module II:(3 hrs +2 hrs)

- Mutually Exclusive Events, Dependent and Independent Events. Conditional Probability

Project-2: A Report on Dependent and Independent Events with Examples

Module III:(3 hrs +2 hrs)

- Discrete random variables and probability distributions, Continuous random variables and probability distributions , Mean ,Variance and Moment Generating Function of Distributions

Project-3: Application of random variables in Engineering Field

Module IV:(3 hrs +2 hrs)

- Uniform Distribution, Binomial Distribution, Poisson Distribution

Project-4: Applications of Poisson distribution

Module V:(3 hrs +2 hrs)

- Normal Distribution, Working with Normal Tables, Normal Approximation to the Binomial Distributions

Project-5: Normal Distribution utilized in statistics, business settings, and government entities.

Module VI:(3 hrs)

- Statistics: Random Sampling, Population and Sample, Sample Mean and Variances, Point and Interval Estimations, Confidence Intervals

Module VII:(3 hrs +2 hrs)

- Regression and Correlation Analysis: Correlation Coefficient, Co-variance independent random
  variables, linear regression of two variables

Project-6: Uses of Regression and Correlation Analysis in Business

Text Books:

- Advanced Engineering Mathematics by E. Kreyszig Publisher: John Willey & Sons Inc-8th Edition

Reference Books:

- Statistical Methods by S.P. Gupta (31st Edition); Publisher: Sultan Chand & Sons
- Mathematical Statistics by S.C. Gupta & V.K. Kapur (10th Edition); Publisher: Sultan Chand & Sons.

Courseware link:

http://courseware.cutm.ac.in/courses/probability-and-statistics-2/

6.	CUTM1010	Environmental Science	2 (0+0+2)

Course Objectives

- To understand the concept of multi-disciplinary nature of Environmental Science where different aspects are dealt with a holistic approach.
- Students will develop a sense of community responsibility by becoming aware of environmental issues in the larger social context.
- One must be environmentally educated.

Course Outcomes

- Understand the natural environment and its relationships with human activities.
- Characterize and analyse human impacts on the environment.
- Integrate facts, concepts and methods from multiple disciplines and apply to environmental problems.
- Design and evaluate strategies, technologies and methods for sustainable management of environmental systems and for the remediation or restoration of degraded environments.

Module - I

- Environment and its multidisciplinary nature; Need for public awareness; Renewable and non -renewable resources–forest, water, mineral, land, food and energy resources; Structure and function of ecosystems of forest, grass land, desert and aquatic types.

Module -II

- Biodiversity and its conservation: Biodiversity at global, national and local levels; Threats to biodiversity -Habitat loss; wild life poaching and man-wildlife conflicts; Endangered and endemic species; conservation measures. Causes, effects and control measures of pollution, air, water and noise pollution; nuclear hazards; solid-waste management, Causes, effects and control measures; Management of disasters due to natural causes of floods, earthquakes, cyclones and landslides.

Module-III

- Social issues and the environment; Sustainable environment, Water conservation measures; Rain water harvesting; Resettlement and rehabilitation of people; Climate change and global warming; Acid rain; Ozone layer depletion; water land reclamation; Consumerism and waste products; Features of Environment Protection Act, Air pollution and Control of Pollution Acts; Water Pollution and its Control Act. Effects of Pollution explosion on environment and public health; Need for value education to Protect environment and resources.

Text Book:

- Anubhav Kaushik & C.P. Kaushik: Environmental Studies -New age International Publishers.

Reference Books:

- Benny Joseph: Environmental Studies -Tata Mac Graw Hill.
- E. Bharucha: Text book of Environmental Studies for under graduate courses– Universities Press. (Book prepared by UGC Committee).

Courseware link:

	http://courseware.cutm.ac.in/courses/environmental-science/		
7.	**CUTM1006**	**Mechanics for Engineers**	**3(2-1-0)**

Course Objectives

- To provide the students with a clear and thorough understanding on fundamentals of mechanics as applied to solve real-world problems

Course Outcomes

- Upon successful completion of this course student should be able to:
- Use scalar and vector analytical techniques for analyzing forces in statically determinate structures.
- Analyze the frictional forces involved in planes, ladder friction and belt friction.
- Determine the centroid and moment of inertia of composite shapes.
- Apply fundamental concepts of kinematics and kinetics of particles to the analysis of simple, practical problems.
- Apply basic knowledge of mathematics and physics to solve real-world problems

Module I: **Force and Moment**

- Law of Transmissibility of a Force, Composition and Resolution of Forces, Resultant and Equilibrant, Resultant of Two and Several Forces, Moment of a Force and a Couple, Varignon's Principle of Moment

Practice-1: Verification of laws of parallelogram law of forces

Module II: **Equilibrium**

- System Isolation and Free Body Diagram, Particle Equilibrium, Lami's theorem, General Conditions of Equilibrium, Types of Supports and Support Reactions, Rigid Body Equilibrium.

Practice-2: To verify the condition of equilibrium by finding reactions at the support of a beam

Module III: **Friction**

- Basic Terms used in Dry Friction, Laws of Coulomb Friction, Equilibrium of Bodies on a Inclined Plane, Ladder Friction, Belt Friction

Practice-3: Determination of Angle of Repose

Module IV: **Centroid**

- Axis of Symmetry, Centroid of Lines, Areas and Volumes, Centroid of Composite Section.

	Module V: **Moment of Inertia** • Rectangular and Polar Moment of Inertia, Radius of Gyration, Parallel Axis Theorem and Perpendicular Axis Theorem, Moment of Inertia of Composite Section **Practice-4**: Determination of Moment of Inertia of a fly wheel. **Module VI**: **Kinematics of Linear Motion** • Kinematics of a Particle, Uniform and Variable Acceleration, Motion under Gravity. **Module VII**: **Kinetics of Linear Motion** • Principles of Dynamics such as Newton's Second Law, Work-Energy Principle, Impulse-Momentum Principle, Law of Conservation Law of Momentum and Energy **Practice-5**: Verification of Newton's second law of motion **Practice-6**: Verification of conservation of momentum in collision **Text Books**: • Engineering Mechanics; Statics and Dynamics by A. K. Tayal, Umesh Publications **Reference Books**: • Engineering Mechanics by S. Timoshenko, D.H. Young and J.V. Rao, Tata McGraw Hill. • Engineering Mechanics by D.S. Kumar, S.K. Kataria and Sons **Courseware link:** http://courseware.cutm.ac.in/courses/mechanics-for-engineers/		
8.	**CUTM1007**	**Optics and Optical Fibres**	**3 (2+1+0)**
	Course Objectives • To train the students for Optics and the applications of laser, and optical fiber in the field of engineering and technology. • To learn and practice the techniques used by an optical phenomenon so that these can be applied to actual field studies. **Course Outcomes**		

	Upon successful completion of this course, students will be able to • Understand optical phenomena. • Understand the basic knowledge of, laser, and optical fiber and instrumentation involved. • Understand optical fiber principle, operations, and its applications. **Module I: Reflection and Refraction (Derivation is not required)** • Reflection at a plane surface, reflection at spherical mirrors, Paraxial rays and approximation. Sign convention, Location of the image formation, Spherical mirror equation, Refraction, Total internal reflection, Dispersion by a prism, Refraction through a prism. **Practice: 1** • To determine the refractive index of a glass slab using a traveling microscope. **Module II: Lenses (Derivation is not required** • Definition, Types of Lenses, Terminology associated with the Lens, Sign Convention, Location of the image formation by graphical method for Lenses, Lens formula. **Practice: 2** • To determine the dispersive power and Cauchy constants of the material of a prism using mercury source. **Module III: Interference (Derivation is not required)** • Superposition principle, the definition of Interference, Coherence, Young's double-slit experiment, Newton's rings theory- Determination of wavelength of light. **Practice: 3** • Newtons Ring,s-Refractive index of the liquid **Module IV: Diffraction and Polarization (Derivation is not required)** • Types of diffraction, Fraunhofer diffraction at a single sit, Diffraction at N-parallel slits (plane diffraction grating). Polarisation**,** Types of polarized light and their representation, Brewster LawTo verify Brewster's law and to find Brewster's angle. Malus Law, polarization by double refraction, polarimeter, Applications of polarized light. **Practice: 4** • To find the grating element of a plane transmission diffraction grating.

Module V: Optical Properties and Laser

- Scattering, refraction, reflection, absorption & transmission, Introduction to optoelectronics, Concept of Light Emitting Diode, Stimulated and spontaneous emission, Basic principle of Lasers, Population inversion, Laser Pumping, Different levels of the laser system, Ruby Laser, Applications of Lasers (Medicine, Metrology, Defenses, Nuclear energy, in communication, in the consumer electronics industry)

Practice: 5

- Wave length of LASER source by diffraction grating method

Module VI: Optical Fibers

- Introduction to fiber optics, the structure of optical fibers, classification of optical fibers on the variation of refractive index, Classification of optical fibers on the variation of the mode of transmission/core diameter, Numerical Aperture, Acceptance angle. Principle of optical fibers communication, optical communication (block diagram only),

Practice: 6

- To find the numerical aperture of a given optic fiber and hence to find its acceptance angle.

Module VII: Optical Fibers

- Attenuation in optical fibers (Qualitative Only-Scattering losses, Absorption losses, bending loses). Fiber Materials-Glass fibers, Plastic fibers, Light sources for fiber optics,V-number of an optical fiber, optical fiber cables design, optical fiber connection, fiber splices, fiber connectors. Application of optical fibers- Cable TV, Networking, Power companies, Imaging, Sensors, Medical (Dental surgery, Endoscopy, Surgery)

Practice: 7

- Measurement of bending loss.

Text Books:

- A Text-Book of Optics by M.N. Avadhanulu, Brij Lal, N. Subrahmanyam, S Chand; 23rd Rev. Edn. [Module I&II]
- Engineering Physics, by D.Thirupathi Naidu, M.Veeranjaneyulu, V.G.S Book links,2017.[Module-III,IV]
- Principles of Engineering Physics-2 by Md.Khan, S.Panigrahi, Cambridge University Press 2016. [Module-V, VI&VII]

Reference Books:

- Optics by Ajoy Ghatak, McGraw Hill Education; 6 editions, 2017.
- Physics-I for engineering degree students byB.B. Swain and K.Jena.
- Concepts in Engineering Physics by I Md. N. Kha, 2016.

Courseware link:

http://courseware.cutm.ac.in/courses/optics-and-optical-fibers/

9.	CUTM1008	Applied Analytical Chemistry	3 (2+1+0)

Course Objectives

- Explain fundamental principles for environmental analytical methods (titration, electrochemistry, instrumentation and basic parameters of water, soil, fuel, etc
- Point out suitable analytical techniques for analyzing a specific compound in an environmental matrix

Course Outcomes

- Apply quality control on chemical analysis and laboratory work and explain its importance
- Plan and carry out laboratory experiments, including data analysis and conclusions
- Point out suitable techniques for sampling and handling of environmental samples

Module-I (4Hrs)

- Water softening processes: Lime-Soda, Zeolite and Ion exchange methods. Removal of DO and dissolved CO2 from water by De-aeration method, Desalination of Brackish water by Reverse osmosis and electro dialysis process, Numericals on calculation of Temporary and Permanent hardness of water, Lime-Soda calculation

Practice

1. Determination of hardness of water by EDTA method. (V. lab)
2. Determination of alkalinity of water. (V. lab)
3. Determination of Dissolved Oxygen in water. (V. lab)
4. Determination of Biological Oxygen Demand. (V. lab)
5. Determination of Chemical Oxygen Demand. (V. lab)

Module-II (2Hrs)

- Soil Analysis: Soil profile, Structure, and properties, Determination of soil properties

Practice

6. Determination of specific gravity of the soil by using pycnometer. (V.lab)
7. Determination of pH and electrical conductivity of soil sample. (V. lab)
8. Determination of moisture content in soil by oven drying method. (V. lab)

Module-III (3 Hrs)

- Classification, combustion and chemical principles involved in fuel, calorific value: gross and net calorific values and their determination by bomb calorimeter, Proximate and ultimate analysis of coal and their importance. LPG, Water gas, producer gas, CNG .

Practice

9. Determination of calorific value of a fuel sample by using Bomb calorimeter.
10. Analysis of flue gases by Orsat's apparatus.

Module-IV (4 Hrs)

- Petroleum: its chemical composition and fractional distillation, cracking of heavy oil residues – thermal and catalytic cracking, knocking and chemical structure, octane number, synthesis and applications of bio-fuels, Photovoltaic cell.

Practice

11. Synthesis of biodiesel by trans esterification process

Module-V (3 Hrs)

- Corrosion-Mechanisms, Factors affecting Corrosion; Protection from corrosion.

Practice

12. Estimation of ferrous ion in the given solution using standard potassium dichromate.

Module-VI (2Hrs)

- Electrochemical Phenomenon
  Electrochemical cell, Electrode potential, Determination of pH of a solution Using Clomel/ Quin Hydrone Electrode.

Module-VII (2Hrs)

- Error in Chemical analysis
  Types of errors, Accuracy and precision, Absolute and relative uncertainty, mean and standard deviation.

Text Books

	• Engineering chemistry By Jain &Jain-16th Edn,2015, Dhanpat rai publications • Engineering chemistry By Sashi Chawla,3rd Edn,Dhanpati roy publications,2011 • Industrial Chemistry By B.K.Sharma 21st Edn-2018,Satya Publications. • **Reference Books** • Applied Chemistry By Aruna Kumari-2nd Edition,Paramount publications,2016 • Engineering chemistry by OG Palanna,McGrahill Education(India) private Limited,2009 • Engineering chemistry by K.Sesha Maheswaramma,Mridula.Chuch.PearsonIndia Education services pvt Ltd,2016 • Engineering chemistry by Prasanth Rath,Cengage Learning India pvtLtd,2013 • Engineering chemistry by R.V.Gadag,A.Nityananda, Shetty,I.K.International Publishishing house,2006 • Engineering chemistry –Fundamentals and applications,ByShika Agarwaal-Cambridge University Press Edition,2017 **Courseware link:** http://courseware.cutm.ac.in/courses/applied-analytical-chemistry-2/		
10.	**CUTM1009**	**Applied Engineering Materials**	**3 (2+0+1)**
	Course Objectives • To give an introduction to materials, ceramics, polymers, and electronic materials in the context of a molecular level understanding and their application in various field **Course Outcomes** • After completion of this course students will able to understand the physical/chemical behaviours of materials. • Select materials, based on their properties and behaviours, for a given application. • Understand how molecular interactions to the behaviour of material give rise to microscopic properties. **Module I: New Materials/Nanomaterials (5hrs)** • Nanostructures and nanomaterials: classification (dimensionality, Morphology/ shape/structure of nano-entities, new effect/ phenomena). hybrid nanomaterials. effect of size, structure, mechanism, and property on material performance. applications of nanomaterials in catalysis, telecommunication and medicine. **Project 1** • Synthesis of TiO_2 and ZnO nanoparticles by sol gel, sonication and precipitation method and study their application.		

Module II: Carbon Nanomaterials (5hrs)

- Carbon nanomaterials, such as graphene, carbon nanotubes (CNTs), crystalline diamond, and diamond-like carbon, properties and application of fullerenes

Project 2

- Synthesis and fabrication of graphene and graphene oxide by sol-gel techniques

Module III: Polymer (5 hrs)

- Mechanism of polymerization and synthesis of polymers, copolymerization, viscoelasticity, elastomers-structure, conducting polymers and applications, fabrication and moulding of polymers, synthesis, properties and uses PMMA, formaldehyde resins, melamine-formaldehyde-urea resins

Project 3

- Preparation of polystyrene by anionic/cationic/emulsion polymerization method

Module IV: Composites (5 hrs)

- Composites: characteristics, types and applications, nanocomposites, polymer/ Metal oxide nanocomposites and its application

Project 4

- Fabrication of ceramic matrix particulate composite by powder metallurgy route.

Module V: Adhesives Lubricants (4hrs)

- Adhesives, adhesive mechanism and applications, lubricants-physical and chemical properties, types and mechanism of lubrication, Additives of lubricants and freezing points of lubricants

Module VI: Energy Storages Material-I (4Hrs)

- Fundamental aspects related to energy storage and conversion, lithium-ion batteries, lead acid batteries; nickel cadmium batteries; advanced batteries

Module VII: Energy Storages material-II (4 Hrs.)

- Super capacitors, fuel cells and photovoltaic, future of battery technology

Project 5

- Fabrication of fuel cell and its application

	Text Books: • A Text book of Engineering Chemistry, by Shashi Chawla • Engineering Chemistry, by P. C Jain and M. Jain • Advanced Polymer Chemistry, by M. Chanda **Reference Books:** • Surfactants and Polymers in Aqueous Solution, by K. Holmberg, B. Jonsson, B.Kronberg and B. Lindman • Energy Scenario beyond 2100, by S. Muthukrishna Iyer **Courseware link:** http://courseware.cutm.ac.in/courses/applied-engineering-materials/

BASKET-II

(Humanities and Management)
(Total Credits: 12; A: 6 credit (Choice); B: 6 credit Compulsory)

1.	CUTM1011	Optimization Techniques	2 (0+2+0)

Course Objectives

- To Create an Engineering design methodology using a mathematical formulation of a design problem to support selection of the optimal design among alternatives

Course Outcomes

- Ability to apply the theory of optimization methods and algorithms to develop and for solving various types of optimization problems
- Ability to go in research by applying optimization techniques in problems of Engineering and Technology
- Ability to solve the mathematical results and numerical techniques of optimization theory to concrete Engineering problems by using computer software

Module-I: Linear Programming: Graphical Method, Simplex method, Penalty Method,

Module-II: Transportation Models, Assignment Models, Sequencing and Scheduling Models by Johnson's Algorithm

References

- Harvey M. Wagner, *Principles of Operations Research*, Englewood Cliffs, Prentice-Hall, 1969
- S D Sharma and Himansu Sharma, Operations Research: Theory, Methods and Applications, 15 Edition, Kedarnath Ramnath & Co

Courseware link:

http://courseware.cutm.ac.in/courses/optimization-techniques/

2.	CUTM1012	Engineering Economics and Costing	3 (2+0+1)

Course Objectives

- Facilitate students to understand the basics of Economics and its application in the field of engineering
- Enable students to understand the concepts of the time value of money and techniques for evaluation of engineering project
- Equip students with the skills required to understand cost statements/records of the product and its effect on decision making

Course Outcomes

After the completion of the course, students will be able to:

	• Understand the microeconomics concepts related to business and its impact on enterprise • Develop an awareness and understanding time value of money and techniques for evaluation of engineering project • Understand and apply cost concepts to analyse common business management decisions such as pricing a product and services. **Module-I** • Engineering Economics – Nature and scope, General concepts on micro & macroeconomics. The Theory of demand, Demand function, Law of demand and its exceptions, Elasticity of demand, Law of supply and elasticity of supply. Theory of production, Law of variable proportion, Law of returns to scale. **Module-II** • Time value of money: Simple and compound interest, Cash flow diagram, Principle of economic equivalence. Evaluation of engineering projects: Present worth method, Future worth method, Net present value method, internal rate of return method, Cost-benefit analysis in public projects. Depreciation: Meaning Causes, Factors affecting depreciation, Methods of providing depreciation, Straight Line Method & Diminishing Balance Method **Module-III** • Cost concepts, Elements of costs, Preparation of cost sheet, Segregation of costs into fixed and variable costs. Break-even analysis (Simple numerical problems to be solved) Indian Banking System: Banks: Meaning, nature, characteristic of the Indian banking system, functions of commercial banks, functions of Reserve Bank of India, Overview of Indian Financial System. **Reference Books** • Sasmita Mishra, "Engineering Economics & Costing ", PHI • Sullivan and Wicks, "Engineering Economy", Pearson • R.Paneer Seelvan, " Engineering Economics", PHI • Gupta, "Managerial Economics", TMH • Lal and Srivastav, "Cost Accounting", TMH **Courseware link:** http://courseware.cutm.ac.in/courses/engineering-economics-and-costing		
3.	**CUTM1013**	**Project Management**	**3 (2+0+1)**
	Course Objectives • The successful development and implementation of all project's procedures. • Learn project management methodology to initiate and manage projects efficiently and effectively • Acquire key project management skills and strategies for Productive guidance,		

efficient communication and supervision of the project's team
- The achievement of the project's main goal within the given constraints

Course Outcomes
- Develop a Project Charter document for any project
- Develop Project Management Plan document
- Acquire 10 knowledge area identified by PMI and its application while delivering a project
- Implement the Project and Prepare a project document that they have undertaken as a learning tool
- Qualify CAPM/PMP certification offered by PMI

Module I:

- **Project Management framework; Introduction to Project Management;** Project Life Cycle and Organisation, Project vs. Operational work, Stakeholders, Organisational Influences **Project Management Process for a Project**, groups, Initiating, planning, executing, monitoring &controlling and closing process groups.**Project management Knowledge area; Project Integration Management;** Develop project charter, develop project management plan, direct and manage project execution, monitor and control project work, perform integrated change control, close project or phase.

