



# **ADAMAS UNIVERSITY**

**School of Life Science & Biotechnology  
Department of Biotechnology  
B.Tech. in Food Technology**

**Adamas University**  
**School of Life Science & Biotechnology**  
**Department of Biotechnology B.Tech. (Food Technology)**  
**YEAR 1**

<b>SEMESTER 1</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>BSC</b>	MTH11501	Engineering Mathematics-I	3-1-0	4	4
2	Theory <b>BSC</b>	PHY11201	Applied Science	3-0-0	3	3
3	Theory <b>ESC</b>	GEE11001	Electrical and Electronics Technology	3-0-0	3	3
4	Theory <b>HSSM</b>	ENG11053	HSSM –I (English Communication-I)	3-0-0	3	3
5	Theory <b>BSC</b>	BIT11103	Life Sciences	3-0-0	3	3
6	Practical <b>BSC</b>	PHY12202	Applied Science Lab	0-0-3	3	2
7	Practical <b>ESC</b>	GEE12002	Electrical and Electronics Technology Lab	0-0-3	3	2
8	Practical <b>ESC</b>	MEE12001	Engineering Workshop	0-0-3	3	2
9	Practical <b>HSSM</b>	ENG11043	Communication and Collaboration Skill -I	0-0-2	2	1
10	Practical <b>PC</b>	FTH14001	Capstone Project-I	0-0-2	2	1
11	Theory <b>ESC</b>	DGS11001	Design Thinking	2-0-0	2	2
<b>Total</b>				<b>17-1-13</b>	<b>31</b>	<b>26</b>

**HSSM:** Humanities, Social Science & Management, **BSC:** Basic Science **PC:** Professional Core **ESC:** Engineering Science

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**YEAR 1**

<b>SEMESTER 2</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>BSC</b>	MTH11502	Engineering Mathematics– II	3-1-0	4	4
2	Theory <b>ESC</b>	CSE11001	Introduction to Programming	3-0-0	3	3
3	Theory <b>ESC</b>	MEE11002	Engineering Mechanics	3-1-0	4	4
4	Theory <b>BSC</b>	EVS11104	Environmental Science	3-0-0	3	3
5	Practical <b>ESC</b>	CSE12002	Programming Lab	0-0-3	3	2
6	Practical <b>ESC</b>	CEE12001	Engineering Drawing and CAD	0-0-3	3	2
7	Practical <b>HSSM</b>	ENG11044	Communication and Collaboration Skill -II	0-0-2	2	1
8	Practical <b>PC</b>	FTH14002	Capstone Project-II	0-0-2	2	1
9	Practical <b>BSC</b>	IDP14001	Interdisciplinary Project	0-0-5	5	3
<b>Total</b>				<b>12-2-15</b>	<b>29</b>	<b>23</b>

**HSSM:** Humanities, Social Science & Management

**BSC:** Basic Science

**PC:** Professional Core

**ESC:** Engineering Science

**Total Credits (First Year): 49**

**Adamas University**  
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**YEAR 2**

<b>SEMESTER 3</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>ESC</b>	MTH11527	Probability, Statistics and Numerical Methods	3-1-0	4	4
2	Practical <b>ESC</b>	MTH12531	Numerical Methods Lab	0-0-3	3	2
3	Theory <b>PC</b>	FTH11003	Food Biochemistry & Nutrition I	3-0-0	3	3
4	Theory <b>PC</b>	FTH11004	Basics of Microbiology	3-0-0	3	3
5	Practical <b>PC</b>	FTH12005	Food Biochemistry & Nutrition I Lab	0-0-3	3	2
6	Practical <b>PC</b>	FTH12006	Basics of Microbiology Lab	0-0-3	3	2
7	Theory <b>ESC</b>	EIC11001	Venture Ideation	2-0-0	2	2
8	Practical <b>PC</b>	FTH14007	Capstone Project-III	0-0-2	2	1
9	Practical <b>HSSM</b>	SOC14100	Community Service <sup>#</sup>	-	-	1
<b>Total</b>				<b>14-1-8</b>	<b>23</b>	<b>20</b>

<sup>#</sup> CS will be taken up during the summer break after 2th semester, and will be evaluated in the 3rd semester.

**HSSM:** Humanities, Social Science & Management

**BSC:** Basic Science

**PC:** Professional Core

**ESC:** Engineering Science

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**YEAR 2**

<b>SEMESTER 4</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T- P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>PC</b>	FTH11008	Food Microbiology and Preservations	3-0-0	3	3
2	Theory <b>PC</b>	FTH11009	Food Process Technology- I (Cereals, Fruits, Vegetables & Beverages)	3-0-0	3	3
3	Theory <b>PC</b>	FTH11010	Computational Biology and Algorithm	3-0-0	3	3
4	Theory <b>PC</b>	FTH11011	Fundamentals of Chemical Engineering and Unit operation	3-0-0	3	3
5	Practical <b>PC</b>	FTH12012	Food Microbiology and Preservations Lab	0-0-3	3	2
6	Practical <b>PC</b>	FTH12013	Food Process Technology- I Lab	0-0-3	3	2
7	Practical <b>PC</b>	FTH12014	Computational Biology and Algorithm Lab	0-0-3	3	2
8.	Practical <b>PC</b>	FTH12015	Unit operation Lab	0-0-3	3	2
9	Theory <b>HSSM</b>	ECO11505	HSSM-IV (Economics for Engineers)	3-0-0	3	3
10	Theory <b>ESC</b>	PSG11021	Human Values and Professional Ethics	2-0-0	2	2
11	Practical <b>PC</b>	FTH14016	Capstone Project-IV	0-0-2	2	1
<b>Total</b>				<b>14-0-17</b>	<b>31</b>	<b>26</b>

**HSSM:** Humanities, Social Science & Management

**PC:** Professional Core

**ESC:** Engineering Science

**Total Credits (Second Year): 46**

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**YEAR 3**

<b>SEMESTER 5</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>PC</b>	FTH11017	Food Process Technology-II (Fish, Meat & Poultry)	3-0-0	3	3
2	Theory <b>PC</b>	FTH11018	An Introduction to Enzymology	3-0-0	3	3
3	Theory <b>PC</b>	FTH11019	Economics for Food & Nutrition Policy	3-0-0	3	3
4	Theory <b>PE</b>	FTH11020/ FTH11021	Professional Elective-I	3-0-0	3	3
5	Theory <b>PE</b>	FTH11024/ FTH11025	Professional Elective-II	3-0-0	3	3
6	Practical <b>PC</b>	FTH12026	Enzymology Lab	0-0-3	3	2
7	Practical <b>PC</b>	FTH12027	Food Process Technology- II Lab	0-0-3	3	2
8	Practical <b>PC</b>	FTH12028	Economics for Food & Nutrition Policy Lab	0-0-3	3	2
9	Practical <b>PE</b>	FTH12022/ FTH12023	Professional Elective-I Lab	0-0-3	3	2
10	Practical <b>PC</b>	FTH14029	Capstone Project-V	0-0-2	2	1
<b>Total</b>				<b>15-0-14</b>	<b>29</b>	<b>24</b>

**PC:** Professional Core

**PE 1:** Genomics, Proteomics & Metabolomics (FTH11020)/Fundamentals of Molecular Biology (FTH11021)

**PE 1 Lab:** Genomics, Proteomics & Metabolomics Lab (FTH12022)/ Molecular Biology Lab (FTH12023)

**PE II:** Nanobiotechnology (FTH11024)/ Energy Engineering & Biofuel (FTH11025)

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<b>SEMESTER 6</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>PC</b>	FTH11030	Process Calculations, Thermodynamics in Food Science	3-0-0	3	3
2	Theory <b>PC</b>	FTH11031	Food Process Technology- III (Dairy products, Fats & Oils)	3-0-0	3	3
3	Theory <b>PC</b>	FTH11032	Process Instrumentation and Control	3-0-0	3	3
4	Theory <b>PE</b>	FTH11037/ FTH11038	Professional Elective-III	3-0-0	3	3
5	Theory <b>OE</b>	FTH11039/ FTH11040	Open Elective-I	3-0-0	3	3
6	Practical <b>PC</b>	FTH12033	Process Equipment Drawing Lab	0-0-3	3	2
7	Practical <b>PC</b>	FTH12034	Food Process Technology- III Lab	0-0-3	3	2
8	Practical <b>PC</b>	FTH12035	Food Analysis and Quality Control Lab	0-0-3	3	2
9	Seminar <b>PC</b>	FTH15036	Technical Seminar	-	-	2
<b>Total</b>				<b>15-0-9</b>	<b>24</b>	<b>23</b>

**PE:** Professional Elective

**PC:** Professional Core **PE:** Professional Elective **OE:** Open Elective

**PE III:** Bioanalytical tools (FTH11037) / Food, Nutrition and Health (FTH11038)

**OE 1:** Advances in Microbial Biotechnology (FTH11039)/ Bakery, Confectionary and Extruded foods (FTH11040)

**Total Credits (Third Year): 47**

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**YEAR 4**

<b>SEMESTER 7</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Theory <b>HSSM</b>	MGT11402	HSSM-V (Industrial Management)	3-0-0	3	3
2	Theory <b>PE</b>	FTH11041/ FTH11042	Professional Elective-IV	3-0-0	3	3
3	Theory <b>PE</b>	FTH11045/ FTH11046	Professional Elective-V	3-0-0	3	3
4	Theory <b>OE</b>	FTH11047/ FTH11048	Open Elective-II	3-0-0	3	3
5	Theory <b>OE</b>	FTH11049/ FTH11050	Open Elective-III	3-0-0	3	3
6	Theory <b>OE</b>	FTH11051/ FTH11052	Open Elective-IV	3-0-0	3	3
7	Practical <b>PE</b>	FTH12043/ FTH12044	Professional Elective-IV Lab	0-0-3	3	2
8	Practical <b>PC</b>	FTH14053	Minor Project	0-0-8	8	4
9	Practical <b>PC</b>	FTH14054	Industrial Training <sup>#</sup>	-	-	2
<b>Total</b>				<b>18-0-11</b>	<b>29</b>	<b>26</b>

**HSSM:** Humanities, Social Science & Management

**PC:** Professional Core **PE:** Professional Elective **OE:** Open Elective

**PE 4:** Principles of Human Nutrition (FTH11041)/ Quality Control & Food Safety (FTH11042)

**PE 4 Lab:** Nutritional Biochemistry Lab (FTH12043)/ Quality Control & Food Safety Lab (FTH12044)

**PE 5:** Application of Genetic Engineering in Food Technology (FTH11045)/ Packaging of Food Products (FTH11046)

**OE 2:** Non-Thermal Food Processing Technologies (FTH11047)/Separation and Purification Processes (FTH11048)

**OE 3:** Management of Food Industry Waste (FTH11049)/Food Plant Sanitation (FTH11050)

**OE 4:** Bioethics, Biosafety & IPR (FTH11051)/ Research Methodology and GLP (FTH11052)

<sup>#</sup> Industrial Training for 4-12 weeks will be taken at the end of 6<sup>th</sup> Semester, and will be evaluated in the 7<sup>th</sup> Semester



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<b>SEMESTER 8</b>						
<b>No.</b>	<b>Type</b>	<b>Course Code</b>	<b>Course Title</b>	<b>L-T-P</b>	<b>Contact hrs/wk</b>	<b>Credits</b>
1	Practical <b>PC</b>	FTH14055	Major Project	0-0-20	20	10
2	Practical <b>PC</b>	FTH15056	Comprehensive Viva-Voce	-	-	2
<b>Total</b>				<b>0-0-20</b>	<b>20</b>	<b>12</b>

**PC:** Professional Core

**Total Credits (Fourth Year): 38**

# **SEMESTER I**

## Course Content

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### Engineering Mathematics-I

#### Unit- I

[20 h]

**Group Theory:** Review of concept of set theory, Binary operations, group, abelian group, subgroups, necessary and sufficient condition for a subset of group to be a subgroup, ring, field, examples.

**Sequences and Series:** Sequences and their limits, convergence of series, comparison test, Ratio test, Root test, Absolute and conditional convergence, alternating series, Power series.

**Vector Algebra:** Scalar and vector fields, Vector product, Scalar triple product and their interpretation, directional derivative, gradient, Curl, divergence.

#### Unit- II

[16 h]

**Differential Calculus (Functions of one Variable):** Limit, continuity, differentiability of functions of single variable, successive differentiation, Leibnitz's theorem, Rolle's Theorem, Cauchy's mean value theorem, Taylor's and Maclaurin's theorems with remainders, indeterminate forms, concavity and convexity of a curve, points of inflexion, asymptotes and curvature.

**Differential Calculus (Functions of several variables):** Limit, continuity, Differentiability of functions of several variables, partial derivatives and their geometrical interpretation, differentials, derivatives of composite and implicit functions, Euler's theorem on homogeneous functions, harmonic functions, maxima and minima of functions of several variables, Lagrange's method of multipliers.

#### Unit- III

[14 h]

**Integral Calculus:** Fundamental theorem of integral calculus, mean value theorems, evaluation of definite integrals, reduction formulae. Convergence of improper integrals, tests of convergence, Beta and Gamma functions, elementary properties, Differentiation under integral sign, differentiation of integrals with variable limits, Leibnitz rule. Rectification, double and triple integrals, computations of area, surfaces and volumes, change of variables in double integrals, Jacobian's of transformations, integrals dependent on parameters, applications.

#### Unit-IV

[10 h]

**Ordinary Differential Equations:** First order differential equations, exact, linear and Bernoulli's form, second order differential equations with constant coefficients, method of variation of

parameters, general linear differential equations with constant coefficients, Euler's equations, Cauchy-Legendre's equation system of differential equations.

**References:**

1. Erwyn Kreyszig : Advanced Engineering Mathematics, John Wiley and Sons
2. B.V. Ramana, Higher Engineering Mathematics Tata McGraw-Hill.
3. B.S. Grewal : Higher Engineering Mathematics, Khanna Publications
4. C B Gupta, S R Singh, Mukesh Kumar: Engineering Mathematics, McGraw Hill Publication.
5. R.K. Jain and S.R.K. Iyengar : Advanced Engineering Mathematics, Narosa Publishing House, 2002

## Course Content

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### Applied Science

#### Module 1: Mechanics

[10 lecture hours]

Basic ideas of Vector Calculus Potential energy function , Conservative and non-conservative forces. Conservation laws of energy & momentum. Central and non-central forces, Gravitation, Kepler's Laws, Angular Velocity and Torque, Moment of Inertia, SHM, Damped, Undamped and forced Oscillations (no derivations).

#### Module 2: Optics

[5 lecture hours]

Principle of Superposition and Interference from parallel thin films, Single slit and Double slit diffraction, Diffraction grating, dispersive power of Grating, resolving power of prism and grating, production of plane polarized light by different methods, Brewster and Malus Laws. Double refraction, Nicol prism, specific rotation.

#### Module 3: Electromagnetic Theory

[10 lecture hours]

Gauss's Law in Electrostatics, Boundary Value problems, Dielectrics, Motion of Charged Particles in crossed electric & magnetic fields, Velocity Selector & Magnetic focussing, Gauss law, continuity equation, Biot-Savart Law and its applications, inconsistency in Ampere's Law, Maxwell's equations (differential and integral forms), Poynting vector, Poynting Theorem (Statement only).

#### Module 4: Thermodynamics

[10 lecture hours]

Importance and scope, definition of system and surroundings: type of systems (isolated, closed and open); extensive and intensive properties; steady state versus equilibrium state; concept of thermal equilibrium and the zeroth law of thermodynamics; thermodynamic coordinates, state of a system, equation of state, state functions and path functions; concept of heat and work (IUPAC convention); first law of thermodynamics, internal energy (U) as a state function; enthalpy as a state function; energy conservation in the living organism; heat changes at constant volume and constant pressure; relation between  $C_p$  and  $C_v$  using ideal gas; Thermodynamics of Chemical Processes, Concept of entropy, 2<sup>nd</sup> law of thermodynamics, Idea of Chemical potential, Equilibrium conditions for closed systems.

#### Module 5: Reaction Kinetics, Catalysis & Electrochemistry

[10 lecture hours]

Rate laws, 1<sup>st</sup> Order reaction & 2<sup>nd</sup> order reaction, Arrhenius equation, Mechanism and Theories of reaction rates, kinetic and thermodynamic control of reaction; idea of rate determining step; steady-

state approximation; Characteristics and types of Catalyst, Theories of Catalysis, Electrode potential, Redox reaction & Nernst Equation.

