Haldia Institute of Technology, West Bengal

(An Autonomous Institution under Maulana Abul Kalam Azad University of Technology)

Curriculum Structure for Bachelor of Technology in

BIOTECHNOLOGY

(Applicable for the Academic Session 2023-2024)

VISION

To evolve as a pioneer to combat biological challenges and to develop students with sound concepts in Biotechnology who can excel as Leaders in the field of Research, Entrepreneurship, Industry and Management.

MISSSION

M1. Implementation of outcome based teaching-learning methodology to fulfil current emerging challenges in various areas of Biotechnology.

M2. To fill up the gap between theory and practical in tune with the challenging demands of Biotechnology based industry and academia.

M3. To emphasize on certain areas such as soft skills, ethics, team spirit, environmental and societalissues for overall development.

PROGRAMME EDUCATIONAL OBJECTIVES (PEOs):

PEO 1: Creating Outcome Based Education in Biotechnology: To imbibe outcome based basic education of Biotechnology for the students to help them excel in all related fields with competence, technical knowledge and analytical skill.

PEO 2: Power to Work in Multidisciplinary Arena Bridging the Gap between Knowledge and Application: To train the students for attainment of multidisciplinary technical skills and modern technology to serve as an individual or as a leader with effective communication apt for industry, research & development sectors.

PEO 3: Competence to Provide Service to the Nation as Well as the Society: To fulfill the needs of society for solving medical, agricultural and environmental problems using biotechnological principle, tools and practices in an ethical and responsible manner.

PROGRAMME SPECIFIC OUTCOMES (PSOs):

PSO 1: An ability to understand the basic concepts of Biotechnology and its application in various fields.

PSO 2: An ability to combine the theoretical and practical knowledge to solve complex biological problems using appropriate analytical skills and modern tools.

PSO 3: An ability to build up a successful career compatible in real world with ethical awareness for developing as a working professional or a self-sustaining entrepreneur.

PROGRAM OUTCOMES (POs):

PO 1: Engineering knowledge: Apply the knowledge of mathematics, science, engineering fundamentals, and an engineering specialization to the solution of complex engineering problems.

PO 2: Problem analysis: Identify, formulate, review research literature, and analyze complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences, and engineering sciences.

PO 3: Design/development of solutions: Design solutions for complex engineering problems and design system components or processes that meet the specified needs with appropriate consideration for the public health and safety, and the cultural, societal, and environmental considerations.

PO 4: Conduct investigations of complex problems: Use research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of the information to provide valid conclusions.

PO 5: Modern tool usage: Create, select, and apply appropriate techniques, resources, and modern engineering and IT tools including prediction and modelling to complex engineering activities with an understanding of the limitations.

PO 6: The engineer and society: Apply reasoning informed by the contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to the professional engineering practice.

PO 7: Environment and sustainability: Understand the impact of the professional engineering solutions in societal and environmental contexts, and demonstrate the knowledge of, and need for sustainable development.

PO 8: Ethics: Apply ethical principles and commit to professional ethics and responsibilities and norms of the engineering practice.

PO 9: Individual and team work: Function effectively as an individual, and as a member or leader in diverse teams, and in multidisciplinary settings.

PO 10: Communication: Communicate effectively on complex engineering activities with the engineering community and with society at large, such as, being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.

PO 11: Project management and finance: Demonstrate knowledge and understanding of the engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.

PO 12: Life-long learning: Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Definition of Credit

1 Hr. Lecture (L) per week	1 credit
1 Hr. Tutorial (T) per week	1 credit
1 Hr. Practical (P) per week	0.5 credits

A. Range of credits

All B. Tech. programs include a range of credits from 160 to 165.

B. Mandatory Additional Requirement (MAR) for earning B. Tech Degree

Every student, who is admitted to the 4 years B. Tech program from the academic year 2019-20 onwards, is required to earn minimum 100 Activity Points, in addition to the required academic grades for getting B. Tech degree.

The MAR activities, (as per guideline of AICTE / affiliating University, MAKAUT) will provide necessary needs of modern industry and the society. Through this program, irrespective of one‟s technological field, each student develops the skill of active participation in the co-curricular and extra-curricular activities through SAWYAM based learning activities. Such activities enhance student‟s employability and global acceptances. Details are given in *Annexure-I*.