Module II:

- **Project Scope Management;** collect requirements, define scope, create WBS, verify scope, control scope **Project Time Management;** Define activities, sequence activities, estimate, develop and schedule **Project Cost Management;** Estimate costs, determine budget, control costs.

Module III:

- **Project Quality Management;** Plan quality, perform quality assurance, perform quality control

Project HR Management; Develop HR plan, acquire project team, develop and manage project team **Project Communications Management;** Identify stakeholders, plan communication, distribute information, manage expectation of stake holders, report performance

Module IV:

- **Project Risk Management; Plan risks;** identify risks, perform quality and quantitative risk analysis, plan risk responses, monitor and control risks Project Procurement Management; Plan procurements, conduct procurements, administer procurements, close procurements Project Stakeholders Management**;** Identifying stakeholders, stakeholder analysis, engagement.

	References: • Project Management: A Managerial Process, Clifford F Gray & Eric W Larson, Tata McGrawHill **[Text book]** • A Guide to the Project Management Body of Knowledge, 6th Edition, PMI • Project Management- A system Approach to Planning, Scheduling and Controlling (Harold Kerzner). CBS Publishers and Distributers, New Delhi. • Projects, Preparation, Appraisal and Implementation (Prasanna Chandra), 3rd Edition, Tata Mc Graw Hill, New Delhi. • Project Management (Nagarajan, K), New Age Publishers, New Delhi. • Project Management. A Managerial Approach (Meredith, R.J and Mantel, S.J), Wiley (India). **Courseware link:** http://courseware.cutm.ac.in/courses/project-management/		
4.	**CUTM1014**	**Gender, Human Rights and Ethics**	**(2+0+1)**
	Course Objectives • This course is about gender, human rights and ethics in which the student will be sensitized and exposed to related issues in the context of business and organisations in India. The specific objectives are: • To develop an understanding of gender, human rights and ethics in an unequal society like India • Sensitization of how gender, human rights and ethics are significant in organizations. • Integrating concerns related to gender, human rights and ethics in organizations. **Course Outcomes** • • Understanding the complexity of issues and challenges relating to gender, human rights and ethics • Be sensitive to gender, human rights and ethics within an organizational context, • To integrate concerns related to gender, human rights and ethics into the policies, processes and systems in an organization. **Module I** • Difference between sex and gender; social construction of gender and its outcomes in the form of behavior, roles, gender-based division of labour, hierarchy; gender relations. • Gender issues in organisations - significance of relations between structures, practices, context, interactions and power for construction of gender at organisational level • Gender implications at workplace, management and leadership, Laws and Acts		

	• Comparing different types of organisations; how to create a gender sensitive organisation. **Module II** • Introduction to human rights, Meaning and Definition, Types • Human Rights Law: Protection, violation and the legal framework for their protection - International Human Rights Law, Universal Declaration of Human Rights • Conflicts of Rights and its Significance to Organisations: Challenges of the past and challenges for the future. Persistence of social discrimination and inequality; efforts in the search for justice for past violations, continued struggle for human rights and accountability in an organisational context. **Module III** • Introduction to and study of ethics; Indian and Western ethics • Different ethical systems and perspectives; ethical relativism and its implications, utilitarianism, duty ethics and virtue ethics in organisations • Critique of various ethical positions and develop their own position in an organizational context. **References** • Frankena, WK, 1973, Ethics (2nd Edition), Pearson. • Singer, P. 2011, Practical Ethics (3rd ed), Cambridge University Press. • Smart, JJC and Williams, B. 1973, Utilitarianism: For and Against, Cambridge University Press. **Courseware link:** http://courseware.cutm.ac.in/courses/gender-human-rights-and-ethics/		
5.	**CUTM1015**	**Climate Change, Sustainability and Organizations**	**(2+0+1)**
	Course Objectives • To develop an understanding about climate change in general, responses and debates • To create awareness about the impact of climate change on organizations in performance, growth and sustainability • To facilitate in developing reference points to factor in aspects of climate change in organizational planning and development • To develop an understanding of sustainable development, SDGs and their relevance for sustainability of organisations • To comprehend the application of the Integrated Reporting Framework for Sustainability in business. • **Course Outcomes**		

	• Students will be exposed to current climate change issues, challenges and debates • They will be sensitive to its implications for organisations in different sectors • The course will equip the students of Management to develop strategies for perspective planning of organisations • The student will develop an understanding of perspectives on SDGs, sustainability and development in the context of organisations • Argue the business case for sustainability informed by an understanding of the impact of current global and local economic, social and environmental pressures (including pandemics) **Module I** • Basics of climate change; impacts on various sectors; responses and mitigation efforts by the state and non-state agencies; debates and critiques • Sectoral implications of climate change – Agriculture and Forestry; Transportation; Buildings; Energy; Industry and Manufacturing • Climate change – specific impacts (Migration, Disasters and Pandemics) • Mitigation and adaptation keeping the sustainability of business organisations **Module II** • Sustainable development, debates, SDGs, challenges and opportunities; The business case and leadership for action • Regulatory environment and International policy; Integrated Reporting Framework for Sustainability • Production and consumption; Design, technology, and planning for sustainability • Communication and marketing; Collaboration and partnerships **Group Projects** 1. Climate change impacts on • Agriculture - what is the current practice and its implications for the sector and stakeholders; enumerate policy responses; provide your own recommendations based on your understanding of issues, challenges, debates, critiques • Marine fishing – what is the current practice and its implications for the sector and stakeholders; enumerate policy responses; provide your own recommendations based on your understanding of issues, challenges, debates, critiques • Forest dwellers -what is the current practice and its implications for the sector and stakeholders; enumerate policy responses; provide your own recommendations based on your understanding of issues, challenges, debates, critiques • Business organisations – MSMEs, manufacturing, service industries; application of the integrated framework for sustainability reporting 2. Develop an Action Plan through a Case Study for integrating sustainability across an organization's value chain 3. Develop and apply the Integrated Reporting Framework for Sustainability through a case.

	Courseware link: http://courseware.cutm.ac.in/courses/climate-change-and-sustainable-development/		
6.	**CUTM1016**	**Job Readiness**	**(0-6-0)**
	Course Objectives • Develop additional skills (verbal, logical, quantitative and reasoning) required to enhance employability as well as the entrepreneurial ability of the students **Course Outcomes** Achieve the following scores as a minimum: • IELTS 6.5 • Verbal: 60% (average of 10 exams) • Quantitative: 60% (average of 10 exams) • Logical Reasoning: 60% (average of 10 exams) **Course Division** **Course I:** IELTS - Reading, Listening, Speaking and Writing **Course II:** IELTS Verbal **Course III:** Quantitative Aptitude **Course IV:** Logical Reasoning **Course I: IELTS - Reading, Listening, Speaking and Writing** **Module I: IELTS Reading** • Skimming and Scanning • Sentence Completion • Choose the Correct options (A, B, C, D) • Locating the Specific Information • Assessment on Reading Skill **Module II: IELTS Listening** • Notes/ Form/Table completion • Label the Map/Passage, Multiple Choice Questions • Complete the Sentences, listening to Find Information • Assessment on Listening Skills **Module III: IELTS Speaking** • Speaking about yourself, your family, your work and your interests • Introduction & Interview • Topic Discussion (e.g, Environment, Covid 19, Job)		

- Assessment on Speaking Skills

Module IV: IELTS Writing

- Summarizing the chart, table or graph
- Comparing and contrasting graphs and tables
- Describing maps & diagrams
- Agreeing & disagreeing
- Expressing a personal view & opinion
- Assessment on Writing Skill
- CV Writing (2nd year)
- Letter Writing
- Email Writing (2nd year)
- Getting Started –writing an introduction

Course II: IELTS Verbal

Module I: Grammar (4 Hrs)

- Articles
- Prepositions
- Subject-Verb
- Spotting Errors
- Sentence Correction

Module II: Vocabulary (5 Hrs)

- Synonyms
- Antonyms
- Contextual Vocabulary

Module III: Reading Comprehension (3 Hrs)

- Paragraph/ Sentence Completion
- Jumbled Sentences/ Jumbled Paragraph
- Reading Comprehension

Module IV: Verbal Analogies (3 Hrs)

Course III: Quantitative Aptitude

Module I: Number System & Operation (14 Hrs)

- Speed Math-1: Multiplication tricks, Square, cube, square root, Cube root tricks
- Speed Math-2: Speed Calculations
- Number System-01: Operation on Numbers, Classification of Numbers, Tests of Divisibility, Unit Digit Calculation
- Number System-02: Arithmetic Progression, Geometric Progression, Factors &

	Factorials, Trailing Zeroes, Remainder Theorem • HCF & LCM: Concepts, short tricks, question discussion • Average: Concepts, short tricks, question discussion • Assessments **Module II: Basic Arithmetic (16 Hrs)** • Percentage-01: Basics of Percentage, Effective percentage, shortcuts • Percentage-02: Advanced questions and discussions • Profit & Loss-01: Basics and advanced questions of Profit & Loss and shortcuts • Profit & Loss-02: MRP, Discount, Successive discount • Ratio & Proportion: Types of ratios, Basics & Advanced Question • Age: Concepts & Shortcuts • Partnership: Concepts & Shortcuts • Mixture & Alligation: Rule of Alligation, Basics & Advanced question, Short tricks • Assessments **Module III: Time & Analysis (17 Hrs)** • Time, Speed, Distance: Concepts, Problems based on relations, Average speed, Stoppage time • Trains: Relative Speed & All types of train problems • Boats & Streams: Basics, Upstream, Downstream & Shortcuts • Race: All concepts & Shortcuts • Time & Work: Efficiency, wages, alternative day, chain rule • Pipes & Cistern: Positive & Negative work • Simple Interest: Concepts & Shortcuts on Simple Interest & Installments • Compound Interest: Concepts & Shortcuts on Simple Interest & Installments • Logarithm: All Formulae, concepts & Shortcuts • Assessments **Module IV: Advanced Arithmetic (16 Hrs)** • Equation: Linear & Quadratic • Permutation: All concepts & Shortcuts on factorial, fundamental principles of counting • Combination: All concepts & Shortcuts on Selection (Groups/teams) • Probability: Terms related to Probability, Event, Theorems related Probability, Conditional Probability. Shortcuts on coins, dices, balls, cards, etc • Data Interpretation: (Bar/Pi-Chart /Line) graph • Mensuration: Area & Volume • Height & Distance: Lines of Sight, Horizontal line, Angle of Elevation, Angle of Depression • Assessments **Course IV: Logical Reasoning**

Module I: Verbal Reasoning-I (14 Hrs)

- Series-1: Number series (Missing & Wrong)
- Series-2: Letter, Alpha numeric, Miscellaneous series
- Coding & Decoding: Letter Coding, Number coding, Message coding, Substitution coding, Conditional coding
- Word Problem: Analogy, Odd man out, word formation, letter pair
- Logical Thinking: Brain Riddles
- Assessments

Module II: Verbal Reasoning-II (14 Hrs)

- Order & Ranking: Ranking & Sequence
- Direction Sense Test: Shortest Distance, Angular movement concept and Dusk & Dawn
- Clock: Concepts of Angle, Reflex angle, Right angle Opposite, Coincide and Incorrect clock
- Calendar: All concepts & Shortcuts
- Blood Relation: Jumbled-up descriptions, coded relations, Relation Puzzles
- Assessments

Module III: Non-Verbal Reasoning (14 Hrs)

- Cubes & Dices
- Cubes & Cuboids
- Embedded Figure& Figure series
- Figure Puzzle & Figure grouping
- Figure Counting
- Mirror & Water Image
- Paper Cutting & Paper folding
- Assessments

Module IV: Advanced Reasoning (16 Hrs)

- Sitting Arrangement: Circular, Square, Rectangular, Linear, Triangular
- Puzzle: Box, Floor, Month, Day
- Advanced Puzzle: 3 variables
- Logical Venn Diagram
- Syllogism
- Statement & Conclusion
- Data Sufficiency
- Assessments

Courseware link:

http://courseware.cutm.ac.in/courses/25090/

BASKET-III

Basket III (Smart Stack: Compulsory for all branch of Engineering) (Total Credits: 25)

1.	CUTM1017	Industrial IoT and Automation	6 (3+2+1)

Course Objectives:

- By 2025, there will be 50 billion devices connected to the Internet. How will the students capitalize on this tremendous opportunity?
- Students will learn the new evolution in hardware, software, and data.
- While the promise of the Industrial Internet of Things (IIoT) brings many new business prospects, it also presents significant challenges ranging from technology architectural choices to security concerns.
- Students acquire upcoming Industrial IoT: Roadmap to the Connected World Course offers important insights on overcoming the challenges and thrive in this exciting space.

Course Outcomes:

- Discover key IIoT concepts including identification, sensors, localization, wireless protocols, data storage and security
- Explore IoT technologies, architectures, standards, and regulation
- Realize the value created by collecting, communicating, coordinating, and leveraging the data from connected devices
- Examine technological developments that will likely shape the industrial landscape in the future
- Understand how to develop and implement own IoT technologies, solutions, and applications
- At the end of the program, students will be able to understand how to develop and implement their own IoT technologies, solutions, and applications.

Module I: Introduction & Architecture

- What is IIoT and connected world? the difference between IoT and IIoT, the web of things, architecture of IIoT.

Practice

1. Simulation of RFID using Matlab/Dymola

Module II: Communication Technologies of IIoT

- Industry standards communication technology (LoRAWAN, ZigBee, OPC UA, MQTT), wireless network communication, security issues in IIoT.

Practice

2. Demonstration of MQTT communication using Matlab/Dymola.
3. Site visit to Apparel factory in the Bhubaneswar campus.
4. Wireless communication demonstration using Matlab/Dymola.

Module III: Visualization and Data Types of IIoT

- HMI in an IIoT world, enterprise data for IIoT, emerging descriptive data standards for IIoT.

Practice

5. Assembling the HMI for IIoT environment using Matlab/Dymola.
6. Measurement of temperature & pressure values of the process using sensors.

Module IV: Automation

- Automation definition, automation pyramid, field level sensors, HMI in an automation process.

Practice

7. Visualization of diverse sensor data using dashboard (part of IoT's 'control panel')
8. Wearable sensing for IoT (future user interfaces for IoT - new ways to control and interact with your environment)

Module V: Control & Supervisory Level of Automation

- Programmable logic controller (PLC), Supervisory Control & Data Acquisition (SCADA).

Practice

9. Simulation of PLC to understand the control concept.
10. SCADA HMI demonstration using Matlab.
11. SCADA simulation using Matlab/Dymola.

Module VI: Planning Level & Management Level

- Manufacturing Execution System (MES), Enterprise Resource Planning (ERP)

Practice

12. Designing MES system by using Adobe.

Text Books

- The Internet of Things in the Industrial Sector, Mahmood, Zaigham (Ed.) (Springer Publication)
- Industrial Internet of Things: Cybermanufacturing System**,** Sabina Jeschke, Christian Brecher, Houbing Song, Danda B. Rawat (Springer Publication)

Courseware link:

http://courseware.cutm.ac.in/courses/industrial-iot-and-automation/

2.	**CUTM 1018**	**Data Analysis and Visualization Using Python**	**4 (0+1+3)**

Course Objectives

- How to tell a story from data?
- How to marshal the data for storyline?
- The ability to develop visualization to tell the story
- The focus is on analysis of data using visualization as a tool

Course Outcomes

- To create impactful visualization with good story line.

Module-I: STORY BOARD DEVELOPMENT

- The objective and flow of the story to be understood through cases

Module-II: DATA READING USING PYTHON FUNCTIONS

- Python libraries: Pandas, NumPy, Plotly, Matplotlib, Seaborn, Dash
- Data collection from online data sources, Web scrap, data formats such as HTML, CSV, MS Excel, data compilation, arranging and reading data, data munging

Module-III: DATA VISUALSATION USING PYTHON LIBRARIES

- Different graphs such as Scatterplot, Line chart, Histogram, Bar chart, Bubble chart, Heatmaps etc.
- Dashboard Basics – Layout, Reporting, Infographics, Interactive components, live updating

Projects List

- COVID 19
- World Development Indicators
- ERP dash boarding
- Details of Social/ Empowerment schemes of Govt. etc.

Courseware link:

http://courseware.cutm.ac.in/courses/data-analysis-and-visualisation-using-python/

3.	**CUTM1019**	**Machine Learning using Python**	**4(1-2-1)**

Course Objectives

- Understand the meaning, purpose, scope, stages, applications, and effects of ML.
- Explore important packages of python, such as numpy, scipy, OpenCV and scikit-learn.

Course Outcomes

- Students will able to Create and incorporate ML solutions in their respective fields of study.

Module I: Application and Environmental-setup (12 hrs)

- Applications of Machine Learning in different fields (Medical science, Agriculture, Automobile, mining and many more).
- Supervised vs Unsupervised Learning based on problem Definition.
- Understanding the problem and its possible solutions using IRIS datasets.
- Python libraries suitable for Machine *Learning (*numpy, scipy, scikit-learn, opencv)
- Environmental setup and Installation of important libraries.
-

Module II: Regression (8 hrs)

- Linear Regression
- Non-linear Regression
- Model Evaluation in Regression
- Evaluation Metrics in Regression Models
- Multiple Linear Regression
- Feature Reduction using PCA
- Implementation of regression model on IRIS datasets.

Module III: Classification (24 hrs)

- Defining Classification Problem with IRIS datasets.
- Mathematical formulation of K-Nearest Neighbour Algorithm for binary classification.
- Implementation of K-Nearest Neighbour Algorithm using sci-kit learn.
- Classification using Decision tree.
- Construction of decision trees based on entropy.
- Implementation of Decision Trees for Iris datasets.
- Classification using Support Vector Machines.
- SVM for Binary classification
- Regulating different functional parameters of SVM using sci-kit learn.
- SVM for multi class classification.
- Implementation of SVM using Iris datasets.
- Implementation of Model Evaluation Metrics using sci-kit learn and IRIS datasets.

Module IV: Unsupervised Learning (12 hrs.)

- Defining clustering and its application in ML.
- Mathematical formulation of K-Means Clustering.
- Defining K value and its importance in K-Means Clustering.
- Finding appropriate K value using elbow technique for a particular problem.
- Implementation of K-Means clustering for IRIS datasets
- Projects
- To be defined based on respective study area of student.

	Courseware link: http://courseware.cutm.ac.in/courses/machine-learning-using-python/		
4.	**CUTM1020**	**Robotic Automation with ROS & C++**	**4 (1+2+1)**
	Course Objectives • To upgrade knowledge levels of robotic application in modern industries • Project based training **Course Outcomes** • Advanced knowledge on robotic automation • Understand different types of devices to which robotic modules are connected • Provide the knowledge about understand various types of robotic applications. • Industry based project & advanced learning. **Module I** • Robotic Automation Introduction 1.1. Basics of automation 1.2 Use of robots in industry. **Module II** • Sensor's requirement in robots. 2.1 Selecting sensors as per the project. 2.2 Specification checking of sensors. 2.3 Interfacing of sensor to controllers. **Practice** P 2.1 TILT, PROXIMITY, TEMPERATURE, HUMIDITY, SMOKE, FINGERPRINT P2.2 BLUETOOTH, ESP8266, GPS, GSM **Module III** • Controllers and output port handling. 3.1 Concept of 8951 controller 3.2 Concept of Arduino and concept of Raspberry Pi. **Practice** P3.1 Port handling of 8951 P3.2 Port handling of Arduino P3.3 Port handling of Raspberry Pi **Module IV** • Sequential robot control 4.1 Designing of sequential robot control system. 4.2 Writing of programs in different programming languages. 4.3 Controlling of input/output devices. **Practice**		

	P4.1 Programming of controllers with different programming languages P4.2 Designing of sequential control robot. **Module V** • ROS & C++ 5.1 What is Ubuntu & ROS. 5.2 Requirement and application of ROS. 5.3 ROS based simulation of Turtlbot. 5.4 Adding of robot with wheel & sensor. Placing robot inside Gazebo. **Practice:** P5.1 Ubuntu basic command. P5.2 Installation of Ubuntu, ROS & Gazebo P5.3 Turtlbot control application P5.4 Gazebo based robot control and simulation. P5.5 Python and C++ based programming to control robot. Virtual LAB : Using ROBOMASTER (AWS) **Projects** 1. Mobile controlled robot 2. Autonomous operated robot. 3. 3. Location targeted robot **Courseware link:** http://courseware.cutm.ac.in/courses/25657/		
5.	**CUTM1021**	**Design Thinking**	**2 (0+0+2)**
	Course Objectives The course aims to • Orient the participants on the basics of the design thinking process • Familiarize participants with the elements and application of Design thinking **Course Outcome** • After completion of the course, the student will be able to apply the design thinking process to innovative problem solving **Module: I** • Basics of Design Thinking, Why Design Thinking, Design Thinking Mindset (Inspiration, Ideation and Implementation) Design thinking process, (Empathy, Define, Ideate, Prototype, Test). Cases of application of Design thinking approach (Intuit, IDEO, Infosys, IBM, Google, Apple, Jubilant Foods) • This will be in a flip class mode followed by a workshop, to be conducted by an external expert and a faculty anchor.		