### Text Books

1.	Principles of Engineering Physics by S. P. Kuila, (Volume I) New Central Book Agency (P) Ltd.
2.	Principles of Engineering Physics by S. P. Kuila, (Volume II) New Central Book Agency (P) Ltd.
3.	Engineering Physics by Partha Pratim Das and Abhishek Chakraborty
4.	Engineering Physics I by S. K. Bhattacharya and Soumen Pal
5.	Engineering Physics II by S. K. Bhattacharya and Soumen Pal
6.	Engineering Chemistry (Cambridge University Press-I <sup>st</sup> Edition) –Shikha Agarwal
7.	P. W. Atkins, Physical Chemistry, ELBS/Oxford, 10 <sup>th</sup> Edition, 2014

### Reference Books

1.	Optics by Ajoy Ghatak, Mc-graw Hill
2.	Introduction to Electrodynamics, David J. Griffiths, Pearson Education Limited
3.	Engineering Chemistry (Pearson Ed.)- K. Sesha Maheswaramma and Mridula Chugh
4.	Physical Chemistry (Sarat Book House)- P. C. Rakshit

## Course Content

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### Electrical and Electronics Technology

#### Unit I: 7 lecture hours

**D.C. Circuit Analysis and Network Theorems:** Concept of network, Active and passive elements, voltage and current sources, concept of linearity and linear network, unilateral and

bilateral elements, R, L and C as linear elements, source transformation, Kirchhoff's Law, mesh analysis and nodal analysis, star-delta transformation, network theorems: Thevenin's theorem, Norton's theorem, maximum power transfer theorem, network analysis with dependent sources.

#### Unit II: 7 lecture hours

**Steady State Analysis of Single Phase A.C. Circuits:** Sinusoidal, square and triangular waveforms-average and effective value, form the peak factors, concept of phasor, phasor representation of sinusoidal voltage and current, analysis of series-parallel RLC circuits. Apparent, active and reactive powers, power factor, causes and problems of low power factor, power factor improvement, resonance in series and parallel circuits, bandwidth and quality factors.

#### Unit III: 6 lecture hours

**Three Phase A. C. Circuits:** Its necessity and advantages, meaning of phase sequence, star and delta connections, balanced supply and balanced load, line and phase voltage/current relation, three phase power measurements, two wattmeter method.

#### Unit IV: 6 lecture hours

**Basics of Semi-Conductors and PN Junction:** Introduction; Carrier Concentrations- the Fermi Level; Electron and Hole Concentration at Equilibrium; Temperature Dependence of Carrier Concentration; Drift and diffusion current; The Hall Effect; Optical Absorption, Luminescence; PN Junction Diode in Equilibrium Conditions; PN Junction Diode in Forward Biased and Reverse Biased Condition; Breakdown in PN Junction Diodes.

#### Unit V: 6 lecture hours

**Bipolar Junction Transistors:** Introduction, Types: NPN and PNP; Current Components; Early Effect Eber's Moll Model; Different Configurations of a Transistor and its Characteristics; Transistor as an Amplifier (CE, CB, CC); Transistor as a Switch

#### Unit VI: 6 lecture hours

**Field Effect Transistors:** Introduction, JFET and MOSFET, Realization of digital logic circuit using MOSFET (AND, OR, NOT etc.), Realization of switching circuit using MOSFET

#### Unit VII: 7 lecture hours

**Electronics Instruments & Digital Electronics Fundamental:**

Signal generator, Multimeter, operation of CRO and its application. Number systems, Conversions and codes, Logic gates and truth tables.

### Text Books

5. Electronic Devices & Circuit Theory: Boylestad & Nashelsky
6. Electronics Fundamental and application: D.Chattopadhyay and P C Rakshit
7. Electronic Principle: Albert Paul Malvino
8. Digital circuits and design by S Salivahanan and S Arivazhagan
9. V. N. Mittal and A. Mittal, *Basic Electrical Engineering*, Tata McGraw Hill Publishing Company Ltd

2006.

**Reference Books**

1. Electronic Circuits, Discrete and Integrated- Charles Belove and Donald L. Schilling
2. Principles of Electrical Engineering and Electronics- V K Mehta, Rohit Mehta, S Chand and Company, New Delhi
3. Solid State Electronic Devices- Ben G. Streetman and Sanjay Kumar Banerjee, PHI.
4. Fundamental of Digital Circuits by Anand Kumar 2nd Eddition, PHI LearningPal, Rajendra



## Course Content

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### HSSM I (English Communication-I)

#### **Module I: 6 lecture hours**

**Communication Level 1:** Basics of Communication, Means of Communication, Barriers of Communication.

#### **Module II: 6 lecture hours**

**Grammar and Syntax Level 1:** Tense: types and uses, Idioms, One Word Substitutes, Discussion on the use of Articles and related exercises, Discussion on the use of Prepositions and related exercises, Exercises on Sentence –Making (Syntax), Practice exercises on Voice change, Class Exercises on Synonyms and Antonyms.

#### **Module III: 6 lecture hours**

**Reading and Listening Skills Level 1:** Introduction to listening skills: purposes and practice, Discussion on types of listening: difference between listening and hearing, Active listening: introduction listening exercises, Elementary level listening exercise, Intermediate level listening exercise, Advance level listening exercise, Introduction to Reading Skills, Strategies of reading, Skimming, Scanning and Summarizing, Comprehension exercises.

#### **Module IV: 6 lecture hours**

**Speaking Skills Level 1:** Introduction to Speaking Skills: Mother tongue influence, Discussion on various kinds of narrative styles and techniques: Welcome speech, Vote of Thanks, Farewell Speech, Debate and Elocution, Class Exercises on Descriptive narration, Practical Exercises on Narration styles, Presentation of small skits, Practicing Extempore in the class, Mock practices of Group discussion, Practicing speaking in pairs, Mock practice of job interviews.

#### **Module V: 6 lecture Hours**

**Writing Skills Level 1:** Business letters: definition, types and format, Practice exercises, Business reports: definition, types and format, Practice exercises, CV and Application letters: types and formats, Practice exercises, Compositions: Essays, precis paragraph writing

#### **Text Books:**

1.Kaul Asha. Effective Business Communication. PHI Learning Pvt Ltd. 2014. 2.Wren and Martin. High School Grammar And Composition. S. Chand, 1995. 3.Gupta, A. English Reading Comprehension. Ramesh Publishing House, 2009.

#### **Reference Book:**

1. Lewis, Norman. Word Power Made Easy. Anchor: 2014.  
2. Riordan, Daniel G & Pauley Steven A. :Technical Report Writing Today. 2004.  
3. Hamp-Lyons and Heasley, B . Study Writing; A Course in Written English. For Academic and Professional Purposes, Cambridge Univ. Press, 2006.  
4. Quirk R., Greenbaum S., Leech G., and Svartik, J. A Comprehensive Grammar of the English language, Longman:London, 1985.  
6. Balasubramaniam, T. A Textbook of English Phonetics for Indian Students. Macmillan: 2012.

## **Course Content:**

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### **Life Science**

#### **Unit I: Cell biology & Communication:**

**[7 hours lecture]**

Structure, function, and synthesis of cellular membranes and organelles; cell growth and cancer; cytoskeleton and extracellular matrix; cell cycle; transport, receptors, and cell signaling; functions of specialized cell types.

#### **Unit II: Genetics & Systems Biology**

**[4 hours lecture]**

Genetic switches and oscillators, cell-to-cell interactions, cellular and genetic networks, and evolutionary dynamics.

#### **Unit III: Transport & Flow in Biological Systems**

**[7 hours lecture]**

Diffusion, osmosis, facilitated, and active transport; Heat Conduction and Radiation; Fluid Dynamics; Heat and Mass Transfer. Electromechanical and physicochemical interactions in cells and biomaterials

#### **Unit IV: Human Physiology & Diseases**

**[10 hours lecture]** Anatomical,

physiological and pathological features of the cardiovascular, respiratory and renal systems. Identifications of deficiencies and diseases from blood, urine and feces; genetic disorders and gene therapy.

#### **Unit V: Neurophysiology**

**[10 hours lecture]**

Neuron structure and function; Regeneration of nerve; flow and transport of signals from one neuron to other; Nervous system; Aging and its effect on brain; Behavioral functions of the brain - emotion, memory, learning and consciousness; Disorders of the nervous system and treatment. **Unit**

#### **VI: Medical Biotechnology**

**[7 hours lecture]**

Understanding the handling and usefulness of electrocardiograms, ultrasound images, X-ray images, magnetic resonance images (MRI), computerized tomography (CT) or computerized axial tomography (CAT) images, glucose sensors, and other biosensors.

### **Text Books**

T1. Biology for Engineers by Arthur T. Johnson. CRC Press, 1 edition, 2010.

T2. New Biology for Engineers and Computer Scientists by Aydin Tozeren and Stephen W. Byers. Pearson, 1 edition, 2003.

### **Reference Books**

R1. Applied Cell and Molecular Biology for Engineers by Gabi Nindl Waite and Lee R. Waite. McGraw-Hill Education, 1 edition, 2007.

R2. Samson Wright's Applied Physiology.

## Course Content

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### Applied Science Lab

#### Experiments: Physics (45 hours total)

1. Determination of Young's Modulus of a Beam by traveling microscope by FLEXURE method.
2. Carry Foster's Method to Determine Resistance of a Given Coil.
3. Determination of the Coefficient of viscosity of water by Poiseuille's Capillary Flow method.
4. To determine the wavelength of sodium light by forming Newton's Ring.
5. Determination of Rigidity Modulus by dynamical method.
6. Determine the Plank's constant using photocell.
7. To verify Stefan's law by electrical method.
8. To study the temperature dependence of reverse saturation current in a junction diode and hence to determine the Band gap.
9. Determination of specific charge( $e/m$ ) of electron by J.J. Thomson's method.
10. Determination of the Rydberg constant by studying hydrogen or helium spectrum.
11. Determination of dielectric constant of a given dielectric material.
12. Determination of Hall coefficient of Semiconductor.
13. Study current – voltage characteristic load response of photovoltaic solar cells.

#### Experiments: Chemistry (Any Four)

1. Determination of total hardness of water by complexometric titration method
2. Determination of carbonate and bicarbonate in water
3. Estimation of iron (ferrous ion in Mohr salt) by permanganometry.
4. Determination of strength of an unknown HCl solution with standardized NaOH solution by conductometric titration.
5. Dissolved oxygen by Winkler's metho

## **Electrical and Electronics Technology Lab**

### **List of experiments (Electrical Part):**

1. Verification of Thevenin's theorem and Norton's theorem.
2. Verification of Superposition theorem.
3. Verification of Maximum power transfer theorem.
4. Study of R-L-C series circuit.
5. Study of R-L-C parallel circuit.
6. Performance study of fluorescent, LED, tungsten and carbon lamps.
7. Measurement of power in a three-phase circuit using two-wattmeter method.

### **List of experiments (Electronics Part):**

1. Familiarization of bread board and electronics elements such as R, L, C, diode, and BJT etc.
2. Familiarization of Function generator and measuring instruments such as CRO and multimeter.
3. Study the V-I characteristic of PN junction diode and find knee voltage.
4. Study the input and output characteristic of bipolar junction transistor (BJT): Common emitter (CE) configuration
5. Study the transfer and drain characteristic of junction field-effect transistor (JFET), hence determine the drain resistance, transconductance factor, amplification factor.
6. Study the transfer and drain characteristic of MOSFET, hence determine the drain resistance, transconductance factor, amplification factor.
7. Realization of digital logic circuit using MOSFET (AND, OR, NOT etc.

## **Course Content**

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### **Engineering Workshop**

1. Pattern Making; pattern material, pattern allowances and types of patterns; **[8h]**
2. Mould making Practice: **[9h]**
3. Uses of moulding tools: green sand moulding, gating system, riser system, core making; Making a product using sheet metal; **[9h]**
4. Basic Forging processes like upsetting, drawing down and forge welding; Practicing Resistance Spot Welding, Arc Welding and Gas Welding; **[9h]**
5. Machining of products involving lathe (operations: Straight Turning, Taper Turning, Chamfering, Grooving and Thread cutting), milling/shaping operations and finishing process(s). **[10h]**

### **Reference Books**

- Workshop Technology I,II,III, by S K Hajra, Choudhary and A K Chaoudhary. Media Promoters and Publishers Pvt. Ltd., Bombay
- Workshop Technology by Manchanda Vol. I,II,III India Publishing House, Jalandhar.
- Manual on Workshop Practice by K Venkata Reddy, KL Narayana et al; MacMillan India Ltd.
- Basic Workshop Practice Manual by T Jeyapoovan; Vikas Publishing House (P) Ltd., New Delhi
- Workshop Technology by B.S. Raghuwanshi, Dhanpat Rai and Co., New Delhi.
- Workshop Technology by HS Bawa, Tata McGraw Hill Publishers, New Delhi.

## Course Content - Communication and Collaboration Skill –I

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List of Experiments (Any ten)	
1	The students are introduced to Emotional Intelligence and the need for it. [1h]
2	Self evaluation / assessment happens through a peer-peer / group activity. [1h]
3	The groups will form a team to make a movie. [1h]
4	They will play the roles of director, producer, editor, actors, stuntmen etc. [1h]
5	They learn to team up and communicate. A jury will be elected by the students. [1h]
6	The jury will select the “AdOSCARS” winners. The winners are required to make the speech accepting the award. [2h]
7	3 to 4 groups will be formed who will publish a magazine selecting a specific theme. [2h]
8	They will take multiple roles in this game. [2h]
9	Every class, the groups will do news broadcast on their chosen theme. [2h]
10	Video recording will be done, with follow up discussion on body language, tone etc. [2h]

### Reference Books

1. Stephen R Covey, Seven Habits of Highly Effective People, Free Press, 1989
2. Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998
3. Daniel Goleman, Emotional Intelligence, Bantam Book, 2006
4. Innovation and Entrepreneurship (1985) by Peter F. Drucker.

## **Course Timeline:**

### **Capstone Project (Practical)**

**1<sup>st</sup> Semester: Review of literature will be done based on initial project outline discussion to determine a feasible project.**

**2<sup>nd</sup> Semester:** Discussion of the feasibility of the project and accumulation of all the RAW materials needed for the project.

**3<sup>rd</sup> Semester:** Based on the planned outline, the desired project will be executed. Simultaneously, a back-up planned will also be prepared in case the 1<sup>st</sup> project does not work well.

**4<sup>th</sup> Semester:** After completion of the project, the outcome of the project will be evaluated.

**5<sup>th</sup> Semester:** The overall project will be presented and novelty of the project will also be highlighted.

## Course Content

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### Design Thinking

#### Unit I: 2 Lecture Hours

**WHAT IS DESIGN THINKING:** Designers seek to transform problems into opportunities. Through collaboration, teamwork, and creativity, they investigate user needs and desires on the way to developing human-centered products and/or services. This approach is at the very heart of design thinking.

#### Unit II: 2 Lecture Hours

**THE DESIGN THINKING MODEL:** A tool that helps guide you along a design thinking path. The model does this by providing a series of activities that will help you effectively design a product, service or solution to a user's need. The model presents the approach as a process, allowing us to look at each step – or phase – along the journey to the development of a final design.

#### Unit III: 4 Lecture Hours

**PHASE 1: DISCOVER:** Begin the design thinking process with the Discover phase, where you will identify the specific problem your design is intended to solve, as well as important usability aspects from those who will use your design. Discovery can be performed through a variety of different research methods which you will learn in this module.

#### Unit IV: 4 Lecture Hours

**PHASE 2: DEFINE:** In the Define phase, you come to understand the problem. We often refer to this as framing the problem. You can do this by using a variety of tools, including storytelling, storyboarding, customer journey maps, personas, scenarios, and more.

#### Unit V: 4 Lecture Hours

**PHASE 3: DEVELOP:** Turn your attention to solving the problem. In this phase you brainstorm custom creative solutions to the problems previously identified and framed. To do this, you conceptualize in any way that helps, putting ideas on paper, on a computer, or anywhere whereby they can be considered and discussed.

#### Unit VI: 4 Lecture Hours

**PHASE 4: DELIVER:** This phase is all about testing and building concepts. Here you take all of the ideas that have been discussed to this point and bring them a little closer to reality by building a concept; something that makes it easier for a user to experience a design. This concept is referred to as a prototype.

#### Unit VII: 4 Lecture Hours

**PHASE 5: ITERATE:** You will test the prototype of your design solution, collecting and acting on feedback received. These actions may mean minor or major revisions to your design, and are repeated as often as necessary until a solution is reached. Tools such as focus groups and questionnaires are used to help you collect feedback that can help with your final design.

#### Unit VIII: 2 Lecture Hours

**BEYOND DESIGN THINKING:** The Design Thinking Model is a tool that helps guide you along a design thinking path. The model does this by providing a series of activities that will help you effectively design a product, service or solution to a user's need. The model presents the approach



## Reference Books

1. Brown, Tim. "What We Can Learn from Barn Raisers." Design Thinking: Thoughts by Tim Brown. Design Thinking, 16 January 2015. Web. 9 July 2015.
2. Knapp, Jake. "The 8 Steps to Creating a Great Storyboard." Co.Design. Fast Company & Inc., 21 Dec. 2013. Web. 9 July 2015.
3. Van der Lelie, Corrie. "The Value of Storyboards in the Product Design Process." Journal of Personal and Ubiquitous Computing 10.203 (2006): 159–162. Web. 9 July 2015. [PDF].
4. Millenson, Alisson. "Design Research 101: Prototyping Your Service with a Storyboard." Peer Insight. Peer Insight, 31 May 2013. Web. 9 July 2015.