C. MOOCs for B. Tech Honours

A student will be eligible to get B.Tech Degree *with Honours*, if he/she completes an *additional 20 credits*, through Massive Open Online Courses (MOOCs). The complete description of the MOOCs relevant for the first year course is given in *Annexure-II*.

D. Guidelines regarding Mandatory Induction Program for the new students

The aim of the Induction Programme is to acclimatize the students to the environment of their engineering institution, give them a flavour of the exciting new world of education that they are entering, provide them with mentoring schemes, and make them aware of their neighbourhood, society and people. This will allow them to evolve as well rounded individuals. Details are given in *Annexure-III*.

E. Group division

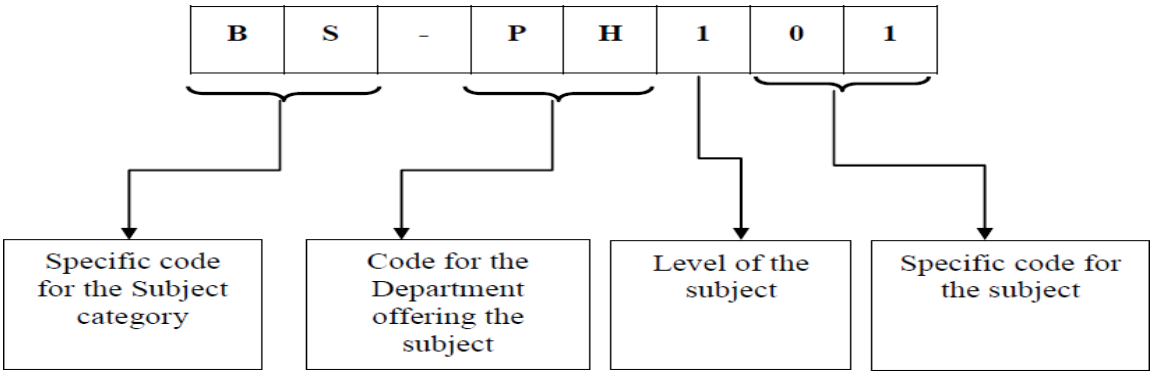
Group-A

All non-IT based programme like - Mechanical Engineering (ME), Chemical Engineering (CHE), Civil Engineering (CE), Electrical Engineering (EE), Applied Electronics & Instrumentation Engineering (AEIE), Biotechnology (BT), Food Technology (FT).

Group-B

All IT-based programme like – Computer Science & Engineering (CSE), Computer Science & Engineering (Cyber Security), Computer Science & Engineering (Data Science), Computer Science & Engineering (Artificial Intelligence & Machine Learning), Information Technology, Electronics & Communication Engineering (ECE).

Subject Numbering Scheme:



1ST YEAR-1ST SEMESTER

Theory							
Sl No.	**Paper Name**	**Paper Code**	**Marks**	**L**	**T**	**P**	**Credit**
1	**Mathematics-I [Group-A & B]**	**BS-M 101**	**100**	**3**	**1**	**0**	**4**
2	**Physics-I [Group-A] /Chemistry-I [Group-B]**	**BS-PH 101/BS-CH101**	**100**	**3**	**1**	**0**	**4**
3	**Basic Elec. & Electro. Engg. [Group-A] / Programming for problem solving [Group-B]**	**ES-EE 101/ES-CS 101**	**100**	**3**	**1**	**0**	**4**
4	**English Language and TechnicalCommunication. [Group-B]**	**HM-HU 101**	**100**	**2**	**0**	**0**	**2**
Total Marks: 300	**Total Credit:**	**12.0 [Group-A]**					
Total Marks: 400	**Total Credit:**	**14.0 [Group-B]**					
Practical							
5	**Physics-I Lab [Group-A]/ Chemistry-I Lab [Group-B]**	**BS-PH 191/BS-CH 191**	**100**	**0**	**0**	**3**	**1.5**
6	**Basic Elec. & Electro. Engg. Lab[Group-A] / Programming Lab [Group-B]**	**ES-EE 191/ ES-CS 191**	**100**	**0**	**0**	**3**	**1.5**
7	**Workshop Practice [Group-A]/Engg. Drawing [Group-B]**	**ES-ME 191/ES-ME 192**	**100**	**1**	**0**	**3**	**2.5**
8	**Language Lab [Group-B]**	**HM-HU 191**	**100**	**0**	**0**	**2**	**1**
Extra Curricular Activity							
9	**NSS[Group-A]**						
Total Marks: 300 &Total Credit: 5.5 [Group-A] **Total Marks: 400 &Total Credit: 6.5 [Group-B]**							