Module: II

- Executing a Design Thinking Project- Apply Interviewing and empathy building technique, Drawing inferences from the observations, Defining a point of view, Ideation process, developing and testing prototypes and writing a story of a minimum viable solution.

Projects

1. Develop a customer friendly insulin pump design (teams of 3 students to be graded on the application of the process, story boarding and the final design elements).
2. Develop a new customer experience for buying a diamond ring online (teams of 3 students to be graded on the application of the process, story boarding and the final design elements).
3. Develop a new disease monitoring device for health workers working in remote areas. (teams of 3 students to be graded on the application of the process, story boarding and the final design elements).
4. Designing an integrated machinery for end-to-end functions for small and marginal farmers.

Recommended References:

Books: Tom Kelly & Jonathan Littman (2001). "The Art of Innovation" Broadway Publication.

Readings:

- Brown Tim (2008). "Design Thinking", Harvard Business Review https://hbr.org/2008/06/design-thinking
- Rikke Friis Damand Teo Yu Siang, "What is Design Thinking and Why Is It So Popular?"
- https://www.interaction design.org/literature/article/what-is-design-thinking-and-why-is-it-so-popular
- Anubhav Gupta, How design thinking can help companies, Forbes July, 2019
- https://www.forbesindia.com/blog/the-innovation-edge/how-design-thinking-can-help-companies/

Links to websites:

- https://dschool.stanford.edu/resources/design-thinking-bootleg
- **Stanford Webinar - Design Thinking = Method, Not Magic** https://www.youtube.com/watch?v=vSuK2C89yjA
- **Rise of Design Thinking in India | Ankur Grover Kunal Gupta | TEDxTISS**
- https://www.youtube.com/watch?v=VuedtXtyCjs
- http://quicksand.co.in/

Courseware link:

http://courseware.cutm.ac.in/courses/basics-of-design-thinking/

6.	CUTM1022	System Integration with DYMOLA	2 (0+0+2)

Course Objectives

- To provide powerful multi-disciplinary systems engineering through compatible model libraries for a large number of engineering domains.
- To design high-fidelity modeling of complex integrated systems.
- To design intuitive modeling i.e., advanced, formally defined object-oriented modeling language.
- To enable users to easily build their own components or adapt existing ones to match their unique needs.
- To provide hardware-in-the-loop simulations (HILS) i.e. real-time simulation with AurdinoUno, Python, Matlab, 3D real-time animation, CAD files import capability.
- To increase the ability to integrate with complex 3D geometry for integrated simulation.
- To increase powerful model management, calibration & optimization capabilities.

Course Outcomes

- The use of open standards such as DYMOLA (Modelica and FMI) is a key enabler to better understand the behavior of systems and to work and communicate accurately with partners and suppliers
- DYMOLA is not only capable to support an ad-hoc modeling level, such as functional behavior or detailed design, but is also able to convert these predictive models into real-time models.
- The user can able to create new elements in an easy and intuitive way, to answer to its own modeling requirements.
- Future Centurions are ready for operating in many industries including automotive, aerospace, architecture, Motorsport, energy, and high tech.

Module I: Introduction Dymola and Modelica library

- Package Browser, Component Browser, Parameter and Variable Editor Simulation Window, Modeling, and Simulation.
- The Modeling window is used to compose models and model components.
- The Simulation experiment on the model, plot results and animate the behavior.
- Creating user-defined models and scripting using Modelica language.
- Role Play – Explore the pre-defined libraries and Models, Creating a Package

Practice Project

- Preparation of animated projects

Module II: Physical Modeling using DYMOLA

- Import of user-defined libraries and packages, Interfacing with physical models using Arduino Uno.
- The Simulation experiment on the model using multi-domain libraries such as mechanical, electrical, control, thermal, pneumatic, hydraulic, powertrain, thermodynamics, vehicle dynamics, air-conditioning domains

	• Dymola interface that is stored in the Python package • Role Play – Explore the pre-defined libraries and Models, Creating a Package **Practice Project** • Preparation of projects using user-defined packages, • Systems Physics with Modelica/Dymola **Module III: Animation and 3D view Using DYMOLA** • Multi Body Frame Connector, Building a Mechanical Model, Concept of Furuta • Role Play - Practical session by students for students **Practice Project** • Modeling of animated projects using the MultiBody library. **Courseware link:** http://courseware.cutm.ac.in/courses/system-integration-with-dymola/		
7.	**CUTM1023**	**Smart Engineering Project (G2M)**	**3(0-0-3)**
	Course Objectives • The main objective of this course is that students from various branches can learn different tools and collaborate together to build a smart live project. • To make the centurion's think beyond engineering. • To provide the platform to express the imagination to reality. • To acculturat*e the* diversity in engineering. • To make the centurions industry ready. **Course Outcomes** On completion of this course a student will • Learn the new tools and use them to solve some current problems in their respective areas. • Be able to learn current industry software's and work on projects based on multidisciplinary fields. • Can able to explore the engineering more conceptually manner. • Can able to discover the engineering as a quality product outcome. • Can able to work with the diversity in present industries scenario. **Project categories:** **<u>Hardware</u>** Arduino Uno Node MCU Raspberry pi W		

	Micro Python Raspberry pi 3b+ FPGA Board **Simulation Software's** Proteus Professional MATLAB/Simulink LabVIEW Xilinx ISE **Proteus Professional Software** ESP8266 Weather Forecaster ESP8266 Publishing DHT22 Readings to SQLite Database ESP8266 Publishing DHT22 Readings with MQTT to Raspberry Pi Raspberry Pi Publishing MQTT Messages to ESP8266 ESP8266 Controlled with Android App (MIT App Inventor) ESP8266 – Wireless Weather Station with Data Logging to Excel Power Supply Circuit Automatic Traffic light Controller Password Based Door Lock system Home Automation using Bluetooth Home Automation using Zig-Bee Digital Real Time Clock Implementation of Automatic Street Light control using LDR Implementation of Automatic Counter Temperature Level Indicator using Temperature sensor Humidity level Indicator using Humidity Sensor Implementation of Social Distancing using ultrasonic sensor. Automated Irrigation System using SMS based Wireless Notice board with Monitoring system using GSM with SMS Gas Leakage Detection System using GSM Communication between two Microcontrollers via serial port MicroPython on the ESP8266 Telegram: ESP8266 NodeMCU Motion Detection with Notifications Receive Data from Multiple Boards (many-to-one) Send Data to Multiple Boards (one-to-many) Two-Way Communication Between ESP8266 NodeMCU Boards **VLSI** Design of High Speed Hardware Efficient 4-Bit SFQ Multiplier Adiabatic Technique for Power Efficient Logic Circuit Design Behavioral Synthesis of Asynchronous Circuits Implementation of Carry Tree Adder: Fixed Angle of Rotation Using CORDIC Designs Design of FPGA based 32-bit Floating Point Arithmetic Unit Design and Synthesis of a Field Programmable CRC Circuit Architecture: Design and Implementation of Efficient Systolic Array Architecture Verilog Environment for Floating Point Arithmetic Logic Unit : Design and Simulation of FFT Processor Using Radix-4 Algorithm Using FPGA:

	Design and Implementation of a Real-time Traffic Light Control System: Design and Implementation of Hamming Code on FPGA using Verilog: **MATLAB** Automated Car Parking Indicator System: Identifying Vehicle Number plates using Matlab Matlab Simulation on Solar Energy system Plant disease detection using image processing (MATLAB) Soil Classification using Image Processing Retinal Disease detection Controlling a Robot hand in MATLAB simulation and reality Pedestrian detection using MATLAB Automatic Certificate Generation using MATLAB Fingerprint recognition algorithm Face Detection and Tracking Using Live Video Acquisition Motion-Based Multiple Object Tracking **Industrial Automation** PLC Based Industrial Monitoring system. PLC based welding robot PLC based industrial or home security system PLC Based on Automatic Alarm System in Plant PLC Based on Automatic Multi-Channel Fire Alarm System PLC Based on Automatic Traffic and Street Light Control System PLC Based on Automatic Timer Control System (for Motor, Pump, and Valve) PLC Based on Automatic Dam Sutter Open or Close System PLC Based on Automatic Motor Speed Monitoring System PLC Based on Agriculture Irrigation System PLC Based on Induction Motor Controlling Using Touch Screen PLC and SCADA based on Milk Process Dairy Plant System PLC and SCADA based on Coal Crushing and Conveyor System PLC and SCADA based on Automatic Control of Boiler Operating System PLC and SCADA based on Design House Monitoring System **Civil** Urban Housing Plan using GENERATIVE DESIGN technique (using AUTODESK SOFTWARE or 3DExpereicne Platform) Analysis Design of G+10 building using ETABS or STAADPRO Parametric Model design of an airport facade using XGENERATIVE Design of a pile foundation ETABS or STAADPRO Detail design and Simulation of a Stadium Tunnel Design and Detailing with showing geology layers 4D Construction Planning using DELMIA for a Residential Building **Engineering Python** Movie Recommendation System using Python Automated Car Parking Indicator System Create scientific Calculator Face reorganization system using Python

	Stock market prediction Electricity price and load forecasting Electricity load forecasting Currency exchange rate prediction Fraud detection Intrusion detection Weather prediction Rainfall prediction Health care system Traffic alert Automatic home appliances Product recommendation Speech Recognition Speech to Text Conversion Text to Speech Conversion Speech and handwriting recognition Product categorization **Aerospace** Wind tunnel design Study of aerodynamics parameters of elliptical, rectangular and swept back wing Airship design Water tunnel design and flow simulation Quad copter VTOL **Mining** Measurement of vibrations during blasting using sensors (Arduino). Development of name plate reader system (image scanner) for opencast mines vehicles. Digitization of vibrating sensor instruments using embedded system. Development of anti-colliding vehicle protective system for mine vehicles. Development of alarm system for underground water inrush in mines. Development of wireless monitoring of stress and pressure levels in mines. Development of mobile messenger system for dust concentration in open cast mines. Digitization of roof displacement measurements from Mining instruments. Study of scope of smart mine vehicle monitoring system in mines (can alarm fuel system, air pressure of the vehicle, colliding with walls) **Dairy** 6000Lpd milk processing plant design. **Courseware link:** http://courseware.cutm.ac.in/courses/smart-engineering-project-g2m/

BASKET- IV. A

(Foundation Courses in Engineering)
(Total Credits: 26)

1.	CUTM1089	Fluid Mechanics with Finite Volume Method	3 (2+1+0)

Course Objectives

- To learn fundamentals of computational methods like FVM for solving linear and non-linear partial differential equations related to fluid dynamics
- To emphasizes the basic underlying fluid mechanical principles governing energy transfer in a fluid flow system with their performances in different field of engineering applications.

Course Outcomes

- After completion of the course, the students will able to evaluate finite difference/volume schemes on model problems of computational fluid dynamics.
- Students will learn to develop steady state mechanical energy balance equation for fluid flow systems, estimate pressure drop in fluid flow systems

Module I: Introduction to Finite volume Method (6 hrs)

- Fundamentals of Finite volume methods, different types of finite volume grids, approximation of surface and volume integrals; interpolation methods, Review of governing equations
- Practice 1- 2D mapped Mesh for rectangular pipe
- Practice 2- 2D mapped Meshing for Aerofoil.

Module II: Grid generation (6 hrs)

- Grid generation, creating, updating and managing meshes, Steady diffusion equation on structured meshes, Unsteady diffusion equation on structured meshes, Finite volume discretization of convection-diffusion problem
- Practice 3- 3D structure mesh of Circular Cylinder
- Practice 4- 3D unstructured mesh with primes layers for Aerofoil
- Practice 5- 3D coarse/ medium/ fine sweep mesh for pipe

Module III: Incompressible flow field calculation with finite volume method(5 hrs)

- Navier-stokes equation, Discretization of the Momentum Equation: Stream Function-Vorticity approach and Primitive variable approach, Navier-stokes equation with finite volume method, boundary condition, Reynolds averaged Navier-Stokes's equations.

Module IV: Fluid kinematics (2 hrs)

- Types of flow, Continuity equation (in one, two& three dimension steady state fluid flow analysis with finite volume method, velocity and acceleration fields, streamline, streak line, path line, velocity potential function and stream function, Rotation and vorticity.

Module V: Fluid Dynamics with Finite volume method (4 hrs)

- Lagrangian and Eulerian Approach, Euler's equation of motion along a stream line

for ideal flow, Principle of conservation of energy with finite volume method, Integration of Euler's equation along a stream line, Bernoulli's equation

- Practice- 6. Fluid Analysis of Bernoulli's equation: Flow in a contracting pipe through CFD simulation

Module VI: Flow through Pipes (5 hrs)

- Reynolds's Experiment, Laws of Laminar and Turbulent Friction, Introduction Turbulence modeling through Finite volume method, Hagen Poiseulle Equation for laminar flow through pipe, Darcy-Weisbach Equation for Turbulent flow through pipe.
- Practice- 7. Simulation of Fluid Analysis of Laminar flow in 3D Circular Pipe through
- Practice-8. CFD Simulation of the Water Flow Passing Through a Converging Pipe.
- Practice-9. Analysis to determine the frictional losses in the pipe.

Module VII: Flow Measurement (5 hrs)

- Flow through small orifice meter, Mouthpiece, Velocity Measurement using Pitot tube, Prandtl tube, Flow measurement in pipes-Flow, Venturi Meter, Flow rate Measurement in channel- Weir and Notches
- Practice-10. CFD Analysis of Fluid flow through Orifice meter
- Practice -11.CFD Analysis of Fluid flow through adjustable channel
- Practice-12. Analysis of Fluid flow simulation through Venturi Meter

Text Books:

- R.K. Bansal, Fluid Mechanics and Hydraulic Machines, Laxmi Publications, ninth edition.

Reference Books:

- P.N. Modi & S.N. Seth, Hydraulics & Fluid Mechanics, Rajsons Publications Pvt. Ltd, Twentieth Edition

Source of reference; Online sources

1. https://nptel.ac.in/course.html
2. https://nptel.ac.in/courses/112/105/112105218/
3. https://nptel.ac.in/courses/112/105/112105183/
4. https://nptel.ac.in/courses/112/105/112105182/

Courseware link:

http://courseware.cutm.ac.in/courses/fluid-mechanics-hydraulic-machinery/

2.	CUTM1711	Fundamentals of Microbiology/ General Microbiology	4(3-1-0)

Course Objectives

- To know various Culture media and their applications and also understand various physical and chemical means of sterilization
- To know General bacteriology and microbial techniques for isolation of pure cultures of bacteria, fungi and virus
- To master aseptic techniques and be able to perform routine culture handling tasks safely and effectively

Course Outcomes

- This study demonstrates the theory and practical skills in microscopy and their handling techniques and staining procedures.
- Understanding the details of microbial cell organelles.
- Provides knowledge on the growth of microorganism.
- Provides knowledge culturing microorganism.

Module-I

- History and scope of Microbiology, Recent trends and developments in modern microbiology. Identification, characterization and classification of microorganisms. Distinguishing characteristics between prokaryotic and eukaryotic cells. Structure and function of Cell wall of bacteria, cell membranes, flagella, pili, capsule, gas vesicles, carboxysomes, magnetosomes and phycobolisomes.

Practice:

1. Demonstration the different type of Sterilization technique and operation of the Instruments used in microbiological lab.
2. Demonstration of various parts of microscope its functioning and care.

Module-II

- Methods of sterilization: Physical methods – Dry heat, moist heat, radiation methods, filtration methods, chemical methods and their application. Concept of containment facility, sterilization at industrial level. Different staining techniques used in bacteriology.

Practice:

3. Preparation of bacterial smear and staining – Gram's, Acid-fast, Staining of bacterial spores flagella, capsule, spirochaetes
4. Preparation of media, cultivation of bacteria

Module-III

- Bacterial nutrition – Nutritional requirement of bacteria. Cultivation of aerobes and anaerobes, Reproduction in bacteria and spore formation. Bacterial growth curve and bacterial nutrition Media. Culture Media, Liquid and solid media, defined and synthetic media, routine laboratory media (basal, enriched, selective, enrichment, indicator, and transport media).

Practice:

5. Biochemical tests for identification of bacteria
6. Preservation of stock cultures of bacteria

Suggested Readings

- Textbook of Microbiology- Ananthanarayan & Paniker (10th Ed)
- Medical Microbiology-by Fritz H. Kayser et al
- Medical Laboratory Technology by Kanai Lal Mukherjee, Publisher Tata McGrawHill
- Microbiology (7th Ed)- by Prescott
- Practical Book of Medical Microbiology by Satish Gupta, Publisher JaypeeBrothers
- Medical Laboratory Manual for Tropical Countries Vol. I and II by Monica Cheesbrough
- Essential Medical Microbiology- by Rajesh Bhatia (4th Ed)
- Clinical laboratory methods and diagnosis by Gradwohls, 2000, Publisher Mosby
- Medical laboratory science theory and practice, J Ochei and Kolhatkar, 2002, publisher TBS

Courseware link:

http://courseware.cutm.ac.in/courses/general-microbiology/

3.	CUTM1312	Bio chemistry/Fundamentals of Plant Biochemistry	3 (2+1+0)

Course Objectives:

- Understand the biochemistry plant defence mechanism, Identify the toxic compounds in plants
- Describe the kinetics and characterisation of enzymes, Identify the detoxification mechanisms.
- To provide education that leads to comprehensive understanding of the principles and practices of biochemistry.

Course Outcomes:

- In this course, students will extend their knowledge of biochemistry fundamentals and will learn about the significance of biochemistry and important metabolic processes taking place in plants.
- Acquire a detailed knowledge about the chemistry of carbohydrates, lipids, proteins and amino acids and their classification, structural organization of proteins, metabolism of saccharides, lipids.
- The students get acquainted with the widely used techniques in plant biochemistry like qualitative and quantitative tests for the important biomolecules.

	Theory: Importance of Biochemistry. Properties of Water, pH and Buffer. Carbohydrate: Importance and classification. Structures of Monosaccharides, Reducing and oxidizing properties of Monosaccharides, Mutarotation; Structure of Disaccharides and Poly saccharides. Lipid: Importance and classification; Structures and properties of fatty acids; storage lipids and membrane lipids. Proteins: Importance of proteins and classification; Structures, titration and zwitterions nature of amino acids; Structural organization of proteins. Enzymes: General properties; Classification; Mechanism of action; Michaelis & Menten and Line Weaver Burk equation & plots; Introduction to allosteric enzymes. Nucleic acids: Importance and classification; Structure of Nucleotides, A, B & Z DNA; RNA: Types and Secondary & Tertiary structure. Metabolism of carbohydrates: Glycolysis, TCA cycle, Glyoxylate cycle, Electron transport chain. Metabolism of lipids: Beta oxidation, Biosynthesis of fatty acids. **Practical**: Preparation of solution, pH & buffers, Qualitative tests of carbohydrates and amino acids. Quantitative estimation of glucose/ proteins. Titration methods for estimation of amino acids/lipids, Effect of pH, temperature and substrate concentration on enzyme action, Paper chromatography/ TLC demonstration for separation of amino acids/ Monosaccharides. Sterilization techniques. **References**: • Satyanarayana U,Textbook of biochemistry,2007, 3rd edition, Books and Allied (P) ltd, Kolkata. • Lehninger, Albert L., David L. Nelson, and Michael M. Cox. 2000. Lehninger principles of biochemistry. New York: Worth Publishers. • D T Plummer, An Introduction to Practical Biochemistry, 1987, 3rd edition,McGraw-Hill, USA. • S. Sadasivam and A. Manickam, “Biochemical Methods,” New Age International (P) Limited, New Delhi, Vol. 2. 1996, pp. 124-126. **Courseware link:** http://courseware.cutm.ac.in/courses/fundamentals-of-plant-biochemistry/		
4.	**CUTM 1088**	**Thermodynamics**	**3 (2+1+0)**
	Course Objectives • To know the laws of thermodynamics and conditions for energy transformation • To get familiarity with different thermodynamic properties of pure substances • To acquire knowledge of the temperature scales • To get familiarity with various laws of thermodynamics • To get familiarity with the various properties of steam **Course Outcomes** On completion of the course the student will be able to: • Apply the knowledge of thermodynamics to temperature scales		