# **SEMESTER II**

## Course Content

### Engineering Mathematics II

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#### Unit- I

[18]

**Linear Algebra:** Elementary row and column operations on a matrix, Rank, echelon form, normal form, Inverse of a matrix using elementary operations, solution of system of algebraic equation, consistency, Caley-Hamilton theorem, eigenvalues and eigenvectors, Symmetric and skew-symmetric matrices, orthogonal matrices, complex matrices, Hermitian and skew- Hermitian matrices, algebraic and geometric multiplicity, diagonalization, vector spaces, linear dependence of vectors, basis, linear transformations.

#### Unit- II

[14]

**Vector Calculus:** Ordinary Integrals of Vectors, Multiple integrals, Jacobian, Line, surface and volume integrals of Vector fields, Gauss' divergence theorem, Green's and Stokes Theorems and their applications.

**Complex Variables:** Limit, continuity, differentiability and analyticity of functions, Cauchy-Riemann equations, line integrals in complex plane, Cauchy's integral theorem, independence of path, existence of indefinite integral, Cauchy's integral formula, derivatives of analytic functions, Taylor's series, Laurent's series, zeros and singularities, Residue theorem, evaluation of real integrals.

#### Unit- III

[10]

**Fourier Series:** Periodic functions, Definition of Fourier series, Euler's formulae, Dirichlet conditions, Change of interval, Even and odd functions, half range Fourier Sine & Cosine series.

#### Unit-IV

[18]

**Introduction to Transform Calculus:** Introduction to Laplace transform and its properties (without proof), Inverse Laplace transform, Definition of Fourier integrals, Fourier Sine & Cosine integrals, complex form of Fourier integral, Fourier sine & cosine transforms, inverse Fourier transform, introduction to Z- Transform and its properties, Inverse Z- Transform, Inverse Z-transform by partial fraction and residue methods.

#### References:

1. Erwin Kreyszig, Advanced Engineering Mathematics, John Wiley and Sons
2. B.V. Ramana, Higher Engineering Mathematics, Tata McGraw-Hill
3. David C. Lay, Linear algebra and its application, (Latest edition), Pearson publication, New Delhi

4. B. S. Grewal, Higher Engineering Mathematics, Khanna Publications
5. C B Gupta, S R Singh, and Mukesh Kumar, Engineering Mathematics, Mc Graw Hill Publication
6. R. K. Jain and S. R. K. Iyengar, Advanced Engineering Mathematics, Narosa Publishing House

## Course Content

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### Introduction to Programming

#### Unit I: 4 lecture hours

**Basic Concepts of Programming:** Introduction to components of a Computer System (disks, memory, processor, where a program is stored and executed, operating systems, compilers, etc.), Idea of Algorithm: steps to solve logical and numerical problems, Representation of Algorithms: Flowchart/Pseudocode with examples, From Algorithms to Programs; source code, variables and memory locations, Syntax and Logical Errors in compilation, Object and Executable code

#### Unit II: 10 lecture hours

**Basics of C Programming :** Characters used in C, Identifiers, Keywords, Data type & sizes, Constants & Variables, Various Operators used such as Arithmetic Operators, Relational & Logical Operators, Increment & Decrement Operators, Assignment Operators, Conditional or Ternary Operators, Bitwise Operators & Expressions; Standard Input & Output, formatted input scanf( ), formatted output printf( ); Flow of Control, if-else, switch-case, Loop Control Statements, for loop, while loop, do-while loop, nested loop, break, continue, goto, label and exit( ) function

#### Unit III: 10 lecture hours

**Functions and Pointers:** Definition of Function, Declaration or Prototype of Function, Various types of Functions, Call by Value, Call by Reference, Recursion, Tail Recursion, Definition of Pointer, Declaration of Pointer, Operators used in Pointer, Pointer Arithmetic, Functions with Pointer

#### Unit IV: 17 lecture hours

**Arrays and String:** Definition, Single and Multidimensional Arrays, Representation of Arrays - Row Major Order, and Column Major Order, Application of arrays – searching and sorting, Sparse Matrices and their representations. Definition of a String, Declaration of a String, Initialization of a String, Various String Handling Functions with example

**Structures and Unions:** Definition of a Structure, Declaration of a Structure & Structure Variable, Initialization of a Structure, Operators used in Structure, Structure within Structures, Union, Difference between a Structure and a Union

**Files:** Types of File, File Processing, Handling Characters, Handling Integers, Random File Accessing, Errors During File Processing

#### Unit V: 4 lecture hours

**Overview of Stacks and Queues:** Introduction to Stack, Primitive operations on Stack, Real-life applications of Stack, Introduction to Queues, Primitive operations on Queues, Real-life applications of Queues.

#### Text Books

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: mcgraw-hill.
2. Gotfreid (196) *Schaum's Outline of Programming with C*, 2 edn., USA: McGraw-Hill

3. Brian W. Kernighan, Dennis Ritchie (1988) *C Programming Language*, 2 edn., : Prentice Hall.

**Reference Books**

1. Al Kelley, Ira Pohl (1988) *A Book on C*, 4 edn., : Addison Wesley Longman

## Course Content

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### Engineering Mechanics

#### Unit 1: Basics of Statics and Concurrent Forces

12 Lecture Hours

**Statics of Particles:** Force System: Force, classification & representation, force as a vector, composition and resolution of forces, principle of superposition and transmissibility of forces.

**Statics of Rigid bodies:** Equilibrium of coplanar force system, free body diagrams, determination of reactions, equilibrium of a body under three forces, Lami's theorem. Moment of a force about a point and an axis, moment of coplanar force system, Varignon's theorem.

#### Unit 2: Parallel and Distributed Forces

12 Lecture Hours

Parallel forces in a plane, Distributed Parallel forces in a plane, couple, resolution of a force into a force and a couple, moment of a couple. Centroid and Moment of Inertia: Determination of centre of gravity, centre of mass and centroid by direct integration and by the method of composite bodies, area moment of inertia of composite plane figures and mass moment of inertia, radius of gyration, parallel axis theorem, Pappus theorems, polar moment of inertia.

#### Unit 3: Friction

12 Lecture Hours

Introduction to wet and dry friction, laws of dry friction, cone of friction, block friction, ladder friction, wedge friction, application of friction in machines.

#### Unit 4: Virtual Work

12 Lecture Hours

Virtual displacement, principle of virtual work.

#### Unit 5: Introduction to Dynamics

12 Lecture Hours

Laws of motion, Projectile motion, D'Alembert's Principle, Work and energy, impulse and momentum, impact of bodies.

### Text Books

1. Engineering Mechanics [Vol-I & II] by Meriam&Kraige, 5th ed. – Wiley India
2. Engineering Mechanics by S.S. Bhavikatti and K.G. Rajashekarappa – New Age International
3. Mechanics of Solids by Crandall,Dahl and Sivakumar-MC Graw Hill ,5th Edition, 2015, New Delhi

### Reference Books

1. Engineering Mechanics: Statics & Dynamics by I.H.Shames, 4th ed. – PHI
2. Engineering Mechanics by Timoshenko , Young and Rao, Revised 4th ed. – TMH

## Course Content

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### Environmental science

#### **Module 1: Basics of Environmental Sciences: (5 hrs)**

Definition, Scope and objectives, classification of environment, interrelationship between the components, ecology and ecosystem, structural and functional component of ecosystem, energy flow in an ecosystem, biogeochemical cycles, human impact on the environment, The IPAT equation, Ecological foot print, ecology and environment, ecosystem concept, energy flow in an ecosystem.

#### **Module 2: Energy Resources: (10 hrs)**

Concept of energy, SI Units of Work, Heat and Power, World energy use, Energy consumption pattern in India and U.S., Environmental aspects of energy utilization Renewable and non-renewable sources; Fossil fuel: types, use and environmental impacts, Solar energy: Solar Radiation – Passive and active solar systems – Flat Plate and Concentrating Collectors – Solar direct Thermal Application– Fundamentals of Solar Photo Voltaic Conversion- advantages and disadvantages of Solar Power generation, Solar energy status in India, Wind Energy: site selection, Wind turbine: basic working principle and types, Wind energy status in India, advantages and disadvantages of Wind Power generation, Hydroelectric power : How it is generated, advantages and disadvantages, Biomass energy: various types, generations of biofuel, Biomass direct combustion – Biomass gasifiers – Biogas plants – Digesters – Ethanol production – Bio diesel, Geothermal Energy: source, various methods of extraction: wet steam, dry steam and hot water flashed, advantages and disadvantages

#### **Module 3: Air Pollution and Control: (10 hrs)**

Classification of air pollutants, Criteria air pollutants and their impacts, Major global impacts of air pollution on man: Global warming, Ozone layer depletion, Acid rain; Air quality standards, Air pollution control methods, Methods of reducing air pollutants from IC engines, particulate pollutant and gaseous pollutant.

#### **Module 4: Water Pollution Fundamentals and Control Strategies: (5 hrs)**

Water quality: physical, chemical and biological characteristics, drinking water quality standard, effluent water quality, waste water sources and constituents, waste water treatment: preliminary treatment, primary treatment, secondary treatment, sedimentation, coagulation, floatation, aerobic and anaerobic biological treatment, activated sludge process, lagoons, trickling filters, rotating biological contractor.

#### **Module 5: Solid Waste Management: (5 hrs)**

Sources and generation of solid wastes, their characterization, chemical composition and classification. Different methods of disposal and management of solid wastes, Recycling of waste material. Waste minimization technologies. Hazardous Wastes Management and Handling Rules, 1989

#### **Module 6: Environmental Impact Assessment: (5 hrs)**

Introduction to Environmental Impact Analysis. Environmental Impact Statement and Environmental Management Plan. EIA guidelines 1994, Notification of Government of India. Impact Assessment Methodologies. Generalized approach to impact analysis. Procedure for reviewing Environmental impact analysis and statement. Guidelines for Environmental audit.

#### **Text Books:**

W.P. Cunningham and M. A. Cunningham, Principles of Environmental Science, 3rd Ed., McGraw-Hill Higher Education, 2005.



Mackenzie Davis and David Cornwell, Introduction to Environmental Engineering (The McGraw-Hill Series in Civil and Environmental Engineering), 2ndEd., McGraw Hill Education, 2012.

**Reference Books:**

Gilbert M. Masters and Wendell P. Ela, Introduction to Environmental Engineering and Science, 3rd Ed., Prentice Hall India Learning Private Limited, 2008.

Metcalf and Eddy, Wastewater Engineering: Treatment and Reuse, 4thEd., McGraw Hill Education, 2002.

## **Course Content**

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### **Programming Lab**

#### **Experiments:**

1. Familiarization with LINUX commands and vi editor. **[8h]**
2. Programs to demonstrate Decision Making, Branching and Looping, Use of break and continue statement etc. **[8h]**
3. Implementation involving the use of Arrays with subscript, String operations and pointers. **[8h]**
4. Implementation involving the use Functions and Recursion. **[8h]**
5. Implementation involving the use Structures and Files. **[8h]**
6. Implementation based on Stack Queues and Linked List for example Insertion and Deletion. **[5h]**

#### **Text Books**

1. Balagurusamy, E., n.d. Programming In ANSI C. 5th ed. Bangalore: McGraw-hill.
2. Gotfreid (196) *Schaum's Outline of Programming with C*, 2<sup>nd</sup> ed., USA: McGraw-Hill
3. Brian W. Kernighan, Dennis Ritchie (1988) *C Programming Language*, 2<sup>nd</sup> ed., : Prentice Hall.
4. Das Sumitabha, UNIX Concepts and Applications, 4<sup>th</sup> Ed., New Delhi, Tata McGraw-Hill

#### **Reference Books**

1. Al Kelley, Ira Pohl (1988) *A Book on C*, 4<sup>th</sup> ed. Addison Wesley Longman

## Course Content

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### Engineering Drawing and Cad

#### Module 1

#### Contact Hr. 9

Introduction to Engineering Drawing covering, Principles of Engineering Graphics and their significance, usage of Drawing instruments, lettering, Conic sections including the Rectangular Hyperbola (General method only); Cycloid, Epicycloid, Hypocycloid and Involute; Scales – Plain, Diagonal and Vernier Scales.

#### Module 2

#### Contact Hr. 9

Orthographic Projections covering, Principles of Orthographic Projections Conventions - Projections of Points and lines inclined to both planes; Projections of planes inclined Planes - Auxiliary Planes.

#### Module 3

#### Contact Hr. 8

Projections of Regular Solids covering, those inclined to both the Planes- Auxiliary Views.

#### Module 4

Sections and Sectional Views of Right Angular Solids covering, Prism, Cylinder, Pyramid, Cone – Auxiliary Views; Development of surfaces of Right Regular Solids - Prism, Pyramid, Cylinder and Cone.

#### Module 5

#### Contact Hr. 10

Isometric Projections covering, Principles of Isometric projection – Isometric Scale, Isometric Views, Conventions; Isometric Views of lines, Planes, Simple and compound Solids; Conversion of Isometric Views to Orthographic Views and Vice-versa, Conventions

### Reference Books

1. Engineering Drawing, N. D. Bhat, Charotar Publishing House (2012).
2. Shah, M.B. & B.C. Rana (2008), Engineering Drawing and Computer Graphics, Pearson Education.
3. Engineering Drawing & Graphics using Autocad, T. Jeyapoovan, Vikas Publishing House Pvt. Ltd.-Noida; Third edition (2010).
4. <https://nptel.ac.in/courses/112103019/>

## Course Content

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### Communication and Collaboration Skill -II

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List of Experiments (Any ten)	
1	Individuals will be chosen + volunteers who will do ADA-TEDX talks on chosen subject of interest – current affairs / latest trends / technology / engineering / specific company.
2	Voting for the best speaker.
3	Group will present why they liked a specific speaker. Students will learn how to prepare, create impact and public speaking.
4	The groups will be given debate topics
5	They will be required to prepare. Everyone gets to speak on the topic for / against.
6	Audience gets to vote for winners.
7	Drama / Stand-up comedy topics will be chosen by students
8	They can pick from any source – movies, books etc.
9	Everyone in the groups must have a role to play/act.
10	The audience gets to vote for winners.

### Reference Books

5. Stephen R Covey, Seven Habits of Highly Effective People, Free Press, 1989
6. Carnegie Dale, How to win Friends and Influence People, New York: Simon & Schuster, 1998
7. Daniel Goleman, Emotional Intelligence, Bantam Book, 2006
8. Innovation and Entrepreneurship (1985) by Peter F. Drucker.

## **Course Content**

### **Capstone Project (Practical)**

**1<sup>st</sup> Semester:** Review of literature will be done based on initial project outline discussion to determine a feasible project.

**2<sup>nd</sup> Semester:** Discussion of the feasibility of the project and accumulation of all the RAW materials needed for the project.

**3<sup>rd</sup> Semester:** Based on the planned outline, the desired project will be executed. Simultaneously, a back-up planned will also be prepared in case the 1<sup>st</sup> project does not work well.

**4<sup>th</sup> Semester:** After completion of the project, the outcome of the project will be evaluated. **5<sup>th</sup> Semester:** The overall project will be presented and novelty of the project will also be highlighted.

## Course Content

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### Inter-Disciplinary Project

#### Typical Progress Roadmap

- After discussion with the Project Advisor(s), each student shall prepare an initial outline of their assigned project indicating the major sections of discussion, list the principal research sources for each section, and explain the overall objective of the project, including a justification of the interdisciplinary nature of the work.
- Each student shall meet with the Project Advisor(s) regularly as per the weekly Time- Table. Other meetings may be scheduled at the discretion of the Project Advisor(s) at mutually agreed upon timings.
- Typically, the progress will include a combination of industrial and academic mentoring , self study sessions, case studies, trend studies, presentation by students, interactive sessions, industrial visits etc.
- Regular submission of progress reports shall be required of each student-group as notified through the Project Advisor(s) from time to time.

#### Mode of Evaluation

Students will be evaluated by team participation and a team presentation at the end of the project. Interactive & continuous, task/assignment- based evaluation methodology will be applied for the course.

# **SEMESTER III**

## **Course Content:**

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### **Probability Statistics and Numerical Methods**

#### **Module 1:**

**Lecture Hr. 16**

**Correlation and Regression:** Introduction to Correlation analysis, Karl Pearson correlation coefficient, Rank Correlation, Regression Analysis, Fitting Straight Lines, Method of least square, regression coefficients, properties of regression coefficients and applications

#### **Module 2:**

**Lecture Hr. 18**

**Probability:** Introduction, Probability of an event, additive rule & multiplication rule, conditional probability Bayes' rule and applications.