1ST YEAR-2ND SEMESTER

Theory							
SlNo.	**Paper Name**	**Paper Code**	**Marks**	**L**	**T**	**P**	**Credit**
1	**Mathematics-II [Group-A & B]**	**BS-M 201**	**100**	**3**	**1**	**0**	**4**
2	**Chemistry-I [Group-A]/Physics-I [Group-B]**	**BS-CH 201/BS-PH 201**	**100**	**3**	**1**	**0**	**4**
3	**Programming for problem solving[Group-A]/Basic Elec. & Electro. Engg. [Group-B]**	**ES-CS 201 / ES-EE 201**	**100**	**3**	**1**	**0**	**4**
4	**English Language and Technical Communication [Group-A]**	**HM-HU 201**	**100**	**2**	**0**	**0**	**2**
Total Marks: 400	**Total Credit:**	**14.0 [Group-A]**					
Total Marks: 300	**Total Credit:**	**12.0 [Group-B]**					
Practical							
5	**Chemistry-I Lab [Group-B]/Physics-I Lab [Group-A]**	**BS-CH 291/BS-PH 291**	**100**	**0**	**0**	**3**	**1.5**
6	**Programming Lab [Group-A]/Basic Elec. & Electro. Engg. Lab[Group-B]**	**ES-CS 291/ES-EE 291**	**100**	**0**	**0**	**3**	**1.5**
7	**Workshop Practice [Group-B] Engg.Drawing [Group-A] /**	**ES-ME291 /ES-ME292**	**100**	**1**	**0**	**3**	**2.5**
8	**Language Lab[Group-A]**	**HM-HU 291**	**100**	**0**	**0**	**2**	**1**
Extra Curricular Activity							
9	**NSS [Group-B]**						
Total Marks: 400 & Total Credit: 6.5 [Group-A] **Total Marks: 300 & Total Credit: 5.5 [Group-B]**							

2ND YEAR-3RD SEMESTER

A. THEORY (3rd Sem)							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
HM-BT301	Humanities and social Science and Management course	Ethics and Patenting in Biotechnology	3	0	0	3	3
PC-BT301	Professional Core	Biological Thermodynamics and Kinetics	2	0	0	2	2
PC-BT302	Professional Core	Structure of Biomolecules	3	0	0	3	3
PC-BT303	Professional Core	Biochemistry	3	0	0	3	3
PE-BT301	Professional Core Elective	Industrial Stoichiometry	3	0	0	3	3
BS-BT301	Basic Science Course	Microbiology	3	0	0	3	3
Total of Theory						17	17
B. PRACTICAL (3rd Sem)							
Code	**Field**	**Practical**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
PC-BT391	Professional Core	Biomolecular Analysis Lab	0	0	3	3	1.5
HM-BT391	Humanities and social Science and Management course	Technical Report Writing and Language Lab Practices	0	0	2	2	1
PC-BT392	Professional Core	Biochemistry Lab	0	0	3	3	1.5
BS-BT391	Basic Science Course	Microbiology Lab	0	0	3	3	1.5
Total of Practical						11	5.5
C. SESSIONAL (3rd Sem)							
SI-BT381	Summer Internship	Summer Internship-I [Seminar/Training /Workshop (online/offline)]	0	0	20	20	2
Total of 3rd Semester						48	24.5