	• Utilize the concepts of work and energy to evaluate control volumes as well as closed systems • Students will be able to do energy analysis and determine efficiency of various thermal devices • Students are able to identify steam proprieties from steam tables and Mollier charts. **Module I: Basic Concepts of Thermodynamics (4 hrs.)** • System, Surroundings, Universe, State, Thermodynamic Properties, Process, Types of Process, Reversible and Irreversible process, Quasi-static Process, Cycle, Point and path functions, Thermodynamic Equilibrium, Ideal gas, Ideal gas equation **Module II: Zeroth Law of Thermodynamics (4 hrs.)** • Zeroth Law of Thermodynamics, Temperature, Measurement of Temperature, Temperature Measuring Instruments, Relationship between Temperature Scales **Practice**: • Temperature measurement by using thermocouple, Thermistors and Resistance temperature detector (RTD) **Module III: Work Transfer and Heat Transfer (5 hrs.)** • Work Transfer, Sign Convention of Work, PdV Work for Various Quasistatic Processes, Heat Transfer, Different Modes of Heat Transfer **Practice**: • Simulation of Heat Transfer in Conduction, Convection and Radiation using Finite Element Method in Simulia (Plane Wall, Fin, Metal Rod) • Thermal Stress Analysis of IC Engine Piston using Simulia • Thermal Analysis of Intake Manifold of Engine using Simulia • Thermal Analysis of a Battery using Simulia **Module IV: First Law of Thermodynamics (6 hrs.)** • First Law of Thermodynamics Applied to Closed System, Energy, PMM1, Enthalpy, Specific Heat at Constant Volume and Constant Pressure, First Law of Thermodynamics Applied to Open System, Control Volume, Mass Balance and Energy Balance, Nozzle, Diffuser, Turbine, Compressor, Throttling Device, Heat Exchanger **Practice:** • Thermal Analysis of Nozzle, Diffuser, Turbine, Compressor, Boilor, Heat exchanger using Simulia **Module V: Second Law of Thermodynamics (5 hrs.)** Kelvin Planks statement, Clausius Statement, PMM2, Working of Heat Engine, Refrigerator and Heat Pump, Carnot Cycle & Carnot Theorem **Practice**:

	• Working of Refrigerator and Heat Engine **Module VI: Entropy (4 hrs.)** • Introduction to Entropy, Principle of Increase of Entropy, Clausius Inequality, Change in Entropy in Different Processes **Practice**: Entropy Change of Metal Bar with Temperature Gradient using Simulia **Module VII: Properties of Pure Substances (5 hrs.)** • Introduction to Pure Substance, Phase Change Processes of Pure Substances, T-V, P-V, P-T and H-S Diagram for Steam, Dryness Fraction of Steam, Different Types of Steam. Introduction to Steam Tables: Specific Volume, Pressure, Temperature, Enthalpy and Entropy **Practice**: • Conversion of water to steam • Determination of properties of steam from Mollier Chart **Text Books**: • P.K. Nag, "Engineering Thermodynamics", Tata Mcgraw-Hill Publishing Company Limited • Y.A Cengel, M. A Boles, "Thermodynamics an Engineering Approach", Tata Mcgraw-Hill Publishing Company Limited. **Reference Books**: • R K Rajput, "A Text Book of Engineering Thermodynamics ", Laxmi Publications Sontag,Borgnakke,VanWylen, " Fundamentals of Thermodynamics", Willey Publisher • Course outline Prepared by DrPSVRamanaRao and Prof. ManasRanjanPadhi Date:25.5.20. Source of reference; Udemy, Coursera,VirtualAmrita Laboratories Universalizing Education **Courseware link:** http://courseware.cutm.ac.in/courses/thermodynamics/		
5.	**CUTM1525**	**Heat and Mass Transfer**	**4 (2+1+1)**
	Course Objectives • To understand the basic concepts and mechanisms of heat and mass transfer under steady state and transient conditions. **Course Outcomes**		

	• Apply heat conduction equations to different surface configurations under steady state and transient conditions and solve problems. • Apply free and forced convective heat transfer correlations to internal and external flows through/over various surface configurations and solve problems. • Explain basic laws for radiation and apply these principles to radiative heat transfer between different types of surfaces to solve problems. • Apply diffusive and convective mass transfer equations and correlations to solve problems for different applications. **Module I: Conduction:** • Fourier's Law of Conduction, General Heat Conduction Equation in Different Coordinate Systems (No Derivation), One Dimensional Steady State Conduction in Plane Wall, Composite Wall, One Dimensional Steady State Conduction in Composite Cylinders and Composite Spheres with Convective Atmosphere. Electrical Analogy, Conduction with Internal Heat Generation. **Practice 1**: • To find the thermal conductivity of a material by the two slabs guarded hot plate method. **Project 1:** • Assignment on Conduction. **Module II: Fins and Transient Conduction:** • Overall Heat Transfer Coefficients, Critical Thickness of Insulation, Heat Transfer from Extended Surfaces, Effectiveness and Efficiency, Unsteady State Heat Conduction, Lumped Heat Capacity System and Lumped Capacitance Method. **Practice 2:** • To find the thermal resistance of the sample. **Project 2:** • Assignment on Fins and Transient Conduction. **Module III: Convection:** • Hydrodynamic and Thermal Boundary Layer, Principles and Governing Equations, Forced Convection: External Flow over a Flat Plate, Cylinder, Sphere and Non-Circular Ducts, Use of Empirical Relations, Internal Flow Through Pipe, Annular Spaces and Non-Circular Conduits, Natural Convection: Vertical, Horizontal, Inclined Surfaces. **Practice 3**:

- To determine the overall heat transfer coefficient at the surface of a given vertical metal cylinder by the natural convection method.

Practice 4:

- To verify Newton's Law of Cooling of different materials and different liquids.

Project 3:

- Assignment on Convection.

Module IV: Heat Transfer with Phase Change:

- Film Wise and Drop Wise Condensation, Boiling Heat Transfer, Regimes of Boiling.

Module V: Heat Exchangers:

- Types of Heat Exchangers, Heat Exchanger Analysis, LMTD, Overall Heat Transfer Coefficient, Heat Exchanger Effectiveness, NTU.

Practice 5:

- Determination of Effectiveness and Efficiency of Parallel Flow and Counter Flow Heat Exchanger.

Project 4:

- Assignment on Heat Exchangers.

Module VI: Radiation:

- Electromagnetic Spectrum, Black Body Emission, Emissive Power, Laws of Radiation, Nature of Black and Grey Bodies, Concepts, Radiation Shape Factor, Thermal Resistance and Electrical Analogy, Radiation Heat Transfer Between Two Surfaces, Reradiating Surface, Radiation Shield.

Practice 6:

- To find the emissivity of different material surface.

Project 5:

- Assignment on Radiation.

Module VII: Mass Transfer:

- Introduction, Analogy between heat and mass transfer, Mass diffusion, Fick's law of diffusion, boundary conditions, Steady mass diffusion through a wall, Mass convection.

Project 6:

	• Assignment on Mass Transfer. **Text Books:** • Mahesh M. Rathore, Engineering Heat Transfer , Jones & Bartlett Learning, 2011 • Yunus A. Cengel & Afshin J. Ghajar, "Heat and Mass Transfer-Fundamentals and Applications", McGraw Hill, 5th Edition 2015 • Yunus Cengel, Heat And Mass Transfer: Fundamentals And Applications, McGraw-Hill Higher Education, 2014 **Reference Books:** • C Sachdeva, Fundamentals of Heat and Mass Transfer • K. Rajput, Heat Transfer, Laxmi Publication **Courseware link:** http://courseware.cutm.ac.in/courses/heat-and-mass-transfer/		
6.	**CUTM1057**	**Basic Electrical Engineering**	**2(1-1-0)**
	Course Objectives • In this course, student will come to know about the Basics of Electrical Engineering, Currents and Voltages across various Electrical elements. • Their behavior in both Alternating Current and Direct Current circuits. • Analysis of 1-phase and 3-phase AC wave forms. **Course Outcomes** • Student will be exposed to the breadth of electrical engineering, able to gain knowledge in Electrical Circuits (AC and DC). • Acquire knowledge on various parameters of electrical engineering and their properties with hands-on-practice of basic electrical experiments. • Acquire basic knowledge on electromagnetism. • Application of electromagnetism in generating electricity. • Knowledge gain on AC 1-ϕ and 3-ϕ circuits. **Module I: Basic Concepts and Basic Laws (4 hrs.)** **Theory** • Essence of Electricity, Electric Field; Electric Current, Potential and Potential Difference, E.M.F., Electric Power, Ohm's Law, Basic Circuit Components, Ideal and Practical Sources, Source Conversion. **Practice:** 1. Design and Analysis of Basic electrical circuits using Dymola. Plotting the V-I Characteristics of Incandescent lamp using Dymola. **Module II: Methods of Analysis (4 hrs.)** **Theory**		

- Network Analysis using Series and Parallel Equivalents, Voltage and Current Divider Circuits, Nodal Analysis, Mesh Analysis, Delta-Star & Star-Delta conversion.

Practice

2. Verification of KCL and KVL in series and parallel circuits using Dymola.

Module III: DC Network Theorems (3 hrs.)

Theory

- Analysis of Superposition, Thevenin's and Norton's theorem.

Practice:

3. Verification of Superposition, Thevenin's and Norton's theorem using Dymola.

Module IV: Introduction to Electromagnetism (4 hrs.)

Theory

- Magnetic Circuits, B-H curve, Permeability, Reluctance, Solution of simple magnetic circuits, Hysteresis and Eddy current loss. Methods of preventing such losses. Solenoids and field coils. Application of solenoids in different circuits in Automobiles and in electrical circuit.

Practice (Hardware):

4. Observation of generation of magnetic flux for different input current in a coil and plotting B-H Curve.

Module V: Single-Phase Transformer (2 hrs.)

Practice (Hardware):

5. Study of Transformers, Linear Transformer Model, Ideal Transformer Model, No-load Loss and Load-loss Calculation.

Module VI: AC Circuit Analysis (3 hrs.)
Theory

- Single-phase EMF Generation, Waveform and Phasor Representation, Average and Effective value of sinusoids, Peak factor & Form factor, Complex Impedance and Power using j-operator, Power factor.

Practice:

6. Calculation of current, voltage, power & power factor of series RLC circuit excited by 1-Ø A.C Supply using Dymola.

	Module VII: Phasor Analysis (3 hrs.) **Theory** • Three-Phase AC Circuits: Comparison between single-phase and three-phase systems, Three-phase EMF Generation, Line and Phase quantities in star and delta networks, Power and its measurement in three-phase balanced circuits. **Practice** 7. Measurement of power and power factor in a 3-Ø AC circuit by (one, two and three) wattmeter using Dymola. **Recommended Books**: • P. K. Sathpathy, "Basic Electrical Engineering," 3rd Edition, Oxford. • B. L. Thereja, "Electrical Technology", Volume-I,2005 Edition (24th Revised Edition) • Hughes, "Electrical & Electronic Technology", Ninth Edition (Revised by J Hiley, K Brown, and I Smith), Pearson Education **Courseware link:** http://courseware.cutm.ac.in/courses/basic-electrical-engineering/		
7.	**CUTN1074**	**Design of Structures**	**4 (1-3-0)**
	Course Objectives • To teach the basic theoretical aspects and contemporary issues in the design and fabrication of reinforced concrete members. • To teach the basic fundamental behavior of different section, bolts, members of steel structure used in construction. • To analyze and design of Concrete Structures and Pre-Engineered Building (PEB) by using Software ETABS **Course Outcomes** • To gain the knowledge of RCC design calculation with relevant Indian Standards. • After completion of the courses the students will gain knowledge of Pre-Engineered design calculation with relevant Indian Standards. • Students will develop skill of converting client's requirement to structural drawing by using ETABS. **Module I: Building Structural Frame (9 Hours):** • Introduction to Reinforced Concrete, Mechanical Properties of Concrete, Flexural Analysis, Combined Flexure and Axial Load, Shear analysis. Limit State Method using Indian Standard Codes. **Practice:** 1. Draw grids, Reference planes and joints, create new project models and introduction of the layout. (2hr)		

- 2. Draw building structural frame and define material properties (4hrs)

Module II: Load definition to Building frame (5 Hours)

- Modeling of Building, Load Calculations, Seismic weight, Base shear, Storey shear, Mass source, diaphragm, Meshing of Slab.
- **Practice:**
  3. Building structural frame- Define Properties, Material, Section, Mass source, Load pattern, load combinations
- Define Section Properties + Section Property Modifiers (1hr)
- Load Pattern (Gravity Loads + Earthquake (seismic) Loads (0.5hr)
- Wind Loads, Dead loads, super dead loads and live loads introductory(0.5hr)
- Define Load combination (Manual+Auto)(0.5hr)
- Meshing for Slabs, Walls, beams and Columns (0.5 hr)
- Assign Loads to structure as per IS Codes (0.5)
- Define Mass Source (For Lateral analysis)(0.5 hr)
- Pier Labels and Spandrel Labels for shell members such as shear walls and retaining RCC walls (1hr)

Module III: Analysis and check for Safety (10 Hours):

- Analysis checks, Post design checks, Pushover analysis, response spectrum analysis, time history analysis.

Practice:

4. P Delta Analysis Check (How to include P-delta effects) (2hr)
5. Center of Mass and Center of Rigidity (and Building Eccentricity Check)(1hr)
6. Mass (Weight) Irregularity check as per the code (1hr)
7. Story Displacement, Story Drift checks as per code (1hr)
8. Torsional Irregularity check(1hr)
9. Modal Analysis Case [Eigen or Ritz Vectors], Time period (1hr)
10. Time History Analysis (2hrs)

Module IV: Reinforcement Detailing and scheduling (6 Hours):

Reference of IS codes IS SP 34-1987 (Theory) (1hr)
IS 13920-1993 Ductile Detailing of RC structures (Theory) (1 hr)

Practice:

11. Detailing of Beams, Columns and slabs using Autocad (4hr)

Module V: Design of Foundations using SAFE foundation (6 Hours):

Introduction to SAFE foundation, familiarizing tools used in SAFE foundation. Types of foundations introduction, isolated footing design, combined footing design and mat foundation design.

Practice:

12. Importing ETABS model file into the SAFE foundation software (0.5 hr)
13. design of isolated footing (1 hr)
14. design of combined footing (1 hr)
15. design of mat foundation (1 hr)

Module VI: Materials and Specifications of Steel/ Pre-Engineered Building (PEB) Structures (06 Hours):

- PRE-ENGINEERED BUILDING COMPONENTS: Primary System: Main frames, Gable End Frame - Secondary frame system: Sizes and Properties of Purlins & Girts – Bracing System: Rod, angle, Portal, Pipe bracing – Sheeting and Cladding: Roof Sheeting and Wall sheeting – Accessories: Turbo Ventilators, Ridge vents, Sky Lights, Louvers, Insulation, Stair cases.
- **Practice:**
  16. DESIGN LOADS ON PRE-ENGINEERED BUILDINGS. Design of PEB frame under the influence of Dead, Live, Collateral, Wind, Seismic and Other applicable Loads. Serviceability Limits as per code IS:800. (4hrs)

Module VII: PEB DESIGN METHODOLOGY (8 Hours):

- **Practice:**
  17. Design Parameters of PEB Frames - Depth of the section, Depth to Flange width ratios, Thickness of Flange to thickness of Web ratio. d/tw, bf/tf ratios of sections as per IS code. Section Sizes as per Manufacturing Limitations. Analysis and Design of Rigid Frames. Rigid Frame Moment Connection, Shear Connection-Anchor bolt and base plate design (Pinned and Fixed). (8hrs)

Text Books:

- Reinforced Concrete design-S. N. Sinha. Tata McGraw-Hill, New Delhi
- S K Duggal," Design of steel structures", 2012.
- S. Ramamurtham and R. Narayan," Design of steel structures" ,2014

Courseware link:

http://courseware.cutm.ac.in/courses/design-of-structures/

8.	CUTM1143	Dairy and Food Engineering	3(2-0-1)

Course Objectives

- To impart knowledge on unit operations of dairy products and study of design and layout of dairy plants.

Course Outcomes

- Acquaint the students with various dairy engineering operations such as homogenization, pasteurization, thermal processing, evaporation, freezing, and drying of milk.
- Understand the different types of equipment and their working principles used for processing and dairy and food products.
- Learn to design a dairy plant layout.

Module-I: INTRODUCTION, MILK PROPERTIES (3 h)

- Dairy development in India, Engineering, thermal and chemical properties of milk and milk products, Process flow chart for product manufacture, Principles and

equipment related to receiving of milk.

Project (1 hr):

- Write a two-page note on dairy development in India and Orissa since independence.

Module-II: DIFFERENT PROCESSING METHODS OF MILK (8 h)

- Principles, Equipment's, Controls used in Pasteurization, sterilization, homogenization, centrifugation, cream separation. Evaporation of food products: principle, types of evaporators, steam economy, multiple-effect evaporation, vapour recompression, Thermal Compression

Project (3 hr):

1. Writing a term paper on Ultra High-Temperature Pasteurization of Milk: Kinetics of Microbial Destruction and Changes in Physico-chemical Characteristics.
2. Estimation of cream yield by using Domestic cream separator present in Mini Dairy plant in CUTM Campus.
3. Estimation of Steam Economy, Mass and Energy calculation in an Evaporator.

Module-III: VALUE ADDITION, FILLING AND PACKAGING OF MILK (4 h)

- Preparation methods and equipment for the manufacture of cheese, *paneer*, butter and ice cream, Different packaging material used for packaging of milk and milk products, filling of milk: Principle and Equipment for filling of Liquid milk, Pasty milk products, and power.

Project (3 hr):

1. Preparation of Paneer from different varieties of milk and compare the paneer yield.
2. Estimation of packaging capacity and efficiency of form-fill-seal machine present in the Mini Dairy plant of CUTM Campus for packaging of milk.

Module-IV: DRYING AND SEPARATION METHODS (5 h)

- Drying of liquid and perishable foods: principles of drying, vacuum tray drying, spray drying, drum drying, freeze-drying, Filtration: principle, types of filters; Membrane separation, RO, Nano-filtration, Ultrafiltration and Macro-filtration, equipment and applications. Dairy plant design and layout, Plant utilities

Project (5.5 hr):

1. Preparation of dried mushroom in the Vacuum self-dryer and compare the rehydration quality with hot air tray dryer (2hr)
2. Preparation of Freeze-dried bitter gourd and compared the rehydration quality with tray drying.
3. Estimation of refrigeration requirements of Mini dairy plant present in the CUTM

Campus.

4. Prepare the layout of any dried vegetables manufacturing plant producing 100 kg product per day (1 hr)

References:

- Ahmed, T. 1997. Dairy Plant Engineering and Management. 4th Ed. Kitab Mahal.
- McCabe, W.L. and Smith, J. C. 1999. Unit Operations of Chemical Engineering.
- Mc Graw Hill. Rao, D.G. Fundamentals of Food Engineering. PHI learning Pvt. Ltd. New Delhi.
- Singh, R.P. & Heldman, D.R. 1993. Introduction to Food Engineering. Academic Press.
- Toledo, R. T. 1997. Fundamentals of Food Process Engineering. CBS Publisher.

Courseware link:

http://courseware.cutm.ac.in/courses/dairy-food-process-engineering/

BASKET-IV. B

(Core Dairy Technology Courses)
(Total Credits: 64)

1.	CUTM1144	Milk Production Management and Dairy Development	3 (2+1+0)

Course Objectives

- To acquaint the students about different types of indigenous breed of cattle and buffaloes.
- To provide basic inputs about production, planning and management of dairy farms as well as development of clean milk production.

Course Outcomes

- To develop basic idea about animal husbandry and to learn farm management practices.
- To generate knowledge about the milk production channel in dairy animals and feed resources.
- To access knowledge on reproduction cycle of dairy animals and to familiarize with different bio-techniques.

Module-I: Animal Husbandry and Exotic Breeds (3 hrs)

- Introduction to Animal Husbandry
- Distinguishing characteristics of India and exotic breeds of dairy animals and their performance.
- Systems of breeding and methods of selection of dairy animals.

Module-II: General Dairy Farm Practices (5 hrs)

- 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.
- Systems of housing dairy animals and maintenance of hygiene and sanitation at dairy farm premises.

Practice (4.5 hrs)

- Handling and restraining of dairy animals.
- External body parts and judging of cows and buffaloes.
- Feeding and management practices of calves.
- Milking of dairy animals and cleaning and sanitation of milking equipment.

Module-III: Dairy Farm Records and Disease Problems (2 hrs)

- Dairy farm records and their maintenance.
- Common disease problems in dairy animals, their prevention and control.

Module-IV: Animal Feed Nutrients and its Standards (5 hrs)

	• Feed nutrients required by animal body. • Feed resources for milk production and their nutritive values. • Digestive system of ruminants and measures of feed energy. • Nutrients requirements for growth and milk production. • Feeding standards. **Practice (4 hrs)** • Identification of common feeds and fodders. • Preparation of rations for adult animals. **Module-V: Animal Reproductive System and Artificial Insemination (5 hrs)** • Structure and function of mammary system, milk secretion and milk let-down. • Male and female reproductive system. • Estrus and reproductive cycle, Ovulation, fertilization, gestation, parturition, pregnancy diagnosis. • Artificial insemination and embryo transfer and their role in animal improvement introduction to bio-techniques in dairy animal production. **Practice (4 hrs)** • Identification of reproductive and digestive organs. • Demonstration of semen collection, processing and artificial insemination. ***Suggested Readings*** • Handbook of Animal Husbandry- ICAR, New Delhi • A Textbook of Animal Husbandry- G. C. Banerjee. **Courseware Link** • http://courseware.cutm.ac.in/courses/milk-production-management-and-dairy-development/		
2.	**CUTM1145**	**Physical Chemistry of Milk**	**3 (2+1+0)**
	Course Objectives • Knowledge about the physical composition on milk of different species like density, viscosity, surface tension etc. • Knowledge of the colligative property, electrical conductivity of milk. • Knowledge about the spectrophotometric method, NMR spectroscopy. • Knowledge about nuclear chemistry related to milk. **Course Outcomes** • Students will be able to explain the milk as colloidal system along with its properties		

such as density, specific gravity etc.
- Determine the electrical conductance redox potential of milk and pH etc.
- To know about the field of molecular spectroscopy, nuclear chemistry related to milk.