**Probability Distributions:** Random variable, discrete and continuous probability distribution, Mathematical expectation, Variance of a random variable, Binomial, Hyper-geometric, Geometric, Poisson distribution, Uniform, Normal, Exponential Distribution.

**Test of hypothesis:** Introduction, type I and type II Error, one and two tailed test, test on a single mean when variance is known & variance is unknown. Test on two means, test on a single mean population and test on two populations, one and two sample test for variance, - Test for goodness of fit and test for independence.

#### **Module 3:**

**Lecture Hr. 16**

**Numerical Methods:** Introduction, Concept of Errors, Bisection Method, False Position Method, Secant Method, Newton-Raphson Method, Successive Approximation Method, Discussion of Convergence, Interpolation and Extrapolation, Calculus of difference, Newton's Forward Interpolation Formula and Backward Interpolation Formula, Lagrange's method, Newton's divided difference formula, Inverse Interpolation and its applications.

**Numerical differentiation and integration:** Differentiation formulae based on polynomial fit, trapezoidal, Simpson's and Gaussian quadrature formulae.

#### **Module 4:**

**Lecture Hr. 10**

**Solution of simultaneous linear equations and ordinary differential equations:** Gauss elimination method, pivoting, ill conditioned equations, Gauss Seidel and Gauss Jacobi iterative methods, Taylor series and Euler methods, Modified Euler method, error analysis, Runge-Kutta method.

#### **Text Books:**

T1. S.C. Gupta and V K Kapoor; Fundamentals of Mathematical Statistics, S Chand & Sons T2. T. Veerarajan, T Ramachandran; Numerical Methods.

#### **Reference Books:**

R1. Manish Goyal; Numerical methods and Statistical Techniques using 'C', Laxmi Publications pvt. Ltd

R2. S Dey and S Gupta; Numerical Methods ,Tata McGraw-Hill Education, 2013

R3. R S Goyal; Numerical methods in engineering and science 42 Edition



## **Course Content**

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### **Numerical Methods Lab**

Write C/ MATLAB programs to execute the followings: **(45 hours divided equally)**

1. The root of non-linear equation using Bisection method.
2. The root of non-linear equation using false position method.
3. The root of non-linear equation using Newton-Raphson method.
4. Interpolate values using Newton's forward Interpolation method.
5. Interpolate values using Newton's backward Interpolation method.
6. Interpolate values using Lagrange's interpolation method.
7. Solve a system of linear equation using gauss-elimination method.
8. Solve a system of linear equation using Gauss-Seidel method.
9. Evaluate the integral using different numerical integration rules.
10. Solve an ordinary differential equation using different numerical methods.

### **Text Books**

5. S. Dey, S. Gupta, Numerical Methods, McGraw Hill Education (India) Pvt. Ltd., 2013.
6. Amritava Gupta, S.C. Bose, Introduction to Numerical Analysis, 3rd Ed., Academic Publishers, 2013.
7. D. Kincaid and W. Cheney, Numerical Analysis: Mathematics of Scientific Computing, 3rd Ed., AMS, 2002.
8. K. E. Atkinson, An Introduction to Numerical Analysis, 2nd Ed., John Wiley & Sons, 1989.

### **Reference Books**

2. Laurene V. Fausett, Applied Numerical Analysis Using MATLAB, 2nd Ed., Pearson, 2007.
3. B.S. Grewal, Numerical Methods in Engineering & Science: with Programs in C & C++, 11th Ed., Khanna Publishers, 2013.

## Course Content:

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### Food Biochemistry & Nutrition I.

#### Unit 1 (10 hrs)

*Introduction to biochemistry* – definition, objectives and scope; acids, bases and buffers; overview of chemistry of carbohydrates, proteins and lipids; overview of isolation and purification of proteins (chromatographic separations, isoelectric focussing, gel electrophoresis/SDS-PAGE, ELISA), ultracentrifugation molecular weight of protein; denaturation and renaturation of proteins; biological membranes, membrane proteins, passive and active transport.

#### Unit 2 (10 hrs)

Overview of dietary metabolism, biological oxidation, bioenergetics, electron transport chain, oxidative and substrate level phosphorylations, metalobomics, oxidative stress and antioxidants.

#### Unit 3 (10 hrs)

*Carbohydrate, it's metabolism and regulation:* definition and classification; metabolic pathways for

breakdown of carbohydrates – glycolysis – aerobic and anaerobic, anaerobic fate of pyruvate; metabolism of hexoses other than glucose by feeder pathways; pentose phosphate pathway, Citric acid cycle, Cori cycle, glycogen metabolism, gluconeogenesis; regulation of blood glucose concentration, energy balances

#### Unit 4 (10 hrs)

*Lipid, it's metabolism and regulation:* Definition, classification, structures, physical and chemical properties of lipids and fatty acids, pathways for breakdown (oxidation pathways of even, odd chains and unsaturated fatty acids) and biosynthesis of fatty acids and lipids, ketone bodies; lipoproteins, digestion and absorption of lipids, fatty liver, lipotropic agents, energy balances.

#### Unit 5 (5 hrs)

*Protein, it's metabolism and regulation:* definitions, classification, essential and non-essential amino-acids, structures and properties; peptides – peptide bonds and some important peptides; classification and structures

### Suggested Book:

1. Principles of Physical Biochemistry, by K.E. van Holde, W. C. Johnson, and P.S. Ho. Prentice Hall; 2<sup>nd</sup> edition 2005.
2. Biophysics: Tools and Techniques by Mark C. Leake. 2016 by CRC Press, ISBN 9781498702430.

## Course Content

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### Basics of Microbiology

#### UNIT I

(10 hours)

##### **Fundamentals, History & Evolution of Microbiology:**

The importance of microbes in food and fermentation industries. The microscope Morphology, growth condition and reproduction of bacteria, yeasts and moulds. Bacterial growth and its estimation. Dyes and staining techniques.

#### UNIT II

(10 hours)

**Cultivation & Maintenance of microorganisms:** Nutrition of bacteria. Techniques of pure culture. Thermal death point. Preservation of microbial culture.

#### UNIT III

(10 hours)

**Microbial growth:** Growth curve, Generation time, synchronous batch & continuous culture; measurement of growth & factors affecting growth of bacteria; Microbial Metabolism - Metabolic pathways; amphi-catabolic & biosynthetic pathways; Bacterial Reproduction - Transformation, Transduction & Conjugation; Endospore & sporulation in bacteria.

#### UNIT IV

(15 hours)

**Control of Microorganisms:** By physical, chemical & chemotherapeutic agents; Water Microbiology - Bacterial pollutants of water, coliforms & non-coliforms; Sewage composition & its disposal.

#### **Textbook:**

1. Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006
2. Willey, J.M.; Sherwood, L.; Woolverton, C.J. *Prescott's microbiology*. McGraw-Hill: 2013.

#### **Reference books:**

1. Tortora, G.J.; Funke, B.R.; Case, C.L. *Microbiology: An introduction*. Pearson Education: 2015.

## **Course Content**

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### **Food Biochemistry & Nutrition I. Lab**

#### Analytical Biochemistry

1. Demonstration of analytical instruments (principles and applications) available in the Department as well as in USIC of VU.
2. Methods of cell breakage.
3. Estimation of total protein, carbohydrate, DNA and RNA of a bacterial cell.
4. Chromatography: Paper, TLC for sugar / lipid / amino acid.
5. Determination of activity of amylase, protease. Effect of pH, temperature on enzyme activity; Enzyme kinetics.
6. Purification of enzyme.
7. Determination of MW of protein by PAGE.
8. Study of enzyme by native gel electrophoresis (zymogram).
9. Demonstration of 2D – gel electrophoresis and Gel documentation system.

#### **Text Books:**

1. Introduction To Practical Biochemistry by Plummer D T , 2006
2. Biochemistry (Lippincott Illustrated Reviews Series) by R. Harvey
3. Practical Physiological Chemistry: A Book Designed for Use in Courses in Practical Physiological Chemistry in Schools of Medicine and of Science (Classic Reprint) by Philip Bovier Hawk, 2017

## **Course Content**

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### **Basics of Microbiology Lab**

1. Sterilization techniques along with a introduction on Laboratory safety.
2. Media preparation using different sterilization techniques.
3. Microscopy and Micrometry.
4. Isolation, culture, enumeration and purification of microbes from a given sample.
5. Staining Techniques (Simple, Gram staining, spore staining, flageller staining, capsule staining, negative staining).
6. Antibiotic Assay - Antimicrobial Sensitivity Test (Disc Diffusion Method).
7. Isolation of antibiotics producing bacteria and determination of the number of colony forming units.

### **Textbook:**

1. Microbiology by Pelczar, JR E.C.S Chan and noel R.Krieg. Fifth edition Tata Mc GrawHill -2006
2. Willey, J.M.; Sherwood, L.; Woolverton, C.J. *Prescott's microbiology*. McGraw-Hill: 2013.

### **Reference books:**

1. Tortora, G.J.; Funke, B.R.; Case, C.L. *Microbiology: An introduction*. Pearson Education: 2015.
2. [www.pubmed.org](http://www.pubmed.org) <http://www.mhhe.com/biosci/cellmicro/prescott/student/olcstudn.mhtml>

## Course Content

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### Venture Ideation

#### **Unit 1. Introduction**

**6 hours**

Preview of the Course, Introduction to the Course, Guest Lecture with U.S. Secretary of Commerce Penny Pritzker – Meaning of Innovation, Entrepreneurial opportunities, Factors influencing the feasibility of an innovation, Innovation strategy: technology-push or market- pull, Product-market fit, How to develop a business model, Walkthrough of the business model canvas, Welcome to Innovation for Entrepreneurs: From Idea to Marketplace.

#### **Unit 2. Customer Discovery and Validation**

**6 hours**

Customer types, Customer archetypes, Customer segments and business models, Customer segments, value propositions, product features, value mapping, interviewing customer, insights of your customers.

#### **Unit 3: Product Understanding and Marketing.**

**6 hours**

Customer value, The DNA of customer-centricity, Crossing the chasm, Qualitative and quantitative marketing research, importance and methods of market segmentation, Focusing on the target market, Beyond the chasm, Strategic implications of beyond the chasm, E-commerce: The internet as a selling platform.

#### **Unit 4. Prototyping and Testing.**

**6 hours**

Planning for prototyping, Rapid prototyping and development, Lean startup MVPs, Choosing a wire framing/UX prototyping tool, Anatomy of an experience map, What you'll learn from user testing, Analytics and insight, Troubleshooting your customer discovery, Levels of a product/service.

## Capstone Project (Practical)

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### **Course Timeline:**

**1<sup>st</sup> Semester:** Review of literature will be done based on initial project outline discussion to determine a feasible project.

**2<sup>nd</sup> Semester:** Discussion of the feasibility of the project and accumulation of all the RAW materials needed for the project.

**3<sup>rd</sup> Semester: Based on the planned outline, the desired project will be executed.**

**Simultaneously, a back-up planned will also be prepared in case the 1<sup>st</sup> project does not work well.**

**4<sup>th</sup> Semester:** After completion of the project, the outcome of the project will be evaluated. **5<sup>th</sup>**

**Semester:** The overall project will be presented and novelty of the project will also be highlighted.

## **Course Content**

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### **Community Service**

#### **Unit I:**

Introduction to the course. A brief on social issues facing the society with both global and Indian examples.

#### **Unit II:**

Minimum 24 hours of field work on a social issue and helping the marginalized / affected community / cause with photographs and testimonies.

#### **Unit III:**

Submission of individual reflection on the social service rendered. The benefits that accrue to the students are

##### **A.) Subjective**

1. Psychosomatic benefits: Volunteering increases overall life satisfaction and also helps to relieve stress and acts as an anti-depressant.
2. Intellectual benefits: Enhances knowledge through new experiences, and develops communication skills.
3. Career benefits : Enhances career prospects by acquisition of work-related skills, builds good references for employers and provides a forum to network with future

potential employers. It also The experience allows gained helps students to take up leadership positions. Letters of recommendation can also be easily sought. Research shows that students who indulge in volunteer work perform better in studies as it invigorates their passion for learning

4. Personal benefits : Real world skills like leadership, problem-solving, collaboration with others, time management and communication skills, learn patience and empathy.
5. Connect learning to real world and enables deeper and lifelong learning. B.)

##### **Community**

1. Collective benefits: Strong interpersonal bonds are created, and leads to increased civic and social awareness and responsibility.

##### **Further Reading :**

1. Tadevosyan, Gohar & Schoenhuth, Michael. Participatory Research Approach : Principles, Challenges and Perspectives. [http://ysu.am/files/01G\\_Tadevosyan\\_M\\_Schoenhuth.pdf](http://ysu.am/files/01G_Tadevosyan_M_Schoenhuth.pdf)
2. Bergold, Jarg & Thomas Stefan. Participatory Research Methods: A Methodological Approach in Motion <http://www.qualitative-research.net/index.php/fqs/article/view/1801/3334>

##### **Plan of Work**



1. Reading on social issues facing the society with both global and Indian examples.
2. Selecting an issue where the student wishes to contribute and wants to make a difference.
3. Areas - The internship may be broadly completed by getting in touch with NGO in your city / town / Police / Municipal Corporation / Local Gram Panchayat / Hospital / State Health Department / Women & Child Development Centre / CSR departments of Corporates / school / Old Age Home / Orphanage / Literacy Drive / Aanganwadi Centres / etc.
4. **Online Discussion** – Through discussion, students elaborate their preferred area of work with reference to the Global Scenario and India. Reason for choosing that area also needs and resources of the people in their area of Social Internship and also submit the testimonials, which include signature of the authority where students initiated their work, or the signature of the authority in whose area students are currently working or photographs of work (photographs must include students working).
5. **Final Report Submission** - Submission of the Testimonials include signatures of the authorities you have worked with, or the signature of the authority in whose area you have worked or photographs of your work (photographs must include you working). Students' accomplishment in their area of operation along with the major successes student experienced and major challenges faced.
6. Students will submit the complete elaborated report along with testimonials and completion certificate in the form of signed Template
  - The registration for all students will open twice, during winter and summer breaks. They may enroll for the internship in either of the two breaks.
  - The student will have to submit a continuous record of their 10 to 15 days internship in the form of photographs and testimonies (wherever required).

## **SEMESTER IV**

## **Course Content**

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### **Food microbiology and preservations**

#### **UNIT I**

**(10 hours)**

Introduction – definition, historical development and significance of food microbiology; Microscope; Classification & morphology of microbes; Techniques of pure culture; Bacteriology of air & water; Anti-microbial agents – physical & chemical – mechanism & action.

#### **UNIT II**

**(10 hours)**

Disinfection & disinfectants; Energy metabolism of aerobic & anaerobic microbes; Thermal inactivation of microbes; Concept, determination & importance of TDT, F, Z & D values; Factors affecting heat resistance; Pasteurization and sterilization.

#### **UNIT III**

**(10 hours)**

Microbiology of milk & milk products like cheese, butter, ice-cream, milk powder; Microbiology of meat, fish, poultry & egg and their products. Microbiology of fruits & vegetable and products like jam, jelly, sauce, juice; Microbiology of cereal & cereal products like bread, biscuits, confectionary;

#### **UNIT IV**

**(15 hours)**

Preservation by removal of heat- freezing process, rate of freezing, effects of freezing of foods, preliminary introduction to freezers and cold storage, dehydrofreezing, glass transition temperature, cryopreservation and cryoprotectants, lyophilization, antifreeze proteins, frozen storage and thawing of foods.

Preservation by removal of water- water activity and its effect on keeping quality of foods, sorption isotherms and their use, effect of dehydration on foods, drying techniques, factors affecting rate of drying, preliminary introduction to types of dryers and their suitability to different foods, intermediate moisture foods.

Preservation by irradiation – sources of radiations, units and doses, effect on microorganisms and different nutrients, dose requirements, safe limits at regulatory issues, irradiation mechanism and survival curve of microorganism post irradiation.

Other methods of preservation- curing, pickling, smoking, fermentation, addition of chemical preservatives, high pressure processing, hurdle technology.

#### **Textbook:**

Food Microbiology; WC Frazier; Tata McGraw Hill, Delhi

Modern Food Microbiology; James M Jay; CBS Publishers, Delhi

Microbiology; Pelczar, Chan and Krieg; Tata McGraw Hill, Delhi

#### **Reference books:**

Essentials of Microbiology; K. S. Bilgrami; CBS Publishers, Delhi

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## **Course Content**

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### **Food process technology I**

#### **UNIT I (10 hours)**

Storage of cereals, Infestation control; Drying of grains, Processing of rice and rice products.

Milling of wheat and production of wheat products, including flour and semolina.

#### **UNIT II (10 hours)**

Milling of corn, barley, oat, coarse grains including sorghum, ragi and millets; Processing of tea, coffee and cocoa.

#### **UNIT III (10 hours)**

Storage and handling of fresh fruits and vegetables, Preservation of fruits and vegetable by heat treatment. Production and preservation of fruits and vegetable juices, preservation of fruit juice by hurdle technology. Preparation of Jam, Jelly and marmalade, pickles, vinegar and tomato product.

#### **UNIT IV (15 hours)**

Non-alcoholic beverages; Food Laws, food rules and standards, Statistical Quality Control ; Various types of packaging.

#### **Textbook:**

Principles of Food Science, Vol-I by Fennma Karrel

Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

#### **Reference books:**

Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC

Food Sience by Mudambi.

## **Course Content**

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### **Computational Biology and Algorithm**

#### **Unit I**

Linear Data Structures: Sequential representations, Arrays and Lists, Stacks, Queues and Dqueues, String and their applications. Non-linear Data Structure: Trees – Binary Trees, Binary Search Trees, Insertion and Deletion algorithms, Height-balanced and Weight-balanced trees, B-trees.

#### **Unit II**

Introduction to Bioinformatics: Introduction, Branches of Bioinformatics, Aim, Scope and Research areas of Bioinformatics. Databases in Bioinformatics: Introduction, Biological Databases, Classification format of Biological Databases, Biological Database Retrieval System.

#### **Unit III**

Biological Sequence Databases: National Center for Biotechnology Information (NCBI): Tools and Databases of NCBI, Database Retrieval Tool, Sequence Submission to NCBI, Basic local alignment search tool (BLAST), Nucleotide Database, Protein Database, Gene Expression Database. EMBL Nucleotide Sequence Database (EMBL-Bank): Introduction, Sequence Retrieval, Sequence Submission to EMBL, Sequence analysis tools. DNA Data Bank of Japan (DDBJ): Introduction, Resources at DDBJ, Data Submission at DDBJ. Protein Information Resource (PIR): About PIR, Resources of PIR, Databases of PIR, Data Retrieval in PIR. Swiss-Prot: Introduction and Salient Features.

#### **Unit IV**

Sequence Alignments: Introduction, Concept of Alignment, Multiple Sequence Alignment (MSA), MSA by CLUSTALW, Molecular Phylogeny: Methods of Phylogeny, Software for Phylogenetic Analyses, and Consistency of Molecular Phylogenetic Prediction.

#### **Textbook:**

Algorithms in Bioinformatics: A Practical Introduction (Chapman & Hall/CRC Computational Biology Series) by Wing-Kin Sung (Author).

Computational Molecular Biology by Pavel A. Pevzner.

#### **Reference books:**

Algorithms on Strings, Trees, and Sequences: Computer Science and Computational Biology by Dan Gusfield.

## Course Content

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### Fundamentals of Chemical Engineering and Unit operation

#### UNIT

(10 hours)

*Basic Concepts:* Concept of continuum, microscopic approach, thermodynamic system (closed and open or control volume); thermodynamic properties and equilibrium; state of a system, state diagram, path and process; different modes of work, laws of thermodynamics; concept of temperature; heat. Entropy concept, Entropy and lost work calculations. Microscopic interpretation of entropy.

*Thermodynamic Relations:* Tds relations, Maxwell's equations, Clapeyron equation, Joule-Thomson coefficient, calculation of properties of simple compressible substances, compressibilities and expansion coefficient.

#### UNIT II

(10 hours)

*Phase equilibria:* chemical potential, Gibbs free energy, Fugacity, activity and activity coefficient. Gibbs-Duhem equation and its application to vapor-liquid equilibria. *Chemical equilibria:* Adiabatic reactions, Gibbs phase rule. Estimation of thermodynamic properties from molecular structure.

#### UNIT III

(10 hours)

Fluid definition and classification, Rheological behavior of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems), Basic equations of fluid flow – Continuity equation, Euler's equation and Bernoulli equation. Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation.

#### UNIT IV

(15 hours)

Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger. Diffusion – Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirectional and bi-directional). Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method. Liquid liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction). Drying- drying operations, batch and continuous drying.

#### Textbook:

- Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
- Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.
- Unit Operations of Chemical Engineering by Chattopadhyaya, Vol I & II , Khanna Publishers, Delhi-6, 1996.

## **Course Content**

### **Food Microbiology and Preservations Lab**

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1. Study of a compound microscope.
2. Gram Staining and Study of morphology of bacterial cells.
3. Study of autoclave, Preparation and sterilization of nutrient broth and agar.
4. Subculturing of a bacterial strain in liquid and solid medium.
5. Study of growth of E.coli by a spectrophotometer.
6. Study of microbiological quality of milk by MBRT test.
7. Preparation of synthetic medium for yeast and mould and inoculation with standard strains of yeasts and moulds.
8. Isolation of starch-hydrolyzing organism from soil.
9. Dilution and Plating by spread –plate and pour –plate techniques.
10. Isolation of pure culture.

#### **Textbook:**

Food Microbiology; WC Frazier; Tata McGraw Hill, Delhi

Modern Food Microbiology; James M Jay; CBS Publishers, Delhi

Microbiology; Pelczar, Chan and Krieg; Tata McGraw Hill, Delhi

#### **Reference books:**

Essentials of Microbiology; K. S. Bilgrami; CBS Publishers, Delhi

Basic Food Microbiology; Bannett, Chapman and Hall

## **Course Content**

### **Food Process Technology - I Lab**

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1. Preparation of orange squash.
2. Preparation of mango jam.
3. Preparation of guava jelly.
4. Preparation of tomato ketchup.
5. Preparation of canned peas/ pine apple.
6. Preparation of mango pickle.
7. Preparation of dried carrot.
8. Preparation of frozen prawn.
9. Preparation of sponge cake.
10. Preparation of bread.

#### **Textbook:**

Principles of Food Science, Vol-I by Fennma Karrel

Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

#### **Reference books:**

Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC  
Food Sience by Mudambi.



## Course Content

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### **Computational Biology and Algorithm Lab**

1. Nucleic acid and protein databases.
2. Sequence retrieval from databases.
3. Sequence alignment.
4. Sequence homology and Gene annotation.
5. Construction of phylogenetic tree.

#### SUGGESTED BOOKS:

1. Ghosh Z. and Bibekanand M, Bioinformatics: Principles and Applications. Oxford University Press. (2008)
2. Pevsner J, Bioinformatics and Functional Genomics. II Edition. Wiley-Blackwell. (2009)
3. Campbell A. M., Heyer L. J. Discovering Genomics, Proteomics and Bioinformatics. II Edition. Benjamin Cummings. (2006)

## Course Content

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### Unit operation Lab

1. Experiments on Reynolds's Apparatus –Determination of flow regime and construction of friction factor against NRE.
2. Experiments on flow measuring device — in closed conduit using (a) Venturimeter, (b) Orifice meter, (c) Rotameter.
3. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation, Kozeny-Karman equation, Blake-Plummer Equation.
4. To study the working characteristics of a Jaw Crusher, calculate the energy consumption as a function of size reduction and compare it with the actual energy requirements.
5. To study the working characteristics of a Ball Mill, calculate the energy consumption as a function of size reduction and determine the critical speed.
6. To Determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside diameter of the tube.
7. To study the characteristics of film-wise/drop-wise condensation.

### Textbook:

Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.

Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.

### Reference books:

- Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
- Engineering Fluid Mechanics by Kumar K.L. Eurasia Publishing House (P) Ltd., New Delhi, 1984.

## Course Content

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### HSS – IV (Economics for Engineers)

#### **Module 1: Basic Concepts of Economics:** [10 lecture hours]

Introduction to the Literature of Microeconomics centering around Decision Making at Individual Level. Some Fundamental Concepts: Maximization, Equilibrium and Efficiency.

#### **Module 2: Theories of Economics:** [12 lecture hours]

The Theory of Consumer Choice and Demand, the Theory of Supply, market equilibrium, market structure, market failure and environmental issues, Game Theory, concept of yield and Theories of Term Structure, the Theory of Asset Pricing, decision-making under uncertainty: risk and insurance.

#### **Module 3: Sustainability Study of a Project:** [5 lecture hours]

Budget plan, estimation of the project cost, prices, fees and cost recovery, financing of recurrent costs, sustainability of the activities generated by the project.

#### **Module 4: Economic Feasibility Study:** [12 lecture hours]

Problem of pricing under oligopoly, problem of market stagnation, problem of volatility in open economy, problem of global meltdown, problem of financing a project.

#### **Module 5: Project Report:** [6 lecture hours]

Facets of project viability – commercial, technical, financial, outline of a model project report, a real life case study.

### **Text Books:**

1. R. Panneerselvam, *Engineering Economics*, 2<sup>nd</sup> Ed., Prentice Hall of India, 2014.
2. James Riggs, *Engineering Economics*, 4<sup>th</sup> Ed., McGraw Hill Education, 2004.

### **Reference Books:**

1. Donald G. Newnan, Ted G. Eschenbach and Jerome P. Lavelle, *Engineering Economic Analysis*, 13<sup>th</sup> Ed., Oxford University Press, 2017.
2. Chan S. Park, *Contemporary Engineering Economics*, 6<sup>th</sup> Ed., Pearson, 2015.

## Course Content

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### Human Values and Professional Ethics

**Unit I: Introduction to Human Values:** Character, Integrity, Credibility, Mutual Respect, Dedication, Perseverance, Humility and Perception. Self-Assessment & Analysis, Setting Life Goals, Consciousness and Self-Transformation. Team Work, Conflict Resolution, Influencing and Winning People, Anger Management, Forgiveness and Peace, Morality, Conscience. Yoga and Spirituality.

**Unit II: Harmony and Life Long Learning:** Harmony in human being, Nature and Existence. Harmony in family and society –Responsibilities towards society, Respecting teachers. Transition from School to College - Freedom & Responsibilities, Respecting Cultural Diversity, Learning beyond the Classrooms, Independent study and research

**Unit III: Introduction to Professional Ethics:** Work Ethics, Engineering Ethics, Moral Dilemma, Moral Development Theories, Ethical Theories- Kantianism, Utilitarianism, etc , Case Studies for Choice of the theory, Code of Ethics

**Unit IV: Individual to Global Issues:** Industrial Standards, A Balanced Outlook on Law, Safety, Responsibility, Rights, Confidentiality, Conflict of Interest, Occupational Crime, Whistle Blowing, Environmental Ethics, Business Conduct in MNC, E-Professionalism (IPR, Internet Ethics & Privacy issues)

### Text Books

1. Shetty, Foundation Course in Human Values and Professional Ethics [R.R. Gaur, R. Sangal, G.P. Bagaria]

## Course Content

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### Capstone Project (Practical)

#### Course Timeline:

**1<sup>st</sup> Semester:** Review of literature will be done based on initial project outline discussion to determine a feasible project.

**2<sup>nd</sup> Semester:** Discussion of the feasibility of the project and accumulation of all the RAW materials needed for the project.

**3<sup>rd</sup> Semester:** Based on the planned outline, the desired project will be executed. Simultaneously, a back-up planned will also be prepared in case the 1<sup>st</sup> project does not work well.

**4<sup>th</sup> Semester:** After completion of the project, the outcome of the project will be evaluated.

**5<sup>th</sup> Semester:** The overall project will be presented and novelty of the project will also be highlighted.

# **SEMESTER V**

## **Course Content**

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### **Food Process Technology-II (Fish, Meat & Poultry)**

#### **Unit I**

Classification of fresh water fish and marine fish; Commercial handling, storage and transport of raw fish; Average composition of fish; Freshness criteria and quality assessment of fish; Spoilage of Fish; Methods of Preservation of fish: Canning, Freezing, Drying, Salting, Smoking and Curing.

#### **Unit II**

Fish products - production of fish meal, fish protein concentrate, fish liver oil and fish sauce and other important byproducts; Quality control of processed fish; Fish processing industries in India.

#### **Unit III**

Slaughtering technique of animal; Meat cuts and portions of meat, muscle; Color of meat; Post mortem changes of meat; Meat processing - curing and smoking; Fermented meat products (meat sausages & sauces); Frozen meat & meat storage; By-products from meat industries and their utilization; Meat industries in India.

#### **Unit IV**

Classification of poultry meat; Composition and nutritional value of poultry meat & eggs ; Processing of poultry meat and eggs; Spoilage and control; Byproduct utilization and future prospects; Poultry farms in India.

#### **Text books:**

Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.

Meat; Cole DJA & Lawrie RA; 1975, AVI Pub.

Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.

Developments in Meat Science – I & II, Lawrie R; Applied Science Pub. Ltd.

#### **References:**

Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.

Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.

Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp.

## Course Content

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### An Introduction to Enzymology

#### UNIT I (15 hrs)

**Introduction:** Classification, mechanism of enzyme action, active site determination, identification of binding and catalytic sites, specificity of enzyme action, activation energy and transition state theory, role of entropy in catalysis. Applications of enzymes.

#### UNIT II (10 hrs)

**Kinetics:** Kinetics of single substrate enzyme catalyzed reactions, Michaelis-Menten equation, turnover number, enzyme inhibition- competitive, non-competitive, and uncompetitive, allosteric enzymes and metabolic regulation.

#### UNIT III (10 hrs)

**The technology of enzyme production:** Types of reactors used for enzyme catalysis for free and immobilized enzymes, immobilized enzymes, preparation and properties.

#### UNIT IV (10 hrs)

**Overview of applications of immobilized enzyme systems:** Design of enzyme electrodes & their applications as biosensors; health care & environment; Design of Immobilized Enzyme Reactors; Packed-bed, Fluidized-bed Membrane reactors; Bioconversion calculations in free- enzyme CSTRs & immobilized enzyme reactors.

### Books & Other Resources

Text Book(s)	
T1	Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W H Freeman & Co.
T2	Enzymes And Enzyme Technology 1 <sup>st</sup> Edition by Anil Kumar, Sarika Garg. ISBN-13: 978-1905740871.

T = Text Book; R = Reference Book



## Course Content

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### Economics for Food & Nutrition Policy

#### Unit I

Introduction and Housekeeping. Importance of economics in food sector. Principles used in economics to explain and predict social outcomes. The strengths and limitations of economics as a social science. Describe the strengths and limitations of economics for everyday life. Market equilibrium and social welfare

#### Unit II

Government regulation, taxes and subsidies in food markets. Use production possibility frontiers to derive supply curves from observed prices and observed quantities. Use supply and demand curves to derive producer and consumer surplus measures of economic welfare from observed prices and quantities. The strengths and limitations of using supply curves, demand curves and economic surplus to evaluate social welfare changes. Use supply, demand and economic surplus to evaluate the effects of government regulation and taxes on prices, quantities and social welfare. Use elasticities to characterize consumer and producer response to changes in income, prices and production possibilities. Use supply and demand diagrams with and without international trade to explain and predict prices, quantities and social welfare changes

#### Unit III

Consumer behavior and food demand. Farm production & food supply. Market structure. Market failure and collective action, Poverty, safety nets and risk, Recessions, unemployment & inflation, Growth, investment and agriculture, Globalization, trade and the food system. Use marginal benefits, indifference curves and budget constraints to derive demand curves from observed prices and quantities. Use the distinction between income and substitution effects to assess consumer. Welfare changes in response to variation in prices and preferences. Describe the strengths and limitations of optimization as an explanation for food consumption choices in the U.S. and elsewhere.

#### Text books:

1. The Political Economy of Food and Nutrition Policies (International Food Policy Research Institute) 1st Edition by Mr. Per Pinstrup-Andersen (Author).

#### References:

1. Nutrition Economics, 1st Edition, Principles and Policy Applications, Suresh Babu Shailendra Gajanan J. Arne Hallam, **Hardcover ISBN: 9780128008782, eBook ISBN: 9780128011508.**
2. Food Security, Poverty and Nutrition Policy Analysis, 2nd Edition, Statistical Methods and Applications By Suresh Babu Shailendra Gajanan Prabuddha Sanyal.

## Course Content

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### Genomics, Proteomics & Metabolomics

#### UNIT I (10 hrs)

Introduction to Genomics: DNA sequencing methods – manual & automated: Maxam & Gilbert and Sangers method. Pyrosequencing, Genome Sequencing: Shotgun & Hierarchical (clone contig) methods, Oxford Nanopore next generation sequencing, and computational tools for sequencing projects: Genome sequence assembly software.

#### UNIT II (8 hrs)

Managing and Distributing Genome Data: Web based servers and softwares for genome analysis: ENSEMBL, VISTA, UCSC Genome Browser, NCBI genome. Selected Model Organisms' Genomes and Databases.

#### UNIT III (20 hrs)

Introduction to protein structure & Proteomics: Chemical properties of proteins. Physical interactions that determine the property of proteins; short-range interactions; electrostatic forces, van der waal interactions, hydrogen bonds, Hydrophobic interactions. Determination of sizes (Sedimentation analysis, gel filtration, SDS-PAGE); Native PAGE, Determination of covalent structures – Edman degradation. Analysis of proteomes. 2D-PAGE. Sample preparation, solubilization, reduction, resolution. Reproducibility of 2D-PAGE. Mass spectrometry based methods for protein identification. De novo sequencing using mass spectrometric data.