Module I: Colloid, emulsion density, specific gravity, surface tension and viscosity (7 hrs)

- Constituents and gross composition of milk of different species and breeds of milch animals
- Colloidal State: Distinction between true and colloidal solution, lyophilic & lyophobic solution, properties of colloidal system. Properties of colloidal systems
- Gels-their formation and properties. Milk as a colloidal system and its stability. Elementary idea about emulsion.
- Density: Density and specific gravity, pyknometer 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 normal milk, evaporated milk and condensed milk. Refractive index.

Practice (4 hrs)

- Determination of density and specific gravity of milk using pycnometer, hydrometer and lactometer.
- Determination of viscosity of milk using Ostwald viscometer.
- Determination of surface tension of milk using Stalagmometer. Interfacial tension between water-oil phases.
- Determination of refractive index of skim milk and whey.

Module II: Colligative properties and electrical conductivity (4 hrs)

- 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. Inter-relation of colligative properties
- Aqueous solution of Electrolytes: Electrolytes; non-electrolytes, ionic mobility, electrical conductance, Ostwald Dilution Law, Kohlrausch's Law
- Electrical conductance of milk. Ionic Equilibria: Dissociation of water, ionic product of water

Practice (2 hrs)

- Determination of freezing point of milk.
- Determination of electrical conductance of milk.

Module III: Concept of pH, pOH, Oxidation reduction potential of milk (6 hrs)

- 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- Hasselbach equation and it 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.

Practice (5 hrs)

- Preparation of a buffer solution. Determination pH of buffer solution and milk electrometrically.
- Determination of acidity of milk electrometrically.
- Titration of amino acid in the presence and absence of formaldehyde.
- Determination of redox potential of milk.
- Coagulation of milk using electrolytes.

Module IV: Nuclear chemistry and molecular spectroscopy (3 hrs)

- Nuclear Chemistry: The nature of isotopes, radio isotopes. Half-life period of radio isotopes. Some of the important radio isotopes. Occurrence of radio nuclide in milk & milk products.
- Molecular Spectroscopy: The spectrum of electromagnetic radiation, the laws of Lambert and Beer
- Visible and ultra-violet Spectroscope. Mention of mass, NMR spectroscopy.

Practice (1 hr)

- Determination of PKa1 PKa2 and PL. Verification of Lambert Beer Law.

Suggested Readings

- K. S. Sharma, Physical chemistry of milk, Agrimoon.com
- Ling, E. R. 2008. A Textbook of Dairy Chemistry. J. V. Publ. House, New Delhi.
- Mathur, M. P., Datta, R. D., and Dinakar, P. 2005. Textbook of Dairy Chemistry. Indian Council Agricultural Research Publ., New Delhi.
- Webb, B. H., Johnson, A. H., and Alford, J. A. 1965. Fundamentals of dairy chemistry. AVI Publ. Co., New York.
- Walstra, P., Jenness, R. and Badings, H. T. 1984. Dairy Chemistry and Physics. 1st ed. Wiley-Inter science, New York.

Courseware Link

- http://courseware.cutm.ac.in/courses/physical-chemistry-of-milk/

3.	CUTM1146	Market Milk	3 (2+1+0)

Course Objectives

- To introduce about the processes involved in the market milk of India and several countries.
- To understand the reception and pre-processing of fluid milk in the dairy plant.
- To provide in-depth knowledge for manufacturing different kinds of milk to be marketed.

Course Outcomes

- Explain the list of pre-treatments of milk in dairy processing plant.
- Describe aseptic packaging as well as detect adulterants in milk.
- Able to prepare special types of milk (toned, double toned, standardized, flavoured, sterilized).

Module-I: History of dairy developments in India (2 hrs)

- Dairy development in India: before and after operation flood.
- Milk production and consumption statistics in India and abroad.

Module-II: Clean milk production and procurement (4 hrs)

- Clean milk production practices.
- Milk collection system and pricing policies.
- Preservation of raw milk and Lactoperoxidase system.
- Milk transportation and storage.

Practices (2 hrs)

- Familiarization with equipment's for reception of milk in plant.
- Pre-treatments: Chilling, clarification and filtration.

Module-III: Physico-chemical, microbiological and nutritional properties of milk (2 hrs)

- Macro and micro components of milk.
- Microbiological and nutritional properties of milk.

Practices (2 hrs)

- Detection of adulterants and preservatives in milk.

Module-IV: Common dairy processing operations and processed milk varieties (10 hrs)

- Reception, chilling and storage of milk.

- Filtration, clarification and separation of milk.
- Bactofugation: theory and principles.
- Standardization of milk.
- Homogenization: Principles, theory, types, operation and effect on milk properties.
- Principles of heat treatment and kinetic parameters of heat induced changes.
- Heat Exchangers: Plate and Tubular Type and working of HTST pasteurizer.
- Sterilization: Definition, purpose and methods.
- UHT milk: homogenization, packaging and defects.
- Processed and special milks varieties and standards.

Practices (6 hrs)

- Cream separation: Parts of separator and the process.
- Operation of LTLT, HTST pasteurizer, laboratory sterilizer.
- Standardization and numerical calculation.
- Assessment of homogenisation efficiency in milk.
- Preparation of special milks: toned, double toned.
- Preparation of special milks: standardized, flavoured, sterilized milk.

Module-V: Cleaning, sanitization and packaging of milk (4 hrs)

- Common dairy detergents and their properties.
- Dairy sanitizers and their properties.
- Cleaning and sanitization protocols: CIP and SIP.
- Packaging: Materials and process.

Practices (2 hrs)

- Cleaning of storage tanks, cream separators and HTST plants (1hr).
- Strength of common detergents and sanitizers used in market milk plant (1hr).

Suggested Readings

- Tufail Ahmed: Dairy Plant Engineering and Management.
- G. Kessler: Food Engineering and Dairy Technology.
- Sukumar De: Outlines of Dairy Technology.
- Kainth, G. S. 1998. India's Rural Co-operatives. Daya Books, New Delhi.
- Thompkinson, D. K. and Sabikhi, L. 2012. Quality Milk Production and Processing Technology. Xxvii+ 274 pp. New India Publishing Agency, New Delhi.
- Banerjee, J.C. 1999. A Textbook of Animal Husbandry. 8th Oxford and IBH Publishing Company Pvt. Ltd., Bombay.

Courseware Link

- http://courseware.cutm.ac.in/courses/market-milk/

4.	CUTM1147	Traditional Indian Dairy Products	3 (2+1+0)

Course Objectives

- To provide students in depth knowledge on status and significance of traditional Indian milk products.
- To know the methods of preparation and enhancement of shelf life of the prepared products by preservation methods.

Course Outcomes

- Able to prepare a great assortment of dairy products such as burfi, peda, kalakand, milk cake, gulabjamun, sandesh, rosogolla, kheer, rabri etc.
- Explain the standard methods of manufacture of different dairy based products.
- Explain the advances in preservation and packaging of products.

Module-I: Introduction to Traditional Indian Dairy Products (1 hr)

- Traditional Indian milk products and their classification.

Module-II: Khoa and khoa based sweets (4 hrs)

- Types of khoa, standards methods of manufacture and preservation, factors affecting yield of khoa.
- Burfi, Peda and Milkcake: Product description, compositional profile and manufacturing practices.
- Kalakhand and Gulabjaman: Product description, compositional profile and manufacturing practices.
- Rabri and Basundi: Product description, process description, factors affecting yield, physico-chemical changes during manufacture.

Practice (4 hrs)

- Preparation of khoa from cow, buffalo and concentrated milk.
- Preparation of Burfi, Peda and Milkcake.
- Preparation of Kalakand and Gulabjamun.
- Preparation of Rabri and Burundi.

Module-III: Chhana and Chhana based sweets (3 hrs)

- Chhana: Product description of channa, standards method of manufacture, packaging, preservation and associated defects.
- Chhana-based sweets: Rasogolla, Sandesh, Rasomalai.
- Paneer: Product description, standards, method of manufacture, packaging and preservation.

Practice (3 hrs)

- Preparation of Chhana from cow and buffalo milk and mixed milk.

	• Preparation of Sandesh and Rasogolla. • Preparation of Paneer from cow, buffalo and mixed milk. **Module-IV: Fermented and Cereal dairy products (3 hrs)** • Dahi/Misti Dahi: Preparation Methods, quality of dahi, packaging, shelf life and defects. • Chakka/Maska and Shrikhand: Product description, standards, method of manufacture, small scale and industrial process of production, packaging and preservation aspects. • Kheer and Payasam: Product description methods of manufacture, innovations in manufacturing and packaging processes. **Practice (3 hrs)** • Preparation of Dahi and Misti Dahi. • Preparation of Chhaka and Shrikhand. • Preparation of Kheer. **Suggested Readings** • Sukumar De: Outlines of Dairy Technology • Aneja, R. P., Mathur, B. N., Chandan, R. C. and Banerjee, A. K. (2002). Technology of Indian Milk Products. A Dairy India Publ., Delhi, India. **Courseware Link** • http://courseware.cutm.ac.in/courses/traditional-indian-dairy-products/		
5.	**CUTM1148**	**Microbiology of Fluid Milk**	**3 (2+1+0)**
	Course Objectives • To understand the specific group of microorganisms associated with raw milk. • To acquaint the students about the types of spoilage and public health aspects of fluid milk. • To provide in depth knowledge on clean milk production and management strategies. **Course Outcomes** • Able to estimate microbial quality and microbial load in raw milk. • Determine the mastitic milk from raw milk. • Demonstrate the sources of contamination of raw milk. **Module-I: Microbes associated with raw milk (4 hrs)** • Significance of specific groups of microorganisms in milk i.e. psychrotrophic, mesophilic, thermoduric and thermophillic bacteria - their morphological and biochemical characteristics and classification. • Microbial contaminants in raw milk, their sources during various stages of production -		

milking, chilling, storage and transportation with special reference to psychrotrophic microorganisms.
- Microbiological changes in bulk refrigerated raw milk.

Practice (4 hrs)

- Morphological examination of common dairy microorganisms (size and shape, arrangement and sporulation).
- Enumeration of psychrotrophic, thermophillic, thermoduric and spore forming bacteria in raw and market milk.
- Estimation of microbial load in raw milk by standard plate count (SPC) and dye reduction tests (MBRT, RRT).

Module-II: Sources of contamination and microbial spoilage of raw milk (4 hrs)

- Sources of contamination and microbial spoilage of raw milk.
- Types of microbial spoilage - souring, curdling, bitty cream, proteolysis, lipolysis, abnormal flavours and discolouration.
- Mastitis milk - types of mastitis, causative micro-flora of mastitis, compositional and microbiological changes during mastitis infection, their processing and public health.

Practice (4 hrs)

- Spoilage of milk caused by microorganisms: souring, sweet curdling, gassiness, lipolysis, ropiness, proteolysis and discolouration.
- Detection of mastitis milks: pH, SLST, somatic cell count, chloride content, Hotis test and CAMP test.

Module-III: Concept of clean milk production (5 hrs)

- Hygienic milk production system; Cleaning and sanitation of udder, animal, utensils, equipments and dairy farm environment.
- Microbiological quality of milk produced in organized and un-organized sector in India and comparative information in developed world.
- Microflora of aseptically drawn milk and its natural antimicrobial systems - immunoglobulins, lactoferrin, lysozyme and lactoproxidase (LP) system.

Practice

- Detection of sources of contamination: Air, water, utensils, equipment and personnel.

Module-IV: Microbiological aspects of fluid milk processing (3 hrs)

- Microbiological aspects of pasteurization, boiling, sterilization, ultra-high temperature (UHT)
- Microbiological aspects of non-thermal (pulsed field) micro-filtration, bactofugation, standardization and homogenization.
- Bio-film formation during processing and their control measures.

Practice (1 hr)

- Detection of sources of contamination by line testing.

Module-V: Public health aspects of fluid milk (4 hrs)

- Microbial zoonotic diseases transmitted through fluid milk.
- Milk borne diseases -food infection, intoxication and toxi-infection caused *E. coli*, *Salmonella typhi*, *Staphylococcus aureus*, *Bacillus cereus*, *Listeria monocytogenes*, *Shigella* species, *Campylobacter* etc.
- Microbiological grading and legal standards of raw and processed milk.

Practice (2.5 hrs)

- Detection and estimation of coliforms: presumptive, rapid coliform and IMViC Test (1.5 hr).
- Grading of processed/ market milk by total viable count, coliform and methylene blue reduction time.

Suggested Readings:

- Robinson, R.K. 2002. Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products. 3rd ed. Wiley-Interscience, New York.
- Marth E.H. & Steele J. 1998. Applied Dairy Microbiology- 2nd ed. Taylor and Francis, New York.
- Jadav J.S., Grover S., Batish V.K., A comprehensive Dairy Microbiology, Metropolitan, New Delhi.

Courseware Link

- http://courseware.cutm.ac.in/courses/microbiology-of-fluid-milk/

6.	CUTM1149	Chemistry of Milk	3 (2+1+0)

Course Objectives

- Acquaint students with the definition, chemical composition and structure of milk.
- To impart knowledge regarding classification of milk proteins, milk enzymes, milk carbohydrates, milk lipids and milk salts etc.
- Demonstrate metallic contamination of milk.

Course Outcomes

- Able to determine total milk protein, fat content, total solids and SNF in milk.
- Estimate different enzymes such as alkaline phosphate and lipase in milk.
- Determine the content of lactose, ash, phosphorous and calcium in milk.

Module-I: Milk definition, composition and variation

	• Definition, structure of milk and factors affecting composition of milk **Practice (2 hrs)** • Sampling techniques of chemical examination of milk • Determination of pH and titratable acidity of milk **Module-II: Milk Proteins (5 hrs)** • Casein: Isolation, fractionation and chemical composition, physico-chemical 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-proteins 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. **Practice (2 hrs)** • Determination of casein, whey proteins and NPN in milk. • Determination of total milk proteins by Kjeldahl method. **Module-III: Enzymes in milk (2 hrs)** • Milk enzymes with special reference to lipases, Xanthine Oxidase, phosphatases, proteases and lacto-peroxidase **Practice (1 hr)** • Estimation of alkaline phosphatase and lipase in milk. **Module-IV: Milk Carbohydrates (4 hrs)** • Milk carbohydrates their status and importance. • Physical and chemical properties of lactose • Sugar amine condensation, amadori rearrangement, production of hydroxyl methyl furfural (HMF), Processing related degradation of lactose **Practice (1 hr)** • Determination of lactose in milk. **Module-V: Milk lipids (4 hrs)** • 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 • Fat soluble vitamins **Practice (2 hrs)** • Determination of fat in milk by different methods. • Determination of total solids and solids not fat in milk **Module-VI: Salt composition and metals (3 hrs)** • Milk Salts: Mineral in milk (a) major mineral (b) Trace elements • Physical equilibria among the milk salts • Milk contact surfaces and metallic contamination. **Practice (5 hrs)** • 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. **Suggested Readings** • Fox, P. F. and Sweeny, Mc. (1998). Dairy Chemistry and Bio-Chemistry. Academic /Platinum Publ., NewYork. • Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi. • Mathur, M.P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi. **Courseware Link** • http://courseware.cutm.ac.in/courses/chemistry-of-milk/

7.	**CUTM1150**	**Fat Rich Dairy Products**	**3 (2+1+0)**
	Course Objectives • To understand processing conditions of different types of fat rich dairy products (cream, butter, and ghee) and their status in India and abroad. **Course Outcomes** • Understand the different fat rich dairy products and their status in India and abroad. • Processes and manufacture of cream, butter, and ghee as per legal standards and guidelines.		

- Packaging, storage and compositional changes of cream, butter, and ghee.

Module-I: Introduction to fat rich dairy products

- Status and types of fat-rich dairy products in India and abroad.

Module-II: Cream production, processing, and quality evaluation (6 hrs)

- Definition and legal standards, efficiency of cream separation and factors affecting it; control of fat concentration in cream.
- Planning and operating a cream production unit neutralization, standardization, pasteurization, and cooling of cream.
- Preparation and properties of table cream, sterilized cream, and whipped cream, plastic cream, frozen cream, and chip-dips (cultured cream).
- Factors affecting quality and ripening of cream
- Packaging, storage, and distribution of cream
- Defects (non-microbial) in cream and their prevention.

Practices (4 hrs)

- Standardization and neutralization of cream (2 hrs).
- Pasteurization, sterilized cream and cooling of cream (2 hrs).

Module-III: Butter production, processing, and quality evaluation (6 hrs)

- Definition, classification, composition and uses of butter
- Theory of churning and legal standards and technology of butter manufacture by batch, and continuous methods.
- Over-run in butter; control of fat loses in buttermilk.
- Packaging and storage; transportation; defects in butter; rheology of butter
- Construction, operation, care and maintenance of cream separators, coolers and vacreator
- Factory butter churn and continuous butter making machine.

Practices (5 hrs)

- Study of construction and cooperation of the power operated butter churner.
- Study of construction and cooperation of 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.

Module-IV: Special butters and related products (3 hrs)

- 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.

	• Manufacture, packaging, storage, and characteristics of margarine. **Module-V: Ghee and butter oil (4 hrs)** • Ghee making batch and industrial processes, innovations in ghee production, • Procedure, packaging, and preservation of ghee; utilization of substandard • Composition and changes during manufacture of fat constants in ghee. • Manufacture of butteroil, packaging and storage. **Practices (3 hrs)** • Preparation of ghee from cream and butter. • Study and operation of continuous ghee plant. **Suggested Readings** • Anantakrishnan, C. P. and Srinivasan, M. R.1964. Milk Products of India. ICAR Publications, New Delhi. • Aneja, R. P., Mathur, B. N., Chandan, R. C. and Banerjee, A.K. 2002. Technology of Indian Milk Products. A Dairy India Publication, Delhi. • Bhattacharyya, D. K., Pal, P. K. and Ghosh, S. 2000. Isopropanol Fractionation of oil butter and characteristics of fractions. JAOCS 77: 1215–1218. • De, S.1980. Outlines of Dairy Technology. Oxford University Press, Delhi. • Rangappa, K. S. and Acharya, K. T. 1974. Indian Dairy Products. Asia Publishing House, New Delhi **Courseware Link** • http://courseware.cutm.ac.in/courses/fat-rich-dairy-products/		
8.	**CUTM1151**	**Microbiology of Dairy Products**	**(1+1+0)**
	Course Objectives • To educate students about the microorganisms and their significance associated with different dairy products. • Imparting knowledge on different microbial associated defects of the products. • To disseminate recent information on microbiological standards and bio-preservation of dairy products. **Course Outcomes** • Acquire knowledge on micro-environment of different indigenous dairy products. • Explain the public health significance of various dairy products. • Implement the packaging concepts in dairy industry to avoid spoilage and enhance shelf-life of dairy products. **Module-I: Microbiology of Cream and Butter (3 hrs)**		

	• Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in cream and butter; Microbiological aspects including defects in pasteurized (ripened/ unripened cream), sterilized and UHT cream. • Micro-environment and impact of critical process factors on entry of spoilage and pathogenic organisms in butter • Factors influencing the microbial growth during batch/continuous butter making process; Microbial Defects in butter - Bacterial/mold discoloration, enzymatic deterioration and their control measures; Regulatory microbiological standards. **Practice (4 hrs)** • Microbiological examination of raw and pasteurized cream for Standard plate count (SPC), coliform counts direct microscopic count (DMC), lipolytic, proteolytic counts and dye reduction tests. • Microbiological examination of salted and unsalted butter for SPC, coliforms, yeast and mold count, psychrotrophic, lipolytic and proteolytic counts. **Module-II: Microbiology of Condensed, Evaporated and Dried Products (3 hrs)** • Type of microorganisms associated with condensed and evaporated milks, their growth/ survival during manufacture and storage. • Microbial defects - Bacterial thickening / Mold button formation in SCM; Gassiness/bloating, Bacterial coagulation (Sour and sweet), Bitterness, Fishy flavor in evaporated milk. • Pre-heating/DSI temperature and their impact on microflora of dried products; Effect of reconstitution on microbial quality of milk powder including baby foods and survivability of pathogens; Regulatory microbiological standards. **Practice (3 hrs)** • Microbiological examination of concentrated milk for SPC, coliforms, yeast and mold counts, thermoduric, thermophilic and spore counts. • Microbiological examination of dried milks for SPC, coliforms, *S. aureus, B. cereus, E. coli, Salmonella* **Module-III: Microbiology of Ice Cream and Indigenous Milk Products (2 hrs)** • Microenvironment in ice cream, microbiological quality of ingredients, critical process factors and their impact on entry of pathogens in ice cream and frozen desserts, their survival during storage, food poisoning out breaks and legal standards. • Microbiology of Indigenous Milk Products: Predominance of spoilage and pathogenic organisms in khoa and khoa based sweets – burfi, peda, gulabjamun, etc., paneer, Chhanna and Chhanna based sweets – rasogulla; kheer, shrikhand, dahi, kulfi etc. **Practice (4 hrs)** • Microbiological examination of ice-cream and other frozen desserts for SPC, coliforms, Staphylococcal counts, *Salmonella*. • Microbiological examination of khoa for SPC, coliforms and staphylococcal counts

	besides yeast and mold counts. • Microbiological examination of paneer and shrikhand for SPC, coliforms, yeast and molds and Staphylococcal counts. **Module-IV: Microbial Safety and Packaging (3 hrs)** • Factors affecting the microbiological quality in reference to production, processing, storage and distribution. • Microbial safety in relation to potential pathogens and their public health significance. • Active packaging concepts and role in bio-preservation. **Practice (1 hr)** • Microbiological examination of packaging materials for SPC and yeast and mold counts. **Suggested Readings** • Robinson, R.K. 2002. Dairy Microbiology Handbook - The Microbiology of Milk and Milk Products. 3rd ed. Wiley-Interscience, New York. • Marth E.H. & Steele J. 1998. Applied Dairy Microbiology- 2nd ed. Taylor and Francis, New York. • Varnam, A.H. and Sutherland, J.P. 1994. Milk and Milk Products: Technology, Chemistry and Microbiology, Vol. I, Food Products Series. Chapman and Hall, London. **Courseware Link** • http://courseware.cutm.ac.in/courses/microbiology-of-dairy-products/		
9.	**CUTM1152**	**Dairy Process Engineering**	**3 (2+0+1)**
	Course Objectives • Imparting knowledge about different unit operation in Dairy industry eg. Evaporation, drying, fluidization, process equipments and membrane separation. **Course Outcomes** • Students will learn about milk evaporation, drying, spray dryer, drum dryers, fluidization. • Students will also learn about processing equipment like butter making machines, ghee making machines, cheese making machines. **Module I:** • 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. **Practice:** • Design problems on double effect evaporator and vacuum pan. • Constructional details, operation and maintenance of multiple effect evaporator. **Module II:** • *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. **Practice** • Constructional details, operation and maintenance of spray drier. **Module III:** • *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. *Processing equipments:* Mechanization and equipment used in manufacture of indigenous dairy products, Ice-cream and Cheese making equipments. **Practice:** • Constructional details, operation and maintenance of butter making equipment. • Constructional details, operation and maintenance of equipment related to ghee production. • Constructional details, operation and maintenance of ice-cream making equipment. • Constructional details, operation and maintenance of cheese making equipment. **Module IV:** • *Packaging equipment:* 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. **Practice** • Constructional details, operation and maintenance of reverse osmosis and ultra-filtration system.

- Visit to a milk product plant.

Suggested Readings

- Ahmed, T. 1985. Dairy Plant System Engineering. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
- Ahmed, T. 1990. Dairy Plant System Engineering and Management. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
- Anantakrishnan, C.P. and Simha, N. N. 1987. Technology and Engineering of Dairy Plant Operations. Laxmi Publ., Delhi.
- Brennan. 1969. Food Engineering Operations. Elsevier Publ. Co., Amsterdam, New York.
- Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
- Gardner, A. W. 1971. Industrial drying. Leonard Hill Publ., London.
- Kesseler. 1981. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.

Courseware Link

- http://courseware.cutm.ac.in/courses/dairy-process-engineering/

10.	CUTM1153	Starter Cultures and Fermented Milk Products	3 (2+1+0)

Course Objectives

- Acquaint the students with the importance and classification of health beneficial dairy starters.
- Impart basic knowledge on activity and different preservation techniques of the starter cultures for future use.
- Aware them with the use of dairy starters for the production of different types of milk based fermented foods with improved nutritional and therapeutic value.

Course Outcomes

- Characterize different types of beneficial microorganisms that can be incorporated in the development of fermented dairy foods.
- Implement improvement strategies to develop better starters for dairy industry.
- Prepare different types of fermented milk products possessing nutritional and therapeutic benefits.

Module-I: Types and Propagation of Starter Cultures (4 hrs)

- History, classification and importance of starter cultures in dairy industry
- Single, multiple, defined and mixed strain starters, probiotics and special cultures like exopolysaccharide production
- Propagation of starter cultures-concentrates-direct bulk and direct vat starter cultures, factors affecting propagation

Practice (2 hrs)

- Preparation of single, mixed starter cultures and concentrated starter (DVS).
- Preservation of starter cultures by freeze-drying techniques.

Module-II: Metabolism of Starter Cultures (3 hrs)

- Metabolism of starter cultures (carbohydrate, protein, citrate)
- Production of metabolites and antibacterial substances
- Methods of starter distillates with their merits/demerits

Practice (2 hrs)

- Evaluation of homo-fermentation and hetero-fermentation separately and in combination.
- Effect of physical factors (temperature, pH, Salt and Sugar) on dairy starters.

Module-III: Activity, Purity, Preservation of Starters and Starter Failure (4 hrs)

- Quality and activity tests for dairy starters and preservation methods (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures), merits and demerits; factors affecting the survival of cultures during preservation
- Defects in starters and their control; Starter failures-effect of antibiotic residues, sanitizers and bacteriophages.
- Phages-life cycle, sources, prevention, chemical and mechanically protected systems.

Practice (4 hrs)

- Testing purity of starter cultures by Gram's staining, catalase test, creatine test.
- Testing starter activity by dye reduction tests, Horrell-Elliker, White Head & Cox test.
- Effect of presence of antibiotic residues in milk on starter activity.
- Evaluation of associative growth of starter cultures in milk.

Module-IV: Role of Starters in Fermented Milks (6 hrs)

- Role of starters in the preparation of various fermented milks; yoghurt, different types of yoghurt; preparation; defects and their control.
- Role of starters in the preparation of dahi, different types of dahi; preparation; defects and their control.
- Kefir origin and characteristics; microbiology of kefir grains
- Koumiss origin and characteristics
- Cultured buttermilk
- Fermented milk products (Bulgarian milk, Acidophilus milk, Leben, Villi and Yakult)

Practice (2 hrs)

- Preparation and microbial examination of dahi, yoghurt, cultured butter milk, acidophilus milk and kefir.

	Module-V: Cheese Starters (4 hrs) • Microbiology of fermented milk products; their nutritional and therapeutic significance. • Classification, desirable properties, Artisanal and adjunct cheese cultures, primary and secondary flora of cheese • Biochemical changes during ripening, bacterial and mold ripened cheeses: soft, semi-soft, semi-hard, hard, Brick and Brie cheese, Camembert and Roquefort cheese; • Rennet: rennet substitutes, microbial rennet and recombinant chymosin **Practice (3 hrs)** • Analysis of cheese for total spore and anaerobic spore count. • Microbiological analysis of cheddar cheese at different stages of manufacture of (storage and ripening). • Detection of bacteriophages in cheese whey by plaque assay method. **Suggested Readings** • Yadav, Grover and Batish - Comprehensive Dairy Microbiology • Marth & Steele- Applied Dairy Microbiology- 2nd ed. Taylor and Francis, New York • Edward R. Farnworth-Handbook of Fermented Functional Foods **Courseware Link** • http://courseware.cutm.ac.in/courses/starter-cultures-and-fermented-milk-products/		
11.	**CUTM1154**	**Condensed & Dried Milks**	**3 (2+0+1)**
	Course Objectives • Demonstrate the history, status, scope and legal standards of condensed and dried milk in India and abroad. • Understand the manufacturing processes of condensed, sweetened condensed and evaporated milk. • Acquaint students with the physical properties and physico-chemical changes taking place during manufacture of condensed and dried milk. **Course Outcomes** • Able to manufacture different types of condensed and formulated dried products by grading the quality of raw milk. • Explain various national and international standards for condensed and dried milks. • Describe the chemical defects, their causes and prevention in condensed and dried milks. • Develop concepts with reference to freeze concentration and membrane concentration. **Module-I: History, status, scope and legal standards of condensed and evaporated**		

milks

- History, status, scope and legal standards of condensed milks in India and abroad.

Module-II: Manufacturing techniques of concentrated milks (6 hrs)

- Basics of evaporators and condensed milk
- Manufacture of sweetened condensed milk and operations
- Manufacture of evaporated milk
- Manufacture of evaporated milk including pilot sterilization test
- Recombined sweetened condensed milk
- Grading, quality and pre-treatments of raw milk for condensed and evaporated milk.

Project (6 hrs)

- Manufacture of plain skim concentrated milk
- Manufacture of sweetened condensed milk
- Manufacture of evaporated milk

Module-III: Physico-chemical changes, heat stability and chemical defects of condensed milk (5 hrs)

- Physico-chemical changes taking place during manufacture of condensed milk.
- Physico-chemical properties of condensed milk.
- Heat stability of milk and condensed milk and role of stabilizers in the stability of condensed milk.
- Chemical defects in condensed milk, their causes and prevention.
- Recent advances with reference to freeze concentration and membrane concentration.

Project (2.5 hrs)

- Concentration of milk by membrane processing

Module-IV: Dried milks: status, legal standards, physico-chemical changes, physical properties and defects of dried milks (6 hrs)

- History, status and legal standards of dried milks.
- The milk powder system
- WPN index and heat denaturation.
- Physical properties of dried milks.
- Defects in dried milk during manufacture and storage, their causes and prevention.
- Management of condensed and dried milk industry.

Module-V: Manufacture of dried milks (4 hrs)

- Manufacture of skim milk powder (SMP)
- Manufacture of whole milk powders
- Manufacture of heat classified powders

	• Manufacture of infant foods, malted and formulated dried products **Project (4 hrs)** • Manufacturing of skim milk powder by spray drying/roller drying. • Manufacture of instant milk powder. **Suggested Readings** • Tufail Ahmed: Dairy Plant Engineering and Management • G. Kessler: Food Engineering and Dairy Technology • Sukumar De: Outlines of Dairy Technology **Courseware Link** • http://courseware.cutm.ac.in/courses/condensed-and-dried-milk/		
12.	**CUTM1155**	**Quality and Safety Monitoring in Dairy Industry**	**3 (2+0+1)**
	Course Objectives • To understand about the food safety management system and create awareness among the students about consumer welfare on microbiological quality and safety of dairy foods. • To understand the basic procedure and principles of quality and safety management involved in processing of dairy foods in industry. **Course Outcomes** • Understand the consumer awareness about microbiological quality and safety of dairy foods. • Learn the quality and food safety management system concepts and principles. • Develop concepts on microbiological risk analysis and hygiene in dairy plant. **Module-I: Concept of quality, safety, and food laws (3 hrs)** • Consumer awareness, quality control, quality assurance and food safety. • Global quality and food safety standards: an overview. • Integrated food law, its main features and functions. **Module-II: Food safety and quality management systems (5 hrs)** • Concepts of quality management system • Principles and standard requirements for quality management system • Introduction to Food Safety Management System • HACCP concepts and principles • TQM tools and techniques		

Practices (1 hrs)

- Quality evaluation by HACCP in the preparation of dairy products.

Module-III: Plant hygiene and sanitation (3 hrs)

- Concepts of hygiene and sanitation
- Personnel and equipment hygiene
- Environmental hygiene

Practices (3 hrs)

- Microbiological tests for assessing environmental, equipment and personnel hygiene by swab and rinse methods.
- Evaluation of common sanitizing agents used in dairy plants a) suspension test b) capacity test.

Module-IV: Microbiological risk profile and safety criteria for dairy products (3 hrs)

- Concepts of microbiological risk profile
- Microbiological criteria and sampling guidelines.
- Risk profile and criteria for milk and milk products.

Practices (2 hrs)

- Rapid detection of TPC, yeast and mold counts, coliform using D-count and 3M Petrifilm kits.
- Rapid detection of *coli*, Enterococci, Enterobacteriaceae count using D- count and 3M Petrifilm kits.

Module-V: Microbiological techniques and analysis (9 hrs)

- Biosafety concepts in handling dairy pathogens.
- Enumeration of hygiene indicator organisms.
- Enumeration of *coli*/ *E. coli* O157:H7.
- Enumeration of Salmonella and Shigella.
- Enumeration of *Listeria monocytogenes* and *Staphylococcus aureus*.
- Enumeration of *Bacillus cereus*, *Clostridium botulinum* and *Clostridium perfringens*.
- Rapid enumeration of hygiene and safety indicator organisms.
- Monitoring antibiotic residues and aflatoxin M1.
- Biosensors for monitoring contaminants.

Practices (6 hrs)

- Rapid detection of pathogenic bacteria *Staphylococcus*, *coli* O157:H7,
- Rapid detection of pathogenic bacteria *Listeria monocytogenes* and Salmonella.
- Rapid detection of antibiotic residues in milk using commercial kits.
- Rapid detection of aflatoxin M1/pesticides residues in milk using enzyme inhibition

assay.

Suggested Readings

- Yasmine Motarjemi and Huub Lelieveld: Food Safety Management
- Adnan Y. Tamime: Milk processing and Quality management

Courseware Link

- http://courseware.cutm.ac.in/courses/quality-and-safety-monitoring-in-dairy-industry/

13.	CUTM1156	Ice-cream & Frozen Desserts	3 (2+0+1)

Course Objectives

- To learn about the history, development and status of the ice-cream industry
- Various processes involved in making, freezing and treatment of ice-creams.

Course Outcomes

- Understand the definition, classification and composition and standards of ice cream and other frozen desserts.
- To know the effect of process treatments on the physico-chemical properties of ice-cream mixes and ice cream.
- Able to understand the advances in ice-cream industry and plant management.

Module I: Development of ice cream and importance of stabilizer and emulsifier (5 hrs)

- History, development and status of ice cream industry
- Definition, classification and composition and standards of ice cream and other frozen desserts
- Stabilizers and their classification
- Emulsifiers and-their classification
- Properties and role in quality of ice cream

Module II: Technology of ice cream manufacture (3 hrs)

- Technological aspects of ice cream manufacture
- Thermodynamics of freezing and calculation of refrigeration loads
- Types of freezers, refrigeration control / instrumentation

Project (2 hrs)

- Calculation of standardization of ice-cream mixes. Determination of overrun in ice cream.
- Study of continuous and batch type freezers. Manufacture of ice-cream by continuous process.

	Module III: Physico- chemical properties, packaging, hardening, storage and shipping of ice cream (6 hrs) • 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 and hardening of ice cream • Storage and shipping of ice-cream **Project: (8 hrs)** • Manufacture of plain and fruit flavoured ice-cream. • Manufacture of chocolate, fruit and nut ice cream. • Preparation of sherbets/ices. Manufacture of kulfi. • Preparation of soft served and filled ice-cream. **Module IV: Defects and nutritive value of ice cream (4 hrs)** • Defects in ice cream, their causes and prevention. • Recent advances in ice-cream industry (flavourings, colourings, fat replacers, bulking agents) and plant management • Nutritive value of ice-cream **Project: (2.5 hrs)** • Factory visit (2.5 hr) **Suggested Readings** • Jana,A., Pinto, S. and Moorthy, P.R.S., Ice cream & frozen desserts, Agrimoon.com • Arbuckle, W. S. 1991. Ice Cream. AVI Publ., Co. Inc., West Port, Connecticut. • Hall, C. W. and Hedric, T. T. 1975. Drying of Milk and Milk Products. AVI Publ. Co. Inc., West Port, Connecticut. p-338 • Hui, Y. H. 1993. Dairy Science and Technology Handbook 2- Product Manufacturing. Wiley – VCH Inc., USA. • Sommer, H. H. 1951. The Theory and Practice of Ice Cream Making. 6th ed. Madison, Wisconsin, p 5-10. **Courseware Link** • http://courseware.cutm.ac.in/courses/ice-cream-and-frozen-desserts/
14.	**CUTM1157** | **Chemistry of Dairy Products** | **3 (2+1+0)**
	Course Objectives • To understand the chemical composition and legal standards of milk products • Physico-chemical changes in milk constituents during manufacture and storage of

dairy products.

Course Outcomes

- Understand chemical composition and legal standards of milk products.
- Know about the physico-chemical changes during manufacture and storage of traditional dairy products, concentrated and dried milk products and ice cream and frozen desserts.

Module I: Chemistry of Cream, butter and ghee (7 hrs)

- 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. Butter colour.
- Ghee: Physico-chemical changes during manufacture.
- Hydrolytic and oxidative deterioration, their causes.
- Prevention and role of antioxidants in ghee

Practice (4 hrs)

- Cream: estimation of fat and acidity.
- Butter: estimation of fat, moisture, curd and salt content.
- Ghee: estimation of moisture, acid value.
- Butyro refractive reading and Reichert Meissel value/ Polanske value of ghee.

Module II: Chemistry of traditional dairy products (4 hrs)

- Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Khoa and Paneer
- Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Channa and some channa based products
- Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Dahi and Lassi.
- Physico-chemical changes in milk constituents during manufacture and storage of traditional dairy products: Chakka and Shrikhand.

Practice (2 hrs)

- Estimation of moisture, fat and protein content in khoa/paneer.
- Estimation of moisture, fat and protein content in chhana/chakka.

Module III: Chemistry of cheese (2 hrs)

- Milk clotting enzymes and enzymatic coagulation of milk.
- Biochemical changes during ripening of cheese.

Practice: (2 hrs)

	• Estimation of moisture and fat content in cheese. • Estimation of salt and protein content in cheese. **Module IV: Chemistry of concentrated and dried milk and ice cream (4 hrs)** • Physico-chemical changes during preparation and storage of concentrated milk products • Physico-chemical changes during preparation and storage of dried milk products. • Physico-chemical changes during processing and storage of ice cream and frozen desserts. • Role and mechanism of stabilizers and emulsifiers in ice cream. **Practice: (4 hrs)** • Determination of lactose and sucrose in sweetened condensed milk. • Milk powder: moisture, fat and ash. • Milk powder: solubility, acidity and bulk density. • Ice cream: estimation of fat, total solids and protein. **Suggested Readings** • Fox, P. F. (Ed). (1982). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork. • Fox, P. F. and Sweeny, Mc. (1998). Dairy Chemistry and Bio-Chemistry. Academic /Platinum Publ., NewYork. • Fox, P. F. (Ed). (2006). Developments in Dairy Chemistry. Applied Sci. Publ., NewYork. • Jenness, R. and Patton, S. (1984). Principles of Dairy Chemistry. Wiley Eastern Pvt. Ltd, New Delhi. • Mathur, M. P., Datta, D. R., and Dinakar, P. (1999). Text book of Dairy Chemistry, Directorate of Information and Publs., ICAR, New Delhi. • Webb, B. H., Johonson, A. H., and Alford, J. A. (Eds). (2008). Fundamentals of Dairy Chemistry. CBS Publ. and Distributors Pvt. Ltd., New Delhi. **Courseware Link** • http://courseware.cutm.ac.in/courses/chemistry-of-dairy-products/		
15.	**CUTM1158**	**Cheese Technology**	**3 (2+0+1)**
	Course Objectives • Acquaint students about the origin and history of development of cheese manufacture, status and scope in India and abroad. • Demonstrate the technology involved in the production of different types of cheese and related products. **Course Outcomes**		

	• Able to manufacture Cheddar cheese, Gouda cheese, Mozzarella cheese, Swiss cheese, Cottage cheese, Processed cheese and Processed cheese spread. • Explain application of membrane processing in cheese manufacture. • Demonstrate the factors affecting yield of cheese, packaging, storage and distribution of cheese. **Module-I: History, status and scope of cheese industry** • Origin and history of development of cheese manufacture, status and scope in India and abroad. **Project (2 hrs)** • Familiarization with equipments, accessories and standardization numerical. **Module-II: Definition, standards, classification, nutritive value and basic principles of cheese making (6 hrs)** • Definition, standards and classification and nutritive values of cheese • Basic principles of cheese making. • Milk quality in relation to cheese making. • Pre-treatments of milk for cheese making • Additives and preservatives for cheese making. • Application of membrane processing in cheese manufacture. **Module-III: Rennet preparation and properties (2 hrs)** • Study of factors affecting rennet action • Rennet substitutes. • Action of rennet on milk in relation to cheese making. **Module-IV: Manufacture of cheeses and changes during ripening (9 hrs)** • Cheddar and Gouda cheese • Swiss cheese • Mozzarella cheese • Cottage cheese • Enzyme modified cheese (EMC) • Processed cheese, cheese spread and processed cheese foods • Defects in cheese, causes and preventive measures • Chemical, physical, microbiological and sensory changes during cheese ripening • Accelerated ripening of cheese **Project (8 hrs)** • 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/cheese foods. **Module-V: Packaging, storage and distribution of cheese (4 hrs)** • Factors affecting yield of cheese • Packaging, storage and distribution of cheese • Mechanization and automation in cheese processing **Suggested Readings:** • Banks, J. M. (1998). The Technology of Dairy Products. 2nd ed. R. Early (Ed.), Chapman and Hall, Blackie Academic and Professional, London. • H. Hui: Dairy Science and Technology Handbook **Courseware Link** • http://courseware.cutm.ac.in/courses/cheese-technology/

16.	**CUTM1159**	**By Products Technology**	**3 (2+0+1)**
	Course Objectives • Provide in depth knowledge to students regarding the status, availability, utilization and nutritional characteristics of dairy by-products. • To acquaint them with physico-chemical characteristics of whey, butter milk and ghee residue and by products of whey, skim milk, butter milk and their manufacturing processes. **Course Outcomes** • Able to manufacture edible casein from cow and buffalo milk, rennet casein, sodium and calcium caseinate. • Can manufacture whey proteins, whey drinks, dried whey and coffee whitener. • Process butter milk (condensed butter milk, dried butter milk) and utilize butter milk products. **Module-I: Status, availability and associated problems of dairy by products** • Status, availability and issues involved in the utilization of dairy by-products in India and abroad. **Module-II: Skim milk and its by-products (6 hrs)** • Physico-chemical characteristics of skim milk, casein classification and specifications. • Manufacturing processes with basic principles and industrial applications of caseins. • Manufacture of sodium and calcium caseinates their physico-chemical and functional		

properties and food applications.
- Manufacture of casein hydrolysates and its industrial application.
- Co-precipitates, types, their specifications.
- Manufacturing processes with basic principles involved, functional properties and food applications of co-precipitates.