#### UNIT IV (7 hrs)

Metabolomics: Metabolites - primary and secondary, Microbial secondary metabolites. Concept of Metabolomics: definition and importance; environmental metabolomics, exometabolomics, Metabonomics.

### Books & Other Resources

Text Book(s)	
T1	Introduction to Genomics 2nd eds by Arthur M. Lesk. Oxford University Press, 2012.
T2	Introduction to Proteomics by Daniel. C. Liebler, Humana press, 2002
T3	The Handbook of Metabonomics and Metabolomics 1st eds by John C. Lindon
T4	Genomics and Proteomics: Principles

T = Text Book

## Course Content

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### Fundamentals of Molecular Biology

#### UNIT I

Structures of DNA and RNA / Genetic Material: Miescher to Watson and Crick- historic perspective, DNA structure, Salient features of double helix, Types of DNA, Types of genetic material, denaturation and renaturation, cot curves. DNA topology - linking number, topoisomerases; Organization of DNA Prokaryotes, Viruses, Eukaryotes. RNA Structure, Organelle DNA - mitochondria and chloroplast DNA.

#### UNIT II

Replication of DNA (Prokaryotes and Eukaryotes): Bidirectional and unidirectional replication, semi-conservative, semi-discontinuous replication. Mechanism of DNA replication: Enzymes and proteins involved in DNA replication – DNA polymerases, DNA ligase, primase, telomerase – for replication of linear ends. Various models of DNA replication including rolling circle, D-loop (mitochondrial),  $\Theta$  (theta) mode of replication and other accessory protein, Mismatch and excision repair.

#### UNIT III

Transcription in Prokaryotes and Eukaryotes: Definition, difference from replication, promoter - concept and strength of promoter RNA Polymerase and the transcription unit Transcription in Eukaryotes: RNA polymerases, general Transcription factors.

#### UNIT IV

Post-Transcriptional Processing: Split genes, concept of introns and exons, RNA splicing, spliceosome machinery, concept of alternative splicing, Polyadenylation and capping, Processing of rRNA, RNA interference: siRNA, miRNA and its significance.

#### UNIT V

Translation (Prokaryotes and Eukaryotes): Translational machinery, Charging of tRNA, aminoacyl tRNA synthetases, Mechanisms of initiation, elongation and termination of polypeptides in both prokaryotes and eukaryotes, Fidelity of translation, Inhibitors of protein synthesis in prokaryotes and eukaryotes

#### UNIT VI

Regulation of gene Expression in Prokaryotes and Eukaryotes: Principles of transcriptional regulation, regulation at initiation with examples from lac and trp operons, Sporulation in Bacillus, Yeast mating type switching, Changes in Chromatin Structure - DNA methylation and Histone Acetylation mechanisms.

#### Textbooks

- . Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
- . Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
- . De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia
- . Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
- . Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

## **Course Content:**

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### **Nanobiotechnology**

#### **UNIT I:**

**10 Lecture hours**

**Introduction:** Introduction to Nano-Biotechnology; Nanotechnology definition and concepts. Introduction to Nanostructures; Carbon Nanotubes (CNT), Fullerenes (C60, C300); Nano Peapods Quantum Dots & Semiconductor Nanoparticles.

#### **UNIT II**

**15 Lecture hours**

**Nanostructures:** Metal-based Nanostructures (Iron Oxide Nanoparticles), Polymer based

Nanostructures (Dendrimers), Gold Nanostructures: (Nanorods, Nanocages, Nanoshells), Protein-based Nanostructures: Nanomotors: Bacterial (*E. coli*) & Mammalian (Myosin family).

#### **UNIT III**

**5 Lecture hours**

**Nanobiosensors:** Science of Self-assembly - From Natural to Artificial Structures.

#### **UNIT IV**

**10 Lecture hours**

**Nanostructures for drug delivery:** Concepts, targeting, routes of delivery & advantages; Nanostructures for diagnostics & biosensors; Nanoparticles for diagnostics and imaging; Nanodevices for sensor development, tissue engineering, cancer therapy.

### **Suggested Books**

1. Bionanotechnology by David S. Goodsell, 2004, Wiley Publications.
2. Nanobiotechnology: Concepts, Applications and Perspectives by Christof M. Niemeyer, Chad A. Mirkin. ISBN: 978-3-527-30658-9. Wiley VCH, 2004.

## **Course Content**

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### **Energy Engineering and Biofuels**

#### **Unit 1**

**[Lesson hours: 7]**

Energy: Renewable & non-renewable resources - Water, Minerals, & Energy; Use & overexploitation; Classification & Sources of Energy; Problems relating demand & supply of various energy sources; Coal, Petroleum etc.

#### **Unit 2**

**[Lesson hours: 26]**

Conventional & non-conventional energy: Conventional fuels; firewood, plant & animal wastes; coal, gas, animal oils & their environmental impact; Modern fuels - methanogenic bacteria & biogas; microbial hydrogen production; conversion of sugars to ethanol, the gasohol experiment; solar energy converters; photosynthetic pigments, plant based petroleum industry, cellulose degradation for combustible fuels & their environmental impacts.

#### **Unit 3**

**[Lesson hours: 7]**

Biogas plant & its design: KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes; development in energy routes.

#### **Unit 4**

**[Lesson hours: 14]**

Clean coal technology: Biotechnology & Microbiology of Coal Degradation; Aerobic & Anaerobic pathway of coal degradation; Characterization & identification of bioconversion substrates & products; Biosolubilization & bioliquefaction of coal; Biotransformation of coal & oil; Mechanisms of coal biosolubilization; Enzymes that depolymerise coal; Recent Advances in Bioprocessing of coal.

#### **Unit 5**

**[Lesson hours: 6]**

Green technology – microbial fuel cell: From Microbes to Megawatts; Microbial Fuel Cells; Types of Biological fuel cells; Applications of Biological Fuel cells.

### **Text Books**

T1. Bioenergy and Biofuels by Ozcan Konur, 2017 by CRC Press. ISBN 9781138032811

T2. Madigan MT, Martink JM, Dunlap PV and Clark DP (2014) Brook's Biology of Microorganisms, 14th edition, Pearson-Benjamin Cummings

T3. Prescott & Dunn's Industrial Microbiology by G Reed, 2004

### **Reference Books**

R1. Biofuels and Bioenergy: Processes and Technologies by Sunggyu Lee and Y.T. Shah. 2012 by CRC Press, ISBN 9781420089554.

R2. Biotechnology. U Satyanarayan

**Course Content****Enzyme Technology Lab**

Topic	Contact hours
To study the effect of pH on the activity of an enzyme. Preparation of graph.	3 hrs
To study the effect of temperature on the activity of an enzyme. Preparation of graph.	3 hrs
Concepts on molarity and normality. Preparation of normal and molar solutions	3 hrs
Concepts on buffer and preparation of suitable buffer solutions for enzyme activity	3 hrs
Determination of pKa of amino acid	3 hrs
Estimation of blood glucose by glucose oxidase method	3 hrs
Estimation of blood glucose by biosensor method	3 hrs
Estimation of SGPT	3 hrs
Estimation of SGOT	3 hrs
Estimation of Uric acid	3 hrs
Estimation of Urea	3 hrs
Estimation of Creatinine	3 hrs
Estimation of TSH	3 hrs
Repeat lab	3 hrs
Practical related question discussion	3 hrs

**Books & Other Resources**

Text Book(s)	
T1	Lehninger Principles of Biochemistry Edition 4, Nelson, David L. Cox, Michael M. Lehninger, Albert L. W H Freeman & Co.
T2	Enzymes And Enzyme Technology 1 <sup>st</sup> Edition by Anil Kumar, Sarika Garg. ISBN-13: 978-1905740871.

T = Text Book; R = Reference Book

## **Course Content**

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### **Food Process Technology- II Lab**

1. Preparation of dry onion/ chilli/ garlic.
2. Cultivation of oyster mushrooms.
3. Manufacture of macaroni by extruder.
4. Manufacture of potato powder.
5. Manufacture of ice cream.
6. Manufacture of Rosogolla and Sandesh.
7. Manufacture of candid fruits.
8. Production of dried milk by drum drying
9. Production of milk powder by spray drying

#### **Text books:**

1. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
2. Meat; Cole DJA & Lawrie RA; 1975, AVI Pub.
3. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.
4. Developments in Meat Science – I & II, Lawrie R; Applied Science Pub. Ltd.

#### **References:**

5. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.
6. Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.
7. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp.

## **Course Content**

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### **Economics for Food & Nutrition Policy Lab**

Critiquing popular nutrition information  
Three-five days food quality record keeping  
Personal diet analysis report  
Evaluating carbohydrates in the diet  
Evaluating protein in the diet  
Evaluating fat in the diet  
Evaluating water, vitamins and minerals in the diet  
Consumer concerns about food/market survey

### **Books & Other Resources**

Nutrition Economics, 1st Edition, Principles and Policy Applications, Suresh Babu Shailendra Gajanan J. Arne Hallam, **Hardcover ISBN:** 9780128008782, **eBook ISBN:** 9780128011508.



## **Course Content**

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### **Genomics, Proteomics & Metabolomics Lab (SBT43207)**

1. Use of SNP databases at NCBI and other sites
2. Use of OMIM database
3. Detection of Open Reading Frames using ORF Finder
4. Proteomics 2D PAGE database
5. Softwares for Protein localization.
6. Agarose gel electrophoresis.
7. Native PAGE
8. SDS-PAGE
9. Genome comparison in bacteria, Proteome comparison in bacteria

### **Reference Books**

1. Molecular Biotechnology: Principles and Applications of Recombinant DNA, 4th Edition, B.R. Glick, J.J. Pasternak and C.L. Patten, 2010.
2. Molecular Cloning: A Laboratory Manual (3rd Edition) Sambrook and Russell Vol. I to III, 1989.

## **Course Content**

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### **Molecular Biology Lab (FTH12023)**

1. Study of different types of DNA and RNA using micrographs and model / schematic representations.
2. Study of semi-conservative replication of DNA through micrographs / schematic representations.
3. Isolation of genomic DNA from *E. coli*
4. Estimation of salmon sperm / calf thymus DNA using colorimeter (diphenylamine reagent) or UV spectrophotometer (A260 measurement).
5. Estimation of RNA using colorimeter (Orcinol reagent) or UV spectrophotometer (A260 measurement)
6. Resolution and visualization of DNA by Agarose Gel Electrophoresis.
7. Resolution and visualization of proteins by Polyacrylamide Gel Electrophoresis (SDS-PAGE).

### **Text Books:**

1. Watson JD, Baker TA, Bell SP, Gann A, Levine M and Losick R (2008) Molecular Biology of the Gene, 6th edition, Cold Spring Harbour Lab. Press, Pearson Publication
2. Becker WM, Kleinsmith LJ, Hardin J and Bertoni GP (2009) The World of the Cell, 7th edition, Pearson Benjamin Cummings Publishing, San Francisco
3. De Robertis EDP and De Robertis EMF (2006) Cell and Molecular Biology, 8th edition. Lippincott Williams and Wilkins, Philadelphia

### **Reference Books:**

1. Karp G (2010) Cell and Molecular Biology: Concepts and Experiments, 6th edition, John Wiley & Sons. Inc.
2. Sambrook J and Russell DW. (2001). Molecular Cloning: A Laboratory Manual. 4th Edition, Cold Spring Harbour Laboratory press.

## **Course Content**

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### **Capstone Project (Practical)**

#### **Course Timeline:**

**1<sup>st</sup> Semester:** Review of literature will be done based on initial project outline discussion to determine a feasible project.

**2<sup>nd</sup> Semester:** Discussion of the feasibility of the project and accumulation of all the RAW materials needed for the project.

**3<sup>rd</sup> Semester:** Based on the planned outline, the desired project will be executed. Simultaneously, a back-up planned will also be prepared in case the 1<sup>st</sup> project does not work well.

**4<sup>th</sup> Semester:** After completion of the project, the outcome of the project will be evaluated. **5<sup>th</sup> Semester: The overall project will be presented and novelty of the project will also be highlighted.**

# **SEMESTER VI**

## **Course Content**

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### **Process Calculations, Thermodynamics & Food Science**

#### **Unit 1**

**[Lesson hours: 7]**

Process Calculations, Material & Energy Balances : Mathematical requisites – use of log-log and semi-log graph papers, triangular diagram, graphical differentiation and graphical integration. Material balance without & with chemical reaction. Energy balance: enthalpy changes, heat of reaction and its temperature dependence, heats of solution and mixing, adiabatic flame temperature, use of psychometric charts.

#### **Unit 2**

**[Lesson hours: 26]**

Thermodynamics

Basic Concepts : The Ideal Gas; Review of first and second laws of thermodynamics; PVT behavior of pure substances; Virial equation of state; Application of the virial equations; Cubic equations of state; Generalized correlations for gases and liquids.

Vapour /Liquid, Liquid/Liquid, Solid/Liquid and Solid/Vapour Equilibria : Nature of equilibrium; Phase Rule; Duhem's theorem; Simple model's for vapour/liquid equilibrium; Rault's Law; Henry's Law; Modified Rault's Law; K-value correlations; VLE from Cubic Equations of State; Equilibrium and Stability; Liquid/liquid equilibrium; Solid/liquid equilibrium, Solid/vapour equilibrium.

#### **Unit 3**

**[Lesson hours: 7]**

Application of Thermodynamics : Chemical Potential and Phase Equilibria; Fugacity and fugacity coefficient for pure species and solution; Generalized correlations for fugacity; the Ideal Solution; Property changes and heat effects of mixing processes.

The Vapour-Compression Cycle; the choice of refrigerant; Absorption, Refrigeration and liquefaction: Low temperature cycle: Linde and Claude.

#### **Unit 4**

**[Lesson hours: 20]**

Introduction & definition of Food Science; Palatability of food and measurement of acceptance by :i)testing ii)appearance iii)smell iv)test; General structure and composition of cereals like wheat & rice, nutritive value & various products like whole wheat flour, maida, puffed rice etc; Food additives; classification, composition and nutritive value of fruits & vegetables; Milk & milk products; Classification & properties of sugar; fats, oil & nuts; Spice & beverages & their roles.

### **Text Books**

1. Coulson & Richardson's Chemical Engineering – Volume 3 (Chemical and Biochemical Reactors and Process Controls) ed. Richardson, J.F., Peacock, D.G., First Indian ed. Asian Books Pvt. Ltd. 1998
2. Levenspiel, O., Chemical Reaction Engineering, Willey Eastern Ltd.
3. Smith & Vanness, Thermodynamics for Chemical Engineers, MGH

### **Reference Books**

4. Food Science by Potter
5. Principles of Food Science Vol. I by Fennema, Karrel
6. Food Science by Mudambi

## **Course Content**

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### **Food Process Technology III**

#### **Unit 1**

**[Lesson hours: 7]**

Composition of milk; Varieties of milk; Checks for purity of milk; Handling of fresh milk. Pasteurization of milk; HTST and UHT techniques; Packaging of milk; Fermentation of milk and fermented milk products.

#### **Unit 2**

**[Lesson hours: 26]**

Manufacture of milk products like evaporated milk, powder milk, condensed milk, cream butter, cheese, yogurt, ice cream, ghee, baby food and sweet meat. Quality control of milk and milk products; Milk plant hygiene and sanitation.

#### **Unit 3**

**[Lesson hours: 7]**

Importance of fats and oils in foods; Sources of fats and oils; Extraction of fats and oils – rendering, pressing, solvent extraction; Processing of oils – degumming, refining, bleaching, deodorization, fractionation; Reversion and rancidity of fats and oils.

Natural vegetable oil and animal fat: source, composition, properties and industrial applications; Plastic fat in bakery and confectionary; Preparation of shortenings and margarine.

#### **Unit 4**

**[Lesson hours: 20]**

Manufacture of different types of fat/oil derived products: winterization, hydrogenation, esterification, inter-esterification & emulsification. Production technology of oilseed protein isolates; Standard and quality control of fats and fatty foods; By-products of fat/oil processing industries.

#### **Text Books**

Bailey's Industrial Oil and Fat Products, Vol 1 & 2; Swern D; 4th ed, 1982, John Wiley & Sons.  
The Chemistry & Technology of Edible Oils and Fats; Devine J & Williams PN; 1961, Pergamon Press.

#### **Reference Books**

Food Oils and their Uses; Weiss TJ; 1983, AVI.  
Edible Oils & Fats: Developments since 1978 (Food Technology Review # 57); Torrey S; 1983, NDC.

## **Course Content**

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### **Process Instrumentation and Control**

#### **UNIT I**

**(10 hrs)**

Operational aspect of instrument system, control and requisites; Analytical balance & spring balance, load cell, moisture measurement cells for granular material, infra- red transmission measurement of moisture.