Projects (4 hrs)

- Manufacture of edible casein from cow and buffalo milk.
- Manufacture of rennet casein.
- Manufacture of sodium and calcium caseinate.
- Manufacture of co-precipitate.

Module-III: Processing and utilization of whey (8 hrs)

- Physio-chemical properties and utilization of whey products.
- Whey processing: Fermented products and beverages from whey.
- Deproteinized and demineralized whey.
- Condensed whey, types and their specification, manufacturing techniques.
- Dried whey, types and their specification, manufacturing techniques.
- Application of membrane processing for whey processing.
- Methods of isolation with basic principles involved, physico-chemical properties of whey proteins concentrates.
- Functional properties and food applications of WPC.

Projects (5 hrs)

- Manufacture of whey proteins.
- Isolation of whey proteins by cold precipitation technique.
- Whey protein concentration by ultra-filtration process.
- Manufacture of whey drinks.
- Manufacture of dried whey.

Module-IV: Lactose and butter milk processing (4 hrs)

- Methods for the industrial production of lactose, refining and uses.
- Uses of lactose and hydrolysis of lactose.
- Physico-chemical characteristics of buttermilk and its preservation.
- Types and utilization of butter milk products.

Projects (3 hrs)

- Manufacture of lactose.
- Incorporation of whey protein concentrates in processed cheese foods.
- Manufacture of coffee whitener.

Module-V: Ghee and Nutritional characteristics of by products (2 hrs)

- Ghee residue: Composition, processing and utilization.

	• Nutritional characteristics of dairy by-products. **Suggested Readings** • Caric, M. 1994. Concentrated and Dried Dairy Products. VCH Publishers, Inc., New York. • Webb, B.H. and Whittier, E. O. 1970. By-products from Milk. 2nd ed. AVI Publishing Company, Inc., Westport (Connecticut), USA. • Zadow, J.G. 1992. Whey and Lactose Processing. Elsevier Applied Science, London. **Courseware Link** • http://courseware.cutm.ac.in/courses/by-products-technology/		
17.	**CUTM1160**	**Packaging of Dairy Products**	**3 (2+0+1)**
	Course Objectives • To endow students with the importance of packaging • History of package development • Different types and characteristics of packaging materials used for dairy products **Course Outcomes** • Identify different types and characteristics of packaging materials. • Able to test glass bottle - resistance to thermal shock. • Proficiency in testing of plastics and laminates-thickness, water vapour transmission rate and grease resistance. **Module I: History and type of packaging material (6 hrs)** • Introduction, Importance of Packaging, History of Package Development. • Packaging materials, a) Characteristics of basic packaging materials: Paper (paper board, corrugated paper, fibre board). • Characteristics of Glass and Metal • Characteristics of Plastics • Foils and laminates, retort pouches • Package forms, Legal requirements of packaging materials and product information **Project (10 hrs)** • 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.		

Module II: Packaging of dairy products (5 hr)

- 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 sweet mead
- Concentrated and dried milks including baby foods
- Packaging of functional dairy/food products

Project (2 hrs)

- Packaging of different dairy products by using pre-pack and vacuum packaging machines (2 hr)

Module III: Different packaging techniques (6 hrs)

- 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 equipment (including aseptic tank) and machines- Micro-processor-controlled systems employed for AP
- Package conditions and quality assurance aspects of AP

Module IV: Safety and disposal of packaging materials (3 hrs)

- Microbiological aspects of packaging materials.
- Disposal of waste package materials, Packaging Systems.
- Hazards from packaging materials in food.

Suggested Readings

- Patel, H.G., Modha, H. and Ranganadham, M., Packaging of dairy Products, Agrimoon.com
- Ahvenainen, R. (2003). Novel Food Packaging Techniques. Woodhead Publ. Ltd., Cambridge, England.
- Engineers India Research Institute. (2005). Handbook of Packaging Technology. EIRI, Delhi.
- Han, J. (2005). Innovations in Food Packaging. Elsevier Science & Technology Books.
- Yam, K. L. (2009). Encyclopedia of Packaging Technology. 3rded. John Wiley and Sons, Inc. Publ., USA.

Courseware Link

- http://courseware.cutm.ac.in/courses/packaging-of-dairy-products/

18.	CUTM1161	Chemical Quality Assurance	2 (1+0+1)

Course Objectives

- Learn the quality and food safety management system concepts and principles
- Learn national and international food laws
- Preparation and standardization of dairy reagents and
- Able to calibrate dairy glasswares.
- Detect adulterants, preservatives, and neutralizers in milk and milk products.

Course Outcomes

- Learn the quality and food safety management system concepts and principles
- Learn national and international food laws
- Preparation and standardization of dairy reagents
- Able to calibrate dairy glassware
- Detect adulterants, preservatives, and neutralizers in milk and milk products

Module I: Introduction to different food regulatory systems (2 hrs)

- Importance of chemical quality control, quality assurance and total quality management in dairy industry.
- Role of national and international food regulatory systems and standards with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc.

Module II: Application of FSMS, HACCP and laboratory setup (3 hrs)

- Application of food safety management system (ISO: 22000)
- Hazard analysis and critical control points (HACCP) system and its application in dairy industry with respect to chemical quality
- Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories

Module III: Preparation and standardization of reagents and adulteration detection (3 hrs)

- Preparation and standardization of reagents required in the analysis of milk and milk products
- Sampling procedures; labeling of samples for analysis; choice of analytical tests for milk and milk products for chemical analysis and instrumental methods of analysis
- Calibration of dairy glassware; including butyrometer, pipettes, burettes, hydrometers, lactometers and thermometer; Testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products

Project (12 hrs)

- Calibration of dairy glassware such as pipette, burette, volumetric flasks, hydrometer, butyrometers

	• Preparation and standardization of dairy reagents such as acids, alkalis, sodium thiosulfate, silver nitrate, Fehlings, EDTA solutions etc. Preparation and testing of Gerber sulfuric acid used in fat determination. • Testing the amyl alcohol used for fat determination. Chemical analysis of permissible additives used in milk and milk products. • Chemical analysis of detergents and sanitizers • Detection of adulterants, preservatives, and neutralizers in milk and milk products. • Detection of vegetable oils and animal body fat adulteration in ghee • Analysis of market samples of milk and milk products • Determination of temporary and permanent hardness of water • Estimation of available chlorine from bleaching powder. **Module IV: Analysis of environmental contaminants in milk and milk products (2 hr)** • Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products and their chemical testing methods. Importance of milk contact surfaces, metallic contamination in dairy industry • Chemical quality of water in dairy industry. Prediction of shelf life behavior of milk and milk products (1hr) **Suggested Readings** • Sharma, V., Lal, D. and Aparnathi, K. D. (2016). Chemical Quality assurance, Agrimoon.com • Alli, I. (2004). Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, USA. • Herschdoerfer, S. M. (2004). Quality Control in the Food Industry. Vol. I & II. Academic Press, London. • Kramer, A. and Twigg, B. A. (Eds). (1966). Fundamentals of Quality Control for the food industry, The AVI Publ. Co., West Port, Conn., USA. **Courseware Link** • http://courseware.cutm.ac.in/courses/chemical-quality-assurance/		
19.	**CUTM1162**	**Dairy Plant Design and Layout**	**2 (1+0+1)**
	Course Objectives • To impart knowledge of classification, hygienic consideration for dairy processing plants. • To impart knowledge of different aspect of Dairy plant planning, design aspect, building construction materials and Computer aided design. **Course Outcomes** • Students will learn various aspects of dairy plant design and layouts such as classification, hygienic design consideration, dairy building planning, principles of design layout.		

	• Students will also learn about building constructional materials and to draw layout of different dairy product plants such as butter, ghee, cheese etc. **Module 1: Introduction of Dairy Plant design and layout (3 hrs)** • Type of dairies, perishable nature of milk, reception flexibility. Classification of dairy plants, Location of plant, location problems, selection of site. • Hygienic design considerations for dairy processing plants. Planning: 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. **Project: (3.5 hrs)** • Building symbols and convention. Symbols for equipment. • Study of process schedule. • To draw layout of collection/chilling centre. • Visit to dairy processing plant for understanding of layout of different sections. **Module 2: Dairy plant design aspects (4 hrs)** • 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, and use of planning table in developing plot plant and detailed layout. **Project (3 hrs)** • To draw layout of small dairy plant. • To draw layout of medium dairy plant. • To draw layout of large dairy plant. **Module III: Building construction materials (2 hrs)** • Floors, general requirement of dairy floor finishes, floors for different section of dairy. Foundations, walls doors and windows. • Other design aspects: Drains and drain layout for small and large dairies. Ventilation, fly control, mold prevention, illumination in dairy plants. **Project (4 hr)** • To draw layout of cheese plant. • To draw layout of ice-cream plant. • To draw layout of butter manufacturing unit.

	• To draw layout of ghee plant. **Module IV: Computer aided Design** • Introduction to CAD software. **Project (2 hrs)** • To draw layout of small dairy plant using CAD. • To draw layout of composite dairy plant using CAD. **Suggested Readings** • Chander, L. 2004. Dairy Plant Layout and Design. Directorate of Information and Publ. of Agriculture ICAR. • Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York. • Hall, H. S. and Blombergsson, H. 1963. Milk Plant Layout. Food and Agriculture Organization Publ. United Nations. • Moore, J. M. 1962. Plant Layout & Design. Macmillan Publ., USA. **Courseware Link** • http://courseware.cutm.ac.in/courses/dairy-plant-design-and-layout/		
20.	**CUTM1163**	**Food and Industrial Microbiology**	**3 (2+0+1)**
	Course Objectives • To provide in-depth knowledge to students on different aspects of microbial growth and associated spoilage in foods. • Demonstrate students on principles, different preservation methods of food and mode of action of various preservation methods on microbes. • Acquaint students with types of fermentation processes and microbial production of industrial products. **Course Outcomes** • Explain the interactions between microorganisms and the food environment, and factors influencing their growth and survival. • Illustrate the use of basic microbiological methods for the evaluation of the microbial load in the different food matrices. • Able to compare various physical and chemical methods used in the control of microorganisms. • Involved in the production of different industrial products from microorganisms in industries. **Module-I: Scope of Food Microbiology (3 hrs)**		

- Basic aspects, history, scope and microbes (bacteria, yeasts and molds) associated with food.
- Intrinsic and extrinsic factors that affect microbial growth in different foods.

Project (3 hrs)

- Isolation of psychrophilic, salt and sugar tolerant microorganisms from foods.
- Isolation of industrially important microorganisms from environment.

Module-II: Microbial Spoilage of Foods (4 hrs)

- Overview of food spoilage, microbial spoilage, sources of contamination, control of spoilage of fruits, fruit juices and vegetables.
- Microbial spoilage, sources of contamination, control of spoilage of cereals and canned foods.
- Microbial spoilage, sources of contamination, control of spoilage of meat, poultry, sea foods.

Project (3 hrs)

- Microbiological examination of fresh and canned fruits, vegetables and juices.
- Microbiological examination of flour, bread, eggs and meat.

Module-III: Food Preservation (6 hrs)

- Principles of food preservation: non-thermal methods.
- Principles of food preservation: physical methods viz. high temperature preservation (D, Z and F Values)
- Preservation by drying and chemical preservatives
- Preservation by natural antimicrobial compounds
- Biopreservation
- Mode of action of various preservation methods on microbes

Project (2 hrs)

- Determination of Z, D and F values

Module-IV: Fermentation Processes and Types of Fermenters (6 hrs)

- Fermentation processes: Historical development, the range and components and criteria for selection of industrially important microorganisms
- Types of fermentation (i.e. submerged, surface and solid-state fermentation)
- Preservation and improvement of industrially important micro-organisms using metabolic engineering/genetic engineering; media for industrial process
- Upstream and downstream processing.
- Fermenters: types (batch, fed batch and continuous), functions, design and control, sterilization.
- Growth rate analysis and estimation of biomass, difference in chemostat and

turbidostat**.**

Project (1.5 hrs)

- Demonstration of design and control of a lab fermenter.

Module-V: Microbial Production of Industrial Products (5 hrs)

- Microorganisms and processes involved in the production of single cell protein and industrial alcohol, beer and wine.
- Microorganisms and processes involved in the production of organic acids (citric and lactic).
- Microorganisms and processes involved in the production of enzymes (protease, lipase and rennet) and vitamin (B12).
- Microorganisms and processes involved in the production of antibiotics and bacteriocins.
- Microorganisms and processes involved in the production of fermented foods.

Project (3 hrs)

- Production of lactic acid from whey.
- Production of nisin and assaying the antimicrobial activity of the culture.
- Production of fermented whey beverage.

Suggested Readings

- Frazier,W.C. and Westhoff, D. C. 2004. Food Microbiology. 3rd McGraw Hill, New Delhi.
- Jay, J. M. 1992. Modern Food Microbiology. 4th Van Nostrand Reinhold, New York, USA.
- Okafor, N. 2007. Modern Industrial Microbiology and Biotechnology. Enfield: Science Publ., USA.
- Ray, B. 2004. Fundamental Food Microbiology 3rd, CRC Press, Washington D.C. USA.
- Waites, M. J. 2001. Industrial Microbiology: An Introduction. Blackwell Science, London.

Courseware Link

- http://courseware.cutm.ac.in/courses/food-and-industrial-microbiology/

21.	**CUTM1164**	**Sensory Evaluation of Dairy Products**	**3 (2+1+0)**

Course Objectives

- To impart knowledge on importance of sensory evaluation of dairy products in relation to consumer acceptability and economic aspects.

Course Outcomes

- Understand the importance and basic principles of sensory evaluation processes.
- Analyze factors influencing the sensory quality of different dairy based food and food products.
- To know about consumer acceptance studies and interrelationship of various instrumental and physico-chemical tests.

Module I: Importance of sensory evaluation and sensory organs (4 hrs)

- Introduction, definition and importance of sensory evaluation in relation to consumer acceptability and economic aspects. Terminology related to sensory evaluation.
- Design and requirements of a 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.

Practice (1 hr)

- Determination of threshold value for basic tastes. Determination of threshold value for various odours.

Module II: Type of scoring and grading systems (3 hrs)

- Fundamental rules for scoring and grading of milk and milk products.
- Procedure and 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.

Practice (1 hr)

- Selection of sensory evaluation panel. Training of judges, for recognition of certain common flavour and texture defects using different types of sensory tests.

Module III: Sensory evaluation of milk and milk products (11 hrs)

- Milk: score card and its use. Judging and grading of milk, defects associated with milk.
- Cream: desirable attributes and defects in cream, Score card for cream, sensory evaluation 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.
- Fermented milks: desirable and undesirable characteristics of fermented milks, sensory evaluation of dahi, yoghurt, chakka.
- Fermented milks: desirable and undesirable characteristics of fermented milks, sensory

evaluation of srikhand, lassi and other fermented drinks.

- Frozen dairy products: desirable and undesirable characteristics of frozen dairy products. Sensory evaluation of ice cream, kulfi and milk sherbets.
- Cheese: sensory 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. Sensory evaluation and grading of dry milk products. Concentrated milks: desirable attributes and defects. Sensory evaluation 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 arid undesirable characteristics. Sensory evaluation of paneer, chhana and chhana based sweets.

Practice (8 hrs)

- Sensory evaluation between fresh and defective milk and cream; butter and ghee.
- Sensory evaluation of between fresh and defective condensed and evaporated milk; milk powder and frozen desserts.
- Sensory evaluation between fresh and defective khoa and khoa-based sweets; chhana and chhana based sweets.
- Sensory evaluation between fresh and defective dahi and fermented dairy products; cheese and related products.

Module IV: Consumer acceptance study (2 hrs)

- 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.

Practice (2 hrs)

- Techniques for simulation. Novel techniques of sensory evaluation. (2 hr)

Suggested Readings

- P. S. Prajapati & J. P. Prajapati, Judging of dairy products, Agrimoon.com
- Michael O Mahony: Sensory evaluation of food.
- Harry T. Lawless: Laboratory exercises in sensory evaluation.

Courseware Link

- http://courseware.cutm.ac.in/courses/sensory-evaluation-of-dairy-products/

22.	CUTM1165	Dairy Plant Management	2 (1+0+1)

Course Objectives

- Understand production management
- Knowledge about plant operation and human resource management
- Imparting knowledge about food hygiene and safety hazards

Course Outcomes

- Able to define management, production planning and control
- Learning about energy conservation, auditing, financial and managerial efficiency
- Will be able to know about safety hazards, prevention and breakdown maintenance, and food hygiene.

Module I

Production Management: Definition, Function and structure of Production

- Management, Production planning & Control,
- Work study and measurement motion and time study.
- *Efficiency of plant operation:* product accounting, setting up norms for operational and processing losses for quantity, fat and SNF, monitoring efficiency.

Project

- Flow process charts of different milk products.

Module II

- *Plant Operations:* Energy conservation and Auditing, Product and process control, Control charts, Process Sigma, Efficiency factors losses, Financial and Managerial efficiency.
- Provision for Industrial Legislation in India, particularly in dairy industry, Factory Act & Regulations.

Project

- Identification of steps of material losses on dairy plants.

Module III

- Human Resource Management: Personnel 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.

Project

- Identification of hazardous processes and equipment, safety and precautions.

Module IV

- Prevention & Break-down maintenance: Spare parts inventory, tools & lubricants, etc.
- Food hygiene*:* personnel hygiene, plant hygiene, water quality, etc.

Project

- Identification and uses of common lubricants.

Suggested Readings

- Tufail Ahmed: Dairy plant engineering & management
- David, J. 2007. Contemporary Trends in Dairy Plant Management. Gyan Books Pvt. Ltd., Delhi
- Kumar, H.D. 1998. Environmental Pollution and Waste Management. MD Publ. Pvt. Ltd., New Delhi.
- Maliwal, G.L. 2007. Hand book of Environmental Management. Agrotech Publ. Academy, India.
- Warner, J. N. 1976. Principles of Dairy Processing. John Wiley Publ., New York.

Courseware Link

- http://courseware.cutm.ac.in/courses/dairy-plant-management/

23.	CUTM1166	Waste Disposal and Pollution Abatement	2 (1+0+1)

Course Objectives

- To inculcate among students the basics concepts of wastewater discharge from milk reception dock, liquid milk processing section, butter, ghee, ice-cream, condensed milk, milk powder, cheese and paneer manufacturing.
- To acquaint students with the environmental issues by effluent discharges from dairy plant.
- Provide a brief idea on waste treatment process in dairy processing plant.

Course Outcomes

- Explain the utilization of dairy wastes and implement various treatments for waste disposal.
- Analyse different cleaning agents and sanitizers.
- Able to report and record the maintenance of dairy plant.

Module I: Wastes Discharged from Dairy Plants (5 hrs)

- An overview of wastes discharged from dairy plants and wastewater discharged from

	milk reception dock. • Wastewater discharged from liquid milk processing section. • Wastewater discharged from manufacturing of butter, ghee and milk powder. • Wastewater discharged from manufacturing of ice-cream, condensed milk, cheese and paneer. • Packaging wastes. **Module II: Environmental Issues in Effluent Discharge** • Effects of effluents on waterways, land and on the atmosphere. **Module III: Waste Treatment Process in a Dairy Processing Plant (3 hrs)** • Waste management in dairy industry. • Wastewater treatment options for a dairy processing plant. • Solid waste management. **Project (12.5 hrs)** • Waste utilization processes. • Various treatments in waste disposal. • Analysis of cleaning agents and sanitizers. • Reports and records maintenance of dairy plant. • Operational precautions. • CIP cleaning. **Suggested Readings** • Yung-Tse Hung, Lawrence K Wang & Nazih K Shammas: Handbook of Environment and Waste Management. • Jeffrey Peirce, P Aarne Vesilind & Ruth Weiner: Environmental pollution and control. **Courseware Link** • http://courseware.cutm.ac.in/courses/waste-disposal-and-pollution-abatement/

BASKET V

(Domain, Skills, Internship, Projects: Choice Based)
(Total Credits: 30)

1.	DPCU2240	Dairy Processing and Development	28 (3+15+10)

Domain Track Objectives:

- To acquaint students about the processes involved in the processing of raw milk with constructional details, operation and maintenance of dairy equipments.
- To impart a comprehensive knowledge on dairy starters for production of health beneficial fermented foods.
- To apprise students with the quality control and safety of milk and milk products.