#### **UNIT II**

**(8 hrs)**

Low pressure measurement by McLeod Gage and Pirani Gage; Temperature measurement by bi-metal thermometers – resistance thermometers, thermistors and thermocouples. Radiation and optical pyrometers; Flow measurement by magnetic flow meters.

#### **UNIT III**

**(20 hrs)**

Control system, Open and closed loop system, transfer function of open loop and closed loop control systems; Block diagrams; Laplace transform; Response of a control system; Stability; Feedback; Final control; Electronic circuit components.

#### **UNIT IV**

**(7 hrs)**

Controller mode, Root locus plot, Modulation, Electronic circuit components, Final control.

### **Books & Other Resources**

Instrumentation, Measurement and Analysis; Nakra BC & Chaudhury KK; TMH.  
Process System Analysis & Control; Coughanowr DR; MGH.

## **Course Content**

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### **Bioanalytical Tools**

#### **UNIT I**

Simple microscopy, phase contrast microscopy, florescence and electron microscopy (TEM and SEM), pH meter, absorption and emission spectroscopy

#### **UNIT II**

Principle and law of absorption fluorimetry, colorimetry, spectrophotometry (visible, UV, infrared), centrifugation, cell fractionation techniques, isolation of sub-cellular organelles and particles.

#### **UNIT III**

Introduction to the principle of chromatography. Paper chromatography, thin layer chromatography, column chromatography: silica and gel filtration, affinity and ion exchange chromatography, gas chromatography, HPLC.

#### **UNIT IV**

Introduction to electrophoresis. Starch-gel, polyacrylamide gel (native and SDS-PAGE), agarose-gel electrophoresis, pulse field gel electrophoresis, immuno-electrophoresis, isoelectric focusing, Western blotting. Introduction to Biosensors and Nanotechnology and their applications.

### **Text Books:**

1. Bioanalytics: Analytical Methods and Concepts in Biochemistry and Molecular Biology. May 2018 By Friedrich Lottspeich (Editor), Joachim W. Engels (Editor). ISBN: 978-3-527-33919-8. Wiley.
2. Karp, G. 2010. Cell and Molecular Biology: Concepts and Experiments. 6th Edition. John Wiley & Sons. Inc.
3. De Robertis, E.D.P. and De Robertis, E.M.F. 2006. Cell and Molecular Biology. 8th edition. Lippincott Williams and Wilkins, Philadelphia.
4. Biomolecular and Bioanalytical Techniques. Theory, Methodology and Applications by Vasudevan Ramesh (eds). 2019. ISBN: 9781119484011. Wiley.

### **Reference Books:**

1. Cooper, G.M. and Hausman, R.E. 2009. The Cell: A Molecular Approach. 5th edition. ASM Press & Sunderland, Washington, D.C.; Sinauer Associates, MA.
2. Becker, W.M., Kleinsmith, L.J., Hardin. J. and Bertoni, G. P. 2009 The World of the Cell. 7th edition. Pearson Benjamin Cummings Publishing, San Francisco.



## **Course Content**

### **Food Nutrition and Health**

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#### **Unit I: Introduction to the Study of Nutrition**

Foods, Nutrition and Health, Digestion, Absorption and Utilisation of Nutrients, The Recommended Dietary Allowances for Nutrients

#### **Unit II: Nutritional Biochemistry**

Carbohydrates, Fats and Other Lipids, Proteins and Amino Acids, Energy Metabolism, Fat-soluble Vitamins, Water-Soluble Vitamins, Major and Trace Minerals, Water, Fluids, Electrolytes and Acid-base Balance, Nutrition for Fitness, Athletics and Sports, Disorders of Nutrition

#### **Unit III: Food commodities and Personal Meal management and Family meal management**

Food Guides for Selecting an Adequate Diet, Meal Planning for the Family, Meal Planning for Various Age Groups, Indian Meal Patterns—Vegetarian & Non-Vegetarian

#### **Unit IV: Food Microbiology and Food Sciences**

Food Selection, Purchase and Storage, Food Preparation, Effect of Preparation on Food Components, Factors Affecting Food Acceptance, Food Sanitation and Hygiene

#### **Unit V: Diet and Therapy**

Adaptation of Normal Diet for Changing Needs, Principles of Diet Therapy and Therapeutic Nutrition, Nutrition in Infections, Fever and Lung Diseases, Nutrition in Diseases of the Gastrointestinal Tract, Nutrition in Diseases of Liver, Gallbladder and Pancreas, Nutrition in Diabetes Mellitus, Nutrition in Cardiovascular Diseases, Diet and Nutrition in Kidney Diseases, Nutrition in Cancer, Nutrition in Immune System Dysfunction, AIDS and Allergy, Nutrition Support in Metabolic Disorders, Nutrition in Stress, Burns and Surgery.

#### **Part VI: Natural products and Nutraceuticals**

Herbs and spices (Aloevera, Holy basil etc.), Fruits and vegetables (Noni, Indian Gooseberry, Indian blackberry, bitter gourd etc.), Protein sources (Soya and whey protein, Spirulina etc), Ancient Indian medicinal plants (Triphala, Cissus quadrangularis etc), Other Natural products enriched in Omega 3 fatty acid and vitamins.

#### **Text Books**

1. Complete Food and Nutrition Guide 5th Edition, by Roberta Larson Duyf
2. Molecular Nutrition and Genomics Nutrition and the Ascent of Humankind by Mark Lucock

#### **Reference Books**

1. The Gale encyclopedia of diets a guide to health and nutrition by Jacqueline L. Longe.

## **Course Content**

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### **Advances in Microbial Biotechnology**

#### **Unit 1**

**[Lesson hours: 8]**

Microbial biotechnology, scope and techniques, Bioprospecting of microbial diversity, Isolation and preservation of industrially important microorganisms. Genomics, Transcriptomics, Proteomics Metabolomics, metagenomics and Systems Biology.

#### **Unit 2**

**[Lesson hours: 10]**

Production of proteins and enzymes in bacteria yeast and fungus, recombinant and synthetic vaccines. Microbial polysaccharides and polyesters Microbes as biocontrol agents microbial insecticides (Baculoviruses, entomopathogenic fungi, *Bacillus thuringiensis* *Bacillus sphaericus* *Bacillus popilliae*, Microbe derived inhibitors.

#### **Unit 3**

**[Lesson hours: 10]**

Microbial biomass production, utilization of plant biomass by microorganisms (lignocellulose biodegradation), ethanol production, amino acids, antibiotics. Biotransformation of steroid and non-steroid compounds, metabolic engineering.

#### **Unit 4**

**[Lesson hours: 10]**

Biology of nitrogen fixation, preparation of different, Types of inoculants (nitrogen fixers phosphate solubilizers, plant growth promoting rhizobacteria, PGPR, composting.

#### **Unit-V**

**[Lesson hours: 7]**

Introduction to the use of microbes in environmental applications, Bioremediation, bioaugmentation, Bioemulsifiers, biosurfactants, MEOR, Leaching of ores. Microbial fuels (Methane, Hydrogen).

### **Books & Other Resources**

1. Plant Biotechnology: The Genetic Manipulation Of Plants by Adrian Slater, 2003
2. Biotechnology in Agriculture by Swaminathan, 2009
3. Plant Biotechnology by William G. Hopkins, 2006
4. Plants, Biotechnology and Agriculture (Modular Texts) by Denis Murphy, 2011

## **Course Content**

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### **Bakery, Confectionary and Extruded foods**

#### **MODULE 1 – INTRODUCTION TO BAKING**

Bakery ingredients and their functions; Machines & equipment for batch and continuous processing of bakery products

#### **MODULE 2 – BAKING TECHNIQUES**

Testing of flour; Manufacture of bread, cake and biscuits; Analysis of bakery products; Cake icing techniques, wafer manufacture, cookies and crackers.

#### **MODULE 3 – BAKED PRODUCTS**

Manufacture of bread rolls, sweet yeast dough products, cake specialties, pies and pastries, doughnuts, chocolates and candies; Maintenance, safety and hygiene of bakery plants.

#### **MODULE 4 –EXTRUDING TECHNOLOGY**

Objectives and importance of extrusion in food product development; Components and functions of an extruder; Classification of extruder; Advantages and disadvantages of different types of extrusion

#### **MODULE 5 – EXTRUDED PRODUCTS**

Change of functional properties of food components during extrusion; Pre and post extrusion treatments; Use of extruder as bioreactor; Manufacturing process of extruded products; Application of extrusion technologies in food industries.

#### **TEXT BOOKS**

- 1 Textbook of Bakery and Confectionery, Ashokkumar Y, PHI, 2012.
- 2 The Complete Technology Book on Bakery Products (Baking Science with Formulation & Production)3rd Edition, NIIR Board of Consultants & Engineers, ISBN: 9789381039380, 2014.

#### **Reference Books**

- 1.Hand book of bakery industries (how to manufacture bakery and confectionery products), Author: EIRI Books, ISBN: 9788186732182, 2014.
- 2 A Professional Text to Bakery and Confectionary, Kingslee, John J. ISBN : 978-81-224-1749-4, New Age International, 2014.

## **Course Content:**

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### **Process Equipment Drawing Lab**

#### **Mechanical design and drawing of process equipment:**

Pressure Vessels, Storage Tanks, Heat exchangers, Condensers.

Evaporators, Dryers, Cooling towers, Crystallizers.

Absorption columns, Distillation columns, Extraction columns, Reactors.

### **SUGGESTED BOOKS**

- M. V. Joshi and V. V. Mahajan, “Process Equipment Design”, 3<sup>rd</sup> Edition, MacMillan India Ltd., 1996
- J. M. Coulson and J. F. Richardson, “Chemical Engineering Vol. 6”, Asian Books Pvt Ltd, India, 1998

**Course Content:****Food Process Technology- III Lab**

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1. Analysis of jam.
2. Analysis of spices.
3. Analysis of milk.
4. Analysis of tea and coffee.
5. Analysis of wheat flour and bread.
6. Analysis of non-alcoholic beverages.

**Text books:**

1. Processed Meats; Pearson AM & Gillett TA; 1996, CBS Publishers.
2. Meat; Cole DJA & Lawrie RA; 1975, AVI Pub.
3. Egg and poultry meat processing; Stadelman WJ, Olson VM, Shemwell GA & Pasch S; 1988, Elliswood Ltd.
4. Developments in Meat Science – I & II, Lawrie R; Applied Science Pub. Ltd.

**References:**

5. Egg Science & Technology; Stadelman WJ & Cotterill OJ; 1973, AVI Pub.
6. Fish as Food; Vol 1 & 2; Bremner HA; 2002, CRC Press.
7. Fish & Fisheries of India; Jhingram VG; 1983, Hindustan Pub Corp.

**Course Content:**

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**Food Analysis and Quality Control Lab**

1. Analysis of lysine content in animal /vegetable sources.
2. Estimation of tin in canned foods.
3. Analysis of biscuits.
4. Analysis of fruit juice.
5. Analysis of sweetened condensedmilk.
6. Estimation of a) Iodine value, (b) Saponification value (c) acid value (d) RM value (e) K value of fats and oils.
7. Qualitative identification of adulteration in dairy products.

**Text books/ References:**

1. Bailey's Industrial Oil and Fat Products, Vol 1 & 2; Swern D; 4<sup>th</sup> ed, 1982, John Wiley & Sons.
2. The Chemistry & Technology of Edible Oils and Fats; Devine J & Williams PN; 1961, Pergamon Press.

## **Course Content**

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### **Technical Seminar**

1. Reading of breakthrough and current research papers from high impact journals containing biotechnological/allied-field research work and also performance of laboratory- based research-oriented experiments/design/proposal.

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# **SEMESTER VII**



**Course Content:**

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**Industrial Management****Module 1: Introduction****[10 Lecture Hours]**

Industrial management - Introduction: Concept, Development, application and scope of Industrial Management. Productivity: Definition, measurement, productivity index, types of production system, Industrial Ownership.

**Module 2: Basic Management Functions and Principles****[10 Lecture Hours]**

Management Function: Principles of Management – Time and motion study, work simplification – process charts and flow diagrams, Production Planning. Inventory Control: Inventory, Cost, Deterministic Models, and Introduction to supply chain management.

**Module 3: Quality Assurance****[5 Lecture Hours]**

Quality Control: Process control, SQC, Control charts, Single, Double and Sequential Sampling, Introduction to TQM.

**Module 4: Materials Management****[5 Lecture Hours]**

Fundamentals of Materials Management; Material cycle; Forecasting; Material Classification-need and usage, Single and Multidimensional classifications; Materials Codification-Usage, Codification types;

**Module 5: Production Planning****[10 Lecture Hours]**

Production Planning and Materials Requirements, Materials Procurement; Tendering; Types of Tenders, Storage and warehousing concepts, Receipt, Warehouse type, Layout, issue of materials and Updation of records; Manpower and equipment;

**Module 6: Project Management****[5 Lecture Hours]**

Project Management concept, Project Feasibility Studies, Project Identification, Market and Demand Analysis, Technical Analysis, Project Scheduling with PERT/CPM, Project Cost Estimate, Financial Appraisal of Single Project, Financial Appraisal of Multiple Projects, Project Cost Control (PERT/Cost).

**Text Books:**

1. Arnold, Chapman: Introduction to Materials Management: Pearson, 5th edition, 2008
2. Khanna, O. P., Industrial Engineering and Management, Dhanpat Rai Publications, ISBN- 10: 818992835X; ISBN-13: 978-8189928353

**Reference Books:**

- 1) Gopal Krishnan & Sundarsan: Material Management: An Integrated Approach, Prentice Hall of India Private Limited, New Delhi, 2003
- 2) Industrial Engineering and Management by OP Khanna, Dhanpat Rai Publications, Delhi.
- 3) Industrial Management by VK Sharma, OP Harkut.

## Course Content

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### Principles of Human Nutrition

#### Unit I

Dietary sources, intake levels, physiological role, and requirement of major nutrients.

The biological determinants of nutrient requirements and the assessment of nutrient status in individuals and populations.

#### Unit II

The role of nutrition in growth and health through the life cycle.

The rationale for the development of dietary guidelines and of nutrition policies in different countries.

#### Unit III

The role of diet in the development of chronic diseases, such as cardiovascular disease, cancer, diabetes, etc.

#### Textbooks

1. Principles of Human Nutrition. 2<sup>nd</sup> Edition. 2017. Martin Eastwood. Wiley-Blackwell. ISBN: 978-0632058112.

2. Human Nutrition - 2020 Edition. Marie Kainoa Fialkowski Revilla, University of Hawai'i, Mānoa. ISBN 13: 9781948027014. Publisher: University of Hawaii Manoa.

## Course Content

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### Quality control and Food Safety

#### Unit I

Food quality, food safety, food adulteration, food hazards. Natural toxins. National and international food laws Governing bodies.

#### Unit II

Food contaminants and pesticide residues, heat treatments and related processing techniques. Water and beverages such as soft drinks, tea, coffee, cocoa. Physical, chemical, nutritional, microbial, and sensory. Concepts of quality management. Principles of quality control. Quality management systems in India; Sampling procedures and plans. Food Safety organizations dealing with inspection, traceability and Labeling issues, International food standards.

#### Unit III

HACCP, Definition, Principles, Uses, How HACCP assists the food industry, Quality assurance, Total Quality Management, GMP/GHP, GLP, GAP, Sanitary and hygienic practices, Quality manuals, documentation and audits, Indian & International quality systems and standards like ISO and Food Codex, Export import policy and export documentation, Laboratory quality procedures and assessment of laboratory performance, Applications in different food industries.

#### Unit IV

Quality control in food service institutions, Introduction to the food and beverage sector, Sectors of the foodservice industry, Food and beverage operations, Classifications of food service establishments, Types of food and beverage services.

### Textbook

1. Food Safety and Standards Authority of India. Ministry of Health and Family Welfare, Government of India. Insel, P., Turner, E.R., Ross, D. Nutrition, 3rd edition. American Dietetic Association.
2. Food Quality, Safety and Technology. 2013 edition. Editors: Lima, Giuseppina P. P., Vianello, Fabio (Eds.). ISBN 978-3-7091-1640-1.

## **Course Content**

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### **Application of Genetic Engineering in Food Technology**

#### **Unit I**

Introduction to genetically modified plants, transgenic animals and their engineering methods, genetically modified microorganisms and their applications in foods.

#### **Unit II**

Dna Libraries, Construction of genomic and cDNA libraries, Artificial chromosomes – BACs and YACs, Screening of DNA libraries using nucleic acid probes and antisera.

#### **Unit III**

Sequencing and Amplification of DNA, Maxam Gilberts and Sangers methods of DNA sequencing. Inverse PCR, Nested PCR, AFLP-PCR, Allele specific PCR, Assembly PCR, Asymmetric PCR, Hot start PCR, inverse PCR, Colony PCR, single cell PCR, Real-time PCR/qPCR – SYBR green assay, Taqman assay, Molecular beacons. Site directed mutagenesis.

#### **Unit IV**

Risk and safety assessment of the GM foods and their labeling, Transgenic Crops, Risk Assessment and Regulatory Framework in the whole World.

#### **Unit V**

Applications of Rdna Technology in Foods (Remove Company Names), Genetically engineered proteins: Bovine Somatotropin in Milk; Genetically engineered bacteria: ChymosinLite beer; Tryptophan; Transgenic plants: Calgene Flavr Savr TM tomato, Monsanto Round-Up TM Ready, Ciba GeigyBasta TM resistant crops; Edible vaccines: Cholera vaccine in potatoes; Transgenic Fish: Atlantic salmon.

#### **Text Books:**

1. Rees, Andy Genetically Modifies Food: A Short Guide for the Confused. Pluto Press, 2006.
2. Ahmed, Farid E. Testing of Genetically Modified Organisms in Food. Food Products Press, 2004.

#### **References:**

1. Halford, Nigel G. Genetically Modified Crops. Imperial College Press, 2003.

## Course Content

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### Packaging of food products

#### Unit I

Introduction of Fruits and Vegetables. Classification and composition of fruits and vegetables, Climacteric and no-climacteric fruits; Post harvest handling, precooling methods, post-harvest treatments. Storage of fresh Fruits and Vegetables–Ambient, Refrigerated, Modified atmosphere, evaporative cool storage

#### Unit II

Jams, Jellies and Marmalades. Introduction, Jam: Constituents, selection of fruits, processing & technology, Jelly, Essential constituents (Role of pectin, ratio), Theory of jelly formation, Processing & technology, defects in jelly, Marmalade: Types, processing & technology, defects.

#### Unit III

##### Fruits Beverages

Introduction, Processing of fruit juices, Preservation of fruit juices: pasteurization, chemically preserved with sugars, freezing, drying, tetra-packing, carbonation. Processing of RTS, Processing of squashes, cordials, nectars, concentrates and powder.

#### Unit IV

##### Tomato Products and Potato Products

Introduction, Preparation of tomato juice, Soup, Preparation of tomato puree, Ketchup. Important consideration in potato processing, Potato chips, French fries.

### Textbooks

1. Handbook on Food Packaging Hardcover – August 2010 by John P. Jacob. Daya Publishing House. ISBN: 978-8170356493.
2. Food Packaging: Principles and Practice, Third Edition 2013 by Gordon L. Robertson. CRC Press. ISBN: 978-1439862414

## Course Content

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### Non-Thermal Food processing technologies

#### Unit I

Traditional preservation technologies emerging techniques - principles of minimal processing and non-thermal processing, use of natural food preservatives and hurdle technology concept Irradiation processing - equipment, effect on micro-organisms and foods.

#### Unit II

Non-thermal processing using high hydrostatic pressure, pulsed light, ultrasound, pulsed electric field, reverse osmosis and ultrafiltration Oscillating magnetic field processing - equipment, effect on micro-organisms, enzymes and food components Non-thermal processing applications in fruits and vegetables and sea foods Safety criteria for minimally and non-thermal processed foods.

#### Unit III

Freeze drying, freeze concentration, UV radiation, electron beam, ozone, antimicrobial proteins, non-thermal plasma tech., radio frequency based tech, electrolysed water, steam condensation and pasteurization, bacteriocins and lactoferrin, etc.

### Textbooks

1. Nonthermal Processing Technologies for Food. Editor(s): Howard Q. Zhang Gustavo V. Barbosa- Cánovas V.M. Balasubramaniam C. Patrick Dunne Daniel F. Farkas James T.C. Yuan. First published:31 December 2010 Print ISBN:9780813816685 |Online ISBN:9780470958360. Blackwell Publishing Ltd.

2. Non-thermal Food Engineering Operations by Ortega-Rivas, Enrique. 2012 edition. ISBN 978-1-4614-2038-5. Springer.

## Course Content

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### Separation, Purification Process

#### Unit I:

Purification, isolation Purification/crystallisation, the sublimation, distillation. Separation, Molecular properties utilised during separation.

#### Unit II:

Phase distribution theory: extraction, adsorption, analytical - and preparative chromatography Precipitation/crystallisation.

Migration in an external field: electrophoresis, sedimentation/centrifugation.

#### Unit III:

Analysis Issue - Sampling models for determination of both molecule - and element content in different sample types. - Sample preparation Analytical aspects on common decision methods within titrimetry, the elektroanalysis, spectroscopy (atomic and molecular) and different chromatographic methods. Detection: spectroscopic methods (IR, UV-Vis, fluorescence, AA), light scattering, mass spectroscopy, electrochemical analysis

#### Unit IV:

Experimental data processing. Calibration methods. Quality aspects on chemical methods of measurement. Statistical treatment of measurement data with help of different hypothesis testing (t-tests, F-tests and ANOVA and linear regression). Methods for determination of data uncertainty. Laboratory sessions. GC-HPLC, Preparative LC, extraction + AA, simple electrophoresis, computer exercises.

### Text Books

Belter, P.A., Cussler, E. L., and Hu, W.-S., Bioseparations: Downstream Processing for Biotechnology, Wiley, 1988.

McCabe, W.L., Smith, J.C., and Harriott, P., Unit Operations of Chemical Engineering, McGraw-Hill, 1993

\* Recommended reading will be selected chapters from textbook Additional readings & homeworks will be posted on Laulima: <https://laulima.hawaii.edu/portal> (Log on with your UH username and password, then click BE-437-001 [MAN.88774.SP09]).

## Course Content

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### Management of Food Industry Waste

#### Unit I

Identification of useful products from agricultural waste and food processing waste. Sources of waste and pollutants, Classification and characterization of Solid, Liquid and Gaseous wastes from food industry (Dairy industry, agro processing industry, meat industry, bakery industry) and its treatment. Pretreatment of waste: sedimentation, coagulation, flocculation and floatation, Secondary treatments: Biological oxidation, trickling filters, oxidation ditches, activated sludge process.

#### Unit II

Physico-chemical and microbiological analysis of effluent and treated water. Measurement of levels of Pollution such as COD, BOD, TOD, TDS, Turbidity, hardness of water, fat, oil and grease content, heavy metal content, forms of chlorides, fluorides, phosphorus and sulphur in waste waters, microbiology of effluent and treated water. Identification of insecticide, pesticides and fungicides in effluent water.

#### Unit III

Fish, Meat and Poultry industry's waste utilization: Type of waste from Fish, Meat and Poultry industries. Utilization of waste from these industries to produce various value added products.

#### Unit IV

Utilization of by-products from Wheat, rice, corn and dal mills: By products of wheat milling- germ and bran, rice milling-paddy husk, broken, rice bran, corn dry milling-tip cap, corn cob, germ, corn peel, corn wet milling-steep water, pulses milling - husk, germ, broken, powder.

#### Text Books:

1. Arnold, Chapman: Introduction to Materials Management: Pearson, 5th edition, 2008
2. Khanna, O. P., Industrial Engineering and Management, Dhanpat Rai Publications, ISBN- 10: 818992835X; ISBN-13: 978-8189928353

#### Reference Books:

- 1) Gopal Krishnan & Sundarsan: Material Management: An Integrated Approach, Prentice Hall of India Private Limited, New Delhi, 2003
- 2) Industrial Engineering and Management by OP Khanna, Dhanpat Rai Publications, Delhi.
- 3) Industrial Management by VK Sharma, OP Harkut



## Course Content

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### Food Plant sanitation

#### UNIT I

Food Plant Layout and Equipment Design. General principles of food plant Design and layout, Design of food processing equipments: Size Reduction, mixing, separation, extraction, filtration, centrifugation, distillation and, gas absorption equipments.

#### UNIT II

Warehousing and Cold Chain Management. Food hygiene and safety in transportation, with a focus on warehouse storage and refrigerated ships- Safe food storage at shopping outlets: use of coolers/chillers/freezers, length of time in storage, Design of warehouses Scope of Cold Chain for enhancing marketing potentials of perishables in domestic and international markets Principles of Cold Chain Creation and Management. Physico-chemical changes in stored products during storage Air tight, Non-air tight, Underground, Conventional & Modern storage structures for fruits, vegetables, meat and marine products. Aerated, refrigerated and controlled atmospheric storage. Layout and Design of storage structures, economics of storage structures.

#### UNIT III

Food Plant Hygiene and Sanitation. Waste disposal, Control methods using Physical and Chemical Agents, Pest and Rodent Control, ETP Design and Layout. Food storage sanitation, transport sanitation and water sanitation. 49 By-products utilisation obtained from dairy plant, egg& poultry processing industry and meat industry. Wastewater and solid waste treatment: - Waste-types-solid and liquid waste characterization, physical, chemical, biological, aerobic, anaerobic, primary, secondary and tertiary (advanced) treatments.

#### Textbooks

1. Food Plant Sanitation. Edited By Y. H. Hui, L. Bernard Bruinsma, J. Richard Gorham, Wai-Kit Nip, Phillip S. Tong, Phil Ventresca. ISBN 9781498783033. 2002 by CRC Press.
2. Food Plant Sanitation. Design, Maintenance, and Good Manufacturing Practices, Second Edition By Michael M. Cramer. ISBN 9781138198791. Published October 19, 2016 by CRC Press

## **Course Content**

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### **Bioethics, Biosafety & IPR**

#### **Unit I. Intellectual Property Right (IPR)**

##### **1. Concept and provisions of IPR                      Lecture hours 15**

Patents, Trademarks, Copyright, Conditional information, Breeder's right. Patent; importance, types, scope, criteria, applying for a patent. Protection of Biotechnological inventions. Patent infringement- meaning, scope, litigation, case studies and examples

**2. Agreements and Treaties** History of GATT & TRIPS Agreement; Madrid Agreement; Hague Agreement; WIPO Treaties; Budapest Treaty; PCT

#### **Unit II. Safety in Biotechnology Lecture hours 10**

Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals; Biosafety guidelines , Overview of Biotechnology Regulations and relevant International Agreements including Cartagena Protocol.

#### **Unit III. Bioethics**

##### **Lecture hours 8**

Biotechnology information, communication and public perception, Future prospects of consumers and social acceptance .Case studies

#### **Unit IV. Bio-entrepreneurship**

##### **Lecture hours 12**

Support mechanism for entrepreneurship in India; Leadership skills; Managerial skills; Team building; teamwork;. Taking decision on starting a venture; Assessment of feasibility of a given venture/new venture; Approach a bank for a loan; Sources of financial assistance; Making a business proposal/Plan for seeking loans from financial institution and Banks. Information technology for business administration, E-business setup and management.

#### **Suggested Books:**

1. The Ethics of Biotechnology by Jonathan Morris, 2005
2. Understanding Bioethics and the Law: The Promises and Perils of the Brave New World of Biotechnology by Barry R. Schaller, 2007
3. Nexus of Law and Biology: New Ethical Challenges by Barbara Ann Hocking, 2009
4. Intellectual Property and Biotechnology: Biological Inventions by Matthew Rimmer, 2008
5. An Introduction to Ethical, Safety and Intellectual Property Rights Issues in Biotechnology by Padma Nambisan, 2017
6. Biotechnology Entrepreneurship by Craig Shimasaki, 2014

## RESEARCH METHODOLOGY AND GLP (SBT44121)

## Lecture Hours 2

## Unit II

## Lecture Hours 3

Problem identification; Criteria for prioritizing problems for research.

## Lecture Hours 5

Analyzing the problem; Formulating the problem statement. Literature review: Uses of literature review; Definitions and Formulation of the research objectives.

## Lecture Hours 5

Research methodologies: Study population; Variables; Sampling; Sample size determination; Plan for data collection; Methods of data collection; Plan for data processing and analysis; Ethical considerations.

## Lecture Hours 5

Work Plan; Major components and outline of the different phases in a research process; Summary of the major components of a research proposal; Fieldwork; Writing a research report.

## Lecture Hours 5

**Introduction to the WHO/TDR Handbook on GLP;** Current Good Manufacturing Practices: Introduction, US Cgmp Part 210 and Part 211.EC Principles of GMP (Directive 91/356/EEC) Article 6 to Article 14 and WHO cGMP guidelines GAMP-5; Medical device and IVDs Global Harmonization Task Force(GHTF) Guidance docs.

## Lecture Hours 5

Introduction, USFDA GLP Regulations (Subpart A to Subpart K), Controlling the GLP inspection process, Documentation, Audit, goals of Laboratory Quality Audit, Audit tools, Future of GLP regulations, relevant ISO and Quality Council of India(OCI) Standards.

## Lecture Hours 5 Good Automated Laboratory Practices:

Introduction to GALP, Principles of GALP, GALP Requirements, SOPs of GALP, Training Documentation, 21 CFR Part 11, General check list of 21CFR Part 11, Software Evaluation checklist, relevant ISO and OCI Standards.

## Lecture Hours 5 Good Distribution Practices:

Introduction to GDP, Legal GDP requirements put worldwide, Principles, Personnel, Documentation, Premises and Equipment, Deliveries to Customers, Returns, Self-Inspection, Provision of information, Stability testing principles, WHO GDP, USP GDP (Supply chain integrity), relevant CDSCO guidance and ISO standards

## Lecture Hours 5 Quality management systems:

Concept of Quality, Total Quality Management, Quality by design, Six Sigma concept, Out of Specifications (OOS), Change control. Validation: Types of Validation, Types of Qualification, Validation master plan (VMP), Analytical Method Validation. Validation of utilities, [Compressed air, steam, water systems, Heat Ventilation and Air conditioning

products, ISO 13485, Sch MIII and other relevant

**Textbook:**

2. Handbook of Research Methodology, Dr. Shanti Bhushan Mishra Dr. Shashi Alok..
3. Research Methodology: Methods and Techniques, Book by C. R. Kothari.

## **Course Content**

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### **Nutritional Biochemistry Lab**

Biochemical nutritional status assessments  
Analysis of dietary intake  
Research and clinical dietetics  
Nutrition and related physiological research  
Establish and monitor nutritional requirements  
Assessments of bone remodeling

### **Textbook:**

Principles of Food Science, Vol-I by Fennema Karrel  
Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

### **Reference books:**

Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC  
Food Science by Mudambi.

## **Course Content**

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### **Quality control and food safety Lab**

Sampling techniques for chemical analysis of foods with respect to Macro & micro food nutrient analysis by colorimetric, spectrophotometric, fluorimetric and chromatographic techniques.

Definition and importance of sensory evaluation and General rules of sensory evaluation.

Requirements of sensory evaluation; Techniques of sensory evaluation: types of tests and ranking, scoring techniques.

Detection of Chemical contaminants /residues: pesticides; antibiotics; heavy metals

### **Textbook:**

Principles of Food Science, Vol-I by Fennema Karrel

Preservation of Fruits & Vegetables by Girdhari Lal, Sidhapa and Tandon

### **Reference books:**

Post Harvest Technology of cereal pulse and oil seeds by Chakraborty, AC

Food Science by Mudambi.

## Course Content

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### Minor Project

1. Reading of very recent research papers from high impact journals containing biochemical/allied-field research work and also performance of laboratory based research oriented experiments.

## Course Content

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### Industrial training

**Student Notebook and Portfolio:** A bound, paged notebook should serve as a reservoir of observations, results or conclusions about daily activities during the internship. Each date should be entered with a title of the activity in a form that can be listed in the table of contents, with appropriate page numbers. A brief concluding statement which suggests awareness of the purpose and important events or results acquired during the day should appear following any other observations or entries followed by the intern's signature. In addition, any interim projects or progress reports should be assembled or otherwise documented into a portfolio of products or findings arising from the internship.

**Written Presentation:** At the conclusion of the assignment student will be required to submit a formal written progress report a summary of the important findings; and a statement regarding the impact of these findings on future operations or directions relative to the problem under investigation.

**Oral Presentation:** Each student is required to make a formal oral presentation on the experience. The presentations will summarize the findings and the overall experience, especially reflecting on the experience relative to the course goal and learning objectives.



# **SEMESTER VIII**

## **Course Content**

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### **Major Project**

1. Reading of very recent research papers from high impact journals containing food and biochemical/allied-field research work and also performance of laboratory based research oriented experiments.

### **Catalog Description**

Dissertation allows students present their findings in response to a question or proposition that they choose themselves. The aim of the project is to test the independent research skills students have acquired during their time at university, with the assessment used to help determine their final grade. Although there is usually some guidance from your tutors, the dissertation project is largely independent.

## **Course Content**

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### **Comprehensive Viva-Voce**

1. Reading of Foodtechnology Text books, very recent research papers from high impact journals containing biology research work and also performance of laboratory based research oriented experiments.

### **Catalog Description**

The objective of comprehensive viva-voce is to assess the overall knowledge of the student in the relevant field of Biotechnology acquired over 4 years of study in the undergraduate program