Domain Track Course Outcomes:

- Able to prepare standardized milks as well as able to handle and maintain equipments related to raw milk processing.
- Implement improvement strategies on developing better dairy starters for production of fermented foods with therapeutic properties.
- Detect adulterants, preservatives and neutralizers in milk and milk products.

Courses Division:

1. Milk Processing in Dairy Industry (1-2-0)
2. Dairy Starters in Fermented Milk Products (1-2-0)
3. Quality Assurance in Dairy Industry (1-2-0)
4. Dairy Products Development (0-3-0)
5. Synbiotic Dairy Foods (0-3-0)
6. Quality Analysis of Milk and Milk Products (0-3-0)
7. Projects in Units/Industry/Lab (0-0-10)

Domain Syllabus:

1. Milk Processing in Dairy Industry

Theory

1.1. Collection and Transportation of milk: Organization of milk collection routes, practices for collection of milk, preservation at farm, refrigeration, natural microbial inhibitor, reception, chilling, classification and storage.
1.2. Standardization of milk: Addition or removal of milk fat to make different milk products, numericals.
1.3. Mechanical Separation: Sedimentation, Filtration, Centrifugal separation, Bactofugation.
1.4. Homogenization: Classification, power requirement, care and maintenance
1.5. Pasteurization: Batch, flash and HTST pasteurization
1.6. Packaging machines: Pouch filling machine pre-pack and aseptic filling bulk handling system
1.7. Mixing and agitation: Theory and purpose of mixing, Equipment used
1.8. Evaporation: Basic principles and classification
1.9. Drying: Drum drying, Spray drying
1.10. 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.

Practice

1.1. Familiarization with equipments for reception of milk in plant, platform test.
1.2. Cream separation: parts of separator and the process.
1.3. Preparation of special milks: toned and double toned milk.
1.4. Detection of adulterant and preservatives in milk.
1.5. Constructional details, operation and maintenance of homogenizers.
1.6. Assessment of homogenization efficiency in milk.
1.7. Constructional details, operation and maintenance of HTST pasteurizer.
1.8. Constructional details, operation and maintenance of pouch filling machine.
1.9. Constructional details, operation and maintenance of multiple effect evaporator.
1.10. Constructional details, operation and maintenance of spray drier.
1.11. Constructional details, operation and maintenance of reverse osmosis and ultra-filtration system.

Suggested Readings

1. Ahmed, T. 1985. Dairy Plant System Engineering. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
2. Ahmed, T. 1990. Dairy Plant System Engineering and Management. Kitab Mahal, K.L. Agencies Pvt. ltd., New Delhi.
3. Anantakrishnan, C.P. and Simha, N. N. 1987. Technology and Engineering of Dairy Plant Operations. Laxmi Publ., Delhi.
4. Food Engineering Operations. 1969. Elsevier Publ. Co., Amsterdam, New York.
5. Farrall, A. W. 1963. Engineering for Dairy and Food Products. John Wiley and Sons, New York.
6. Gardner, A. W. 1971. Industrial drying. Leonard Hill Publ., London.
7. Food Engineering and Dairy Technology. V. A. Kessler Publ., Freising, Germany.1981.

2. Dairy Starters in Fermented Milk Products

Theory

2.1. Concept, importance and types of starter cultures in dairy industry.
2.2. Modern trends in propagation, production and preservation methods of starter cultures (liquid, spray drying, vacuum drying, freeze-drying, frozen concentrate, concentrated dried cultures, DVS Starters).
2.3. Metabolism of starter cultures (carbohydrate, protein, citrate).
2.4. Production of metabolites and antibacterial compounds by starters.
2.5. Starter defects and failures.
2.6. Bacteriophages of dairy starters and their impact on dairy industry.
2.7. Lactic acid bacteria as probiotics in development of health foods.
2.8. Role of starters in the preparation of various fermented milks (dahi, yoghurt, acidophilus milk and Yakult) and its associated defects.
2.9. Nutritional and therapeutic significance of fermented milks.
2.10. Cheese Starters: Bacterial and mold ripened cheeses, Rennet substitutes.

Practice

2.1. Testing purity of starter cultures by Gram's staining, catalase test; creatine test
2.2. Testing starter activity by dye reduction tests, Horrell-Elliker, White Head & Cox test.
2.3. Preparation of sterilized reconstituted skim milk and propagation of starter cultures
2.4. Preservation of starter cultures by freeze-drying techniques.
2.5. Preparation of DVS starters.
2.6. Effect of physical factors (temperature, pH, salt and Sugar) on dairy starters.
2.7. Effect of presence of antibiotic residues in milk on starter activity.
2.8. Detection of bacteriophages in cheese whey by plaque assay method.
2.9. Microbial quality of milk for preparation of fermented milks.
2.10. Preparation and microbial examination of dahi, yoghurt and cultured butter milk.
2.11. Analysis of cheese for total spore count.

Suggested Readings

1. Marth & Steele- Applied Dairy Microbiology- 2nd ed. Taylor and Francis, New York
2. Cogan, T. M. and Accolas, J. P. (1995). Dairy Starter Cultures. VCH Publ., USA.
3. Farnworth, E. R. (2008). Handbook of Fermented Functional Foods. 2nd ed. CRC Press, USA.
4. Tamime, A Y. and Robinson, R. K. (1999). Yoghurt Science and Technology, 2nd ed. Woodhead Publ. Ltd. and CRC Press LLC, USA.

3. Quality Assurance in Dairy Industry

Theory

3.1. Awareness about Quality and Safety of Dairy Foods: Concepts of quality control, quality assurance and food safety; Global quality and food safety standards, Integrated food law, its main features and functions.
3.2. Introduction to Food Safety Management System: Concepts of Quality Management System (QMS)–ISO: 9000:2000, ISO: 22000; Principles of QMS; Standard requirements for QMS
3.3. HACCP concept and principle with special reference to biological hazards in dairy foods, TQM tools and techniques.
3.4. Role of national and international food regulatory systems and standards: with respect to quality and safety of milk and milk products: FSSAI, PFA, AGMARK, BIS ISO, IDF, Codex, etc.
3.5. Introduction of risk assessment; Biosafety concepts in handling of dairy pathogens and setting up of a microbiological/ pathogen lab in a dairy plant.
3.6. Setting up of testing facilities and analytical laboratories; concept of mobile testing laboratories. Accreditation of analytical laboratories.
3.7. Preparation and standardization of reagents required in the analysis of milk and milk products.
3.8. Sampling plan and testing methods for the detection of adulterants, preservatives and neutralizers in milk and milk products.

3.9. Environmental contaminates such as pesticides, antibiotics, heavy metals in milk and milk products; Importance of milk contact surfaces, metallic contamination in dairy industry.
3.10. Concepts of hygiene and sanitation in dairy plant, treatment and disposal of waste water and effluents.

Practice

3.1. Standardization of glass wares for quality analysis.
3.2. Preparation and testing of Gerber sulfuric acid used in fat determination. Testing the amyl alcohol used for fat determination.
3.3. Preparation and standardization of dairy reagents such as acids, alkali solutions etc.
3.4. Chemical analysis of permissible additives used in milk and milk products.
3.5. Chemical analysis of detergents and sanitizers.
3.6. Detection of adulterants, preservatives, and neutralizers in milk and milk products. Analysis of market samples of milk and milk products.
3.7. Determination of temporary and permanent hardness of water.
3.8. Estimation of available chlorine from bleaching powder.
3.9. Rapid detection of antibiotic residues in milk using Delvo SP
3.10. Microbiological tests for assessing Environmental, equipment and personnel hygiene by swab and rinse methods.
3.11. Quality evaluation by HACCP in the preparation of dairy products.

Suggested Readings

1. Alli, I. (2004). Food Quality Assurance: Principles and Practices. CRC Press, Boca Raton, USA.
2. Herschdoerfer, S. M. (2004). Quality Control in the Food Industry. Vol. I & II. Academic Press, London.
3. Jacobs, M. B. (1999). Chemical Analysis of Food and Food Products. CBS Distributors, New Delhi.
4. Kramer, A. and Twigg, B. A. (Eds). (1966). Fundamentals of Quality Control for the food industry, The AVI Publ. Co., West Port, Conn., USA.

4. Dairy Products Development (0-3-0)

Practice

4.1. Value addition in paneer by use of spices.
4.2. Preparation of pasteurized milk and flavoured milk
4.3. Preparation of clarified butter
4.4. Preparation of indigenous dairy products (rabidi, khoa, kalakand)
4.5. Manufacture of value-added dairy drinks (herbal lassi)
4.6. Preparation of cereal-based dairy foods (Rice kheer, Payasam)
4.7. Preparation of channa based products (Paneer, rasogolla)

5. Synbiotic Dairy Foods (0-3-0)

Practice

	5.1. Preparation of probiotic curd 5.2. Production of synbiotic whey drink and storage 5.3. Preparation and functional properties of synbiotic ice cream 5.4. Bio-preservation of dairy foods by metabolites of lactic starter **6. Quality Analysis of Milk and Milk Products (0-3-0)** **Practice** 6.1. Platform tests of milk in the receiving dock 6.2. Quality evaluation of dairy products • Assessment of the quality of paneer • Assessment of the quality of butter and ghee • Assessment of the quality of herbal/fermented beverage 6.3. Adulteration detection of milk and dairy products from market 6.4. Detection of presence of vegetable oil in ghee 6.5. Oxidative stability determination in fat rich dairy products i.e ghee, butter **Courseware link:** http://courseware.cutm.ac.in/courses/dairy-processing-and-development/

VALUE ADDED COURSES

1.		Entrepreneurship Development and Industrial Consultancy	2 (2+0+0)

Objectives

- Students can gain knowledge on the basic concepts of entrepreneurship development and industrial consultancy.

Outcomes

- Able to create presentations and business plans that articulate and apply financial, operational, organizational, market, and sales knowledge.
- Identify and secure customers, stakeholders through networks, primary customer research, and competitive and industry analyses in order to pursue an initial target market in real-world projects.
- A student can assess entrepreneurial skills and characteristics to become a successful entrepreneur.

Theory

Module I

- 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;

Module II

- 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 dairy sector. Venture capital.
- Contract farming and joint ventures, public private partnerships.

Module III

- Overview of dairy inputs industry. Characteristics of Indian dairy processing and export industry. Social Responsibility of Business.
- Industrial Consultancy: Dairy plant management system- milk procurement from the rural milk producer, milk processing and products manufacturing.
- Pricing and marketing of milk and milk products. Survey on milk production

	potential and marketed surplus of milk for setting up of milk plants. • Recruitment and training of manpower • Estimation of costs of product manufacture and energy utilization in food processing plants. **Module IV** • Sources of finance for setting up of dairy farms and processing plants/ units. • Guidelines for obtaining ISO/HACCP certification for dairy plants. • Assessment of entrepreneurial skills and characteristics for successful entrepreneur. • Consumer opinion surveys. • Pricing of milk and milk products. reparation of feasibility reports for setting of dairy farms, composite milk plants, collection centres, chilling units and processing units. **Suggested Readings** • The oxford Handbook of Management consulting. • Yakov Fain, Victor Rasputnis & Anatole Tarlakovsky: Enterprise development with flex	
2.	**Financial Management and Cost Accounting**	**3 (2+0+1)**
	Objectives To provide an in-depth study of the cost accounting principles and techniques for identification, analysis and classification of cost components to facilitate managerial decision making. **Outcomes** Explain the basic concepts and processes in determination of products and services cost. • Asses how cost-volume-profit is related and use of CVP analysis as a planning and decision-making aid. • Identify problems on ratio analysis, break even analysis, profit analysis and operating analysis. **Theory** **Module I:** • Introduction: Definition, scope and objectives of financial management. • Different Systems of Accounting: Financial Accounting, Cost accounting, Management Accounting. Double's entry system of Book-Keeping. **Module II**: • 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.

Module III:

- Financial Analysis: 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.

Module IV:

- 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. Introduction, Definition, Objectives, Common terms.

Module V:

- 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. **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. **Suggested Readings** • M. Y. Khan & P. K. Jain: Cost Accounting & Financial Management • Ravi M. Kishore: Cost & management accounting.

LIST OF DOMAIN COURSES

Sl. No.	Category	Type	Code	Title	Total	TYPE (T+Pr+Pj)
1.	A/B/D	Domain	MLCU2000	Data Science and Machine Learning	26	2+9+15
2.	A/B	Domain	STCU2010	Software Technology	20	0+7+13
3.	A/B/D	Domain	ARCU2060	Gaming and Immersive Learning (AR & VR)	20	5+5+10
4.	A/B	Domain	ASCU2020	Aerial Surveying and Remote Sensing Applications	18	4+10+4
5.	A/B	Domain	CUCP2110	Construction Planning Monitoring and Project Management	16	4+6+6
6.	A/B	Domain	SDCU2120	Architectural and Structural Design	20	0+15+5
7.	A/B	Domain	CDCU2130	Composite Design and Manufacturing	24	6+12+6
8.	A/B/D	Domain	GMCU2140	GO-TO-MARKET	22	4+10+8
9.	A/B	Domain	CMCU2150	Manufacturing (Conventional, CNC and Additive)	26	2+16+8
10.	A/B	Domain	WICU2160	Welding and Inspection	22	8+8+6
11.	A/B	Domain	AECU2170	Automobile Engineering	24	7+7+10
12.	A/B	Domain	RECU2190	Renewable Energy Applications	22	4+8+10
13.	A/B/D	Domain	DACU2200	Data Analytics-Visualization	20	0+14+6

14.	A/B/D	Domain	BACU2210	Business Analytics	18	0+12+6
15.	A/B/C/D	Domain	CFCU2180	Computational Fluid Dynamics	18	2+8+8
16.	A/B	Domain	FMCU2220	Smart Farm Machinery	28	6+9+13
17.	A	Domain	OFCU2230	Organic Farming	29	3+15+11
18.	A/B	Domain	DPCU2240	Dairy Processing and Development	28	3+15+10
19.	A	Domain	AQCU2250	Intensive Aquaculture	29	3+15+11
20.	A	Domain	SPCU2260	Seed Production using Manual and Molecular Methods	29	3+15+11
21.	A	Domain	GECU2270	Genetic Engineering & Genomics	29	3+15+11
22.	A/C	Domain	NUCU2280	Nutraceuticals	29	3+9+17
23.	A/B	Domain	SWCU2340	Soil and Water Conservation through Watershed	28	4+11+13
24.	A/B	Domain	PHCU2300	Protected Horticulture	29	3+15+11
25.	A/B/D	Domain	FPCU2310	Food Processing	29	3+15+11
26.	A/B/D	Domain	ABCU2320	Agri Business Management	23	2+0+21
27.	A/B/D	Domain	FSCU2330	Commodity and Food Storage	29	3+15+11

LIST OF SKILL COURSES

Course code	Course Name	Course credit
CUTM3029	Apparel Production & Marketing	4 (0+3+1)
CUTM3030	Line Stitching Supervising	4 (0+3+1)
CUTM3031	Apparel Production	4 (0+3+1)
CUTM3032	Light Motor Vehicle Driving	4 (0+3+1)
CUTM3033	Fork Lift Operation	4 (0+3+1)
CUTM3034	Heavy Vehicle Technology	4 (0+3+1)
CUTM3035	Two-Wheeler Service Technology	4 (0+3+1)
CUTM3036	Four-Wheeler Service Technology	4 (0+3+1)
CUTM3037	E-Vehicle Assembly and Service Technology	4 (0+3+1)
CUTM3038	Robotics	4 (0+3+1)
CUTM3039	CNC Machinist	4 (0+3+1)
CUTM3040	CNC Programming (CAM)	4 (0+3+1)
CUTM3041	Design Supervising Wooden and Modular Furniture	4 (0+3+1)
CUTM3042	Introduction to Composite Manufacturing	4 (0+3+1)
CUTM3043	3D Modelling and Printing	4 (0+3+1)
CUTM3044	Pottery	4 (0+3+1)
CUTM3045	Precast Concrete Manufacturing	4 (0+3+1)
CUTM3046	Fabrication	4 (0+3+1)
CUTM3047	Hi-Tech Surveying	4 (0+3+1)
CUTM3048	Internet of Things	4 (0+3+1)
CUTM3049	Mechatronics System Design	4 (0+3+1)
CUTM3050	Plant/Drug Research using Biovia	4 (0+3+1)
CUTM3051	Introduction to Nanotechnology	4 (0+3+1)

CUTM3052	Drone Piloting	4 (0+3+1)
CUTM3053	Camera Operation	4 (0+3+1)
CUTM3054	Editor	4 (0+3+1)
CUTM3055	Desktop Publishing	4 (0+3+1)
CUTM3056	Introduction to Blender and Unity tools	4 (0+3+1)
CUTM3057	Refraction Technology	4 (0+3+1)
CUTM3058	Emergency Medical Technology	4 (0+3+1)
CUTM3059	Medical Lab Technology	4 (0+3+1)
CUTM3060	Operating Theatre Technology	4 (0+3+1)
CUTM3061	Radiology Technology	4 (0+3+1)
CUTM3062	Phlebotomy Technology	4 (0+3+1)
CUTM3063	First Aid Service	4 (0+3+1)
CUTM3064	General Duty Assistance Service	4 (0+3+1)
CUTM3065	X- ray Technology	4 (0+3+1)
CUTM3066	Wantrepreneur to Entrepreneur	4 (0+3+1)
CUTM3067	Retail Sales	4 (0+3+1)
CUTM3068	Basketball	4 (0+3+1)
CUTM3069	Gym Fitness	4 (0+3+1)
CUTM3070	Swimming	4 (0+3+1)
CUTM3071	Beauty Therapy	4 (0+3+1)
CUTM3072	Yoga & Meditation	4 (0+3+1)
CUTM3073	Solar PV Installation	4 (0+3+1)
CUTM3074	Solar Lighting Technology	4 (0+3+1)
CUTM3075	Gardening	4 (0+3+1)
CUTM3076	Microgrid Design and Implementation	4 (0+3+1)

CUTM3077	Solar Driven Equipment Assembly	4 (0+3+1)
CUTM3078	Solar Thermal Engineering	4 (0+3+1)
CUTM3079	Introduction to Quantum Computing	4 (0+3+1)
CUTM3080	Introduction to High-performance Computing	4 (0+3+1)
CUTM3081	Organic Farming	4 (0+3+1)
CUTM3082	Mushroom Farming	4 (0+3+1)
CUTM3083	Hydroponics Technology	4 (0+3+1)
CUTM3084	Poultry Farming	4 (0+3+1)
CUTM3085	Dairy Farming	4 (0+3+1)
CUTM3086	Vermicomposting Farming	4 (0+3+1)
CUTM3087	Transformer Manufacturing, Repairing and Maintenance	4 (0+3+1)
CUTM3088	CCTV Installation	4 (0+3+1)
CUTM3089	Electrical Installation	4 (0+3+1)
CUTM3090	Repair and Maintenance of Home Appliances	4 (0+3+1)
CUTM3091	Refrigeration and air conditioning	4 (0+3+1)
CUTM3092	Super critical Co2 plant operation	4 (0+3+1)
CUTM3093	Seed production - Paddy	4 (0+3+1)
CUTM3094	Paddy Processing and marketing	4 (0+3+1)
CUTM3095	Business Plan Preparation	4 (0+3+1)
CUTM3096	Dairy Plant operation	4 (0+3+1)
CUTM3097	Fruit processing with dryers	4 (0+3+1)
CUTM3098	Composite fabrication practice	4 (0+3+1)
CUTM3099	Powder coating practice	4 (0+3+1)
CUTM3100	Farm appliances operation	4 (0+3+1)
CUTM3101	Sewage Treatment plant operation	4 (0+3+1)

CUTM3102	Solid Waste management	4 (0+3+1)
CUTM3103	Bio fertilisers preparation	4 (0+3+1)
CUTM3104	PCB designing & fabrication	4 (0+3+1)
CUTM3105	Introduction to Block Chain Technology	4 (0+3+1)
CUTM3106	Introduction to Nutraceuticals	4 (0+3+1)
CUTM3107	Introduction to NLP	4 (0+3+1)
CUTM3108	Introduction to Computational Biology	4 (0+3+1)
CUTM3109	Product Life Cycle Management through Gate process	4 (0+3+1)
CUTM3110	New material development with Biovia	4 (0+3+1)
CUTM3111	Spectral image processing using Python	4 (0+3+1)
CUTM3112	Satellite data processing	4 (0+3+1)
CUTM3113	Working with Graphene and carbon fibre	4 (0+3+1)
CUTM3114	Adobe Tools and Illustrations	4 (0+3+1)
CUTM3115	Digital Painting	4 (0+3+1)