2ND YEAR-4TH SEMESTER

A. THEORY (4th Sem)							
Code	Field	Theory	Contact Hours/Week				Cr. Points
			L	T	P	Total	
OE-BT401	Open Elective Course	Numerical Methods and Biostatistics	3	1	0	4	4
OE-BT402	Open Elective Course	Data Structure and Algorithms	3	0	0	3	3
*MC-BT401	Mandatory Course (Non Credit)	Environmental Science/ Engg.	2	0	0	2	0
ES-BT401	Engineering Science	Transfer Operation I	3	0	0	3	3
PC-BT402	Professional Core	Molecular Biology	3	0	0	3	3
PC-BT403	Professional Core	Industrial Biotechnology and Enzyme Technology	3	0	0	3	3
Total of Theory						18	16
B. PRACTICAL (4th Sem)							
Code	Field	Practical	Contact Hours/Week				Cr. Points
			L	T	P	Total	
OE-BT491	Open Elective Course	Numerical Methods and Biostatistics Lab	0	0	2	2	1
OE-BT492	Open Elective Course	Data Structure and Algorithms Lab	0	0	2	2	1
ES-BT491	Engineering Science	Transfer Operation I Lab	0	0	2	2	1
PC-BT491	Professional Core	Molecular Biology Lab	0	0	2	2	1
Total of Practical						8	4
C. SESSIONAL (4th Sem)							
SI-BT481	Summer Internship	Summer Internship-II (Assessment by Seminar/Viva Voce (online/offline))	0	0	20	20	2
Total of 4th Semester						46	22
Total Credit in 2nd year : 46.5							

NB: * Indicates Sessional Paper

3RD YEAR-5TH SEMESTER

A. THEORY (5th Sem)							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
HM-BT501	Humanities and social Science and Management course	Fundamentals of Management for Engineers	2	0	0	2	2
PC-BT501	Professional Core	Genetics	3	1	0	4	4
PC-BT502	Professional Core	Bioinformatics	3	0	0	3	3
ES-BT501	Engineering Science	Transfer Operation -II	3	0	0	3	3
OE-BT501	Open Elective Course	Data Base Management System and Computer Networking	3	0	0	3	3
PE-BT501	Professional Core Elective	Bioreactor Design And Analysis	3	1	0	4	4
Total of Theory						19	19
B. PRACTICAL (5th Sem)							
Code	**Field**	**Practical**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
PC-BT591	Professional Core	Genetics Lab	0	0	3	3	1.5
PC-BT592	Professional Core	Bioinformatics Lab	0	0	3	3	1.5
ES-BT591	Engineering Science	Transfer operation -II	0	0	3	3	1.5
OE-BT591	Open Elective Course	Data Base Management System Lab	0	0	3	3	1.5
Total of Practical						12	6
C. SESSIONAL (5th Sem)							
SI-BT581	Summer Internship	Summer Internship-III (Seminar/Training /Workshop) (online/offline)	0	0	15	15	1.5
Total of 5th Semester						46	26.5

3RD YEAR-6TH SEMESTER

A. THEORY (6th Sem)							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
HM-BT601	Humanities and social Science and Management course	Project Management and Entrepreneurship	2	0	0	2	2
PC-BT601	Professional Core	Recombinant DNA Technology	3	0	0	3	3
PC-BT602	Professional Core	Immunology	3	0	0	3	3
PC-BT603	Professional Core	Plant Biotechnology	3	0	0	3	3
PC-BT604	Professional Core	Downstream Processing	3	0	0	3	3
PE-BT602	Professional Core Elective	Animal Cell Culture & Animal Biotechnology	3	0	0	3	3
Total of Theory						17	17
B. PRACTICAL (6th Sem)							
Code	**Field**	**Practical**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
PC-BT691	Professional Core	Recombinant DNA Technology Lab	0	0	2	2	1
PC-BT692	Professional Core	Immunology Lab	0	0	2	2	1
PC-BT693	Professional Core	Plant Biotechnology Lab	0	0	2	2	1
PC-BT694	Professional Core	Fermentation Technology and Downstream Processing Lab	0	0	2	2	1
*HM-BT691	Humanities and social Science and Management course	Technical and Popular science article writing and Seminar Presentation (Based on Review article by PPT)	0	0	2	2	1
*MC-BT691	Mandatory Course (Non Credit)	Sports & Yoga (MC-BT691A)/ Personality Development Through Life Enlightenment Skills (MC-BT691B)	0	0	2	2	0
Total of Practical						12	5
C. SESSIONAL (6th Sem)							
SI-BT681	Summer Internship	Summer Internship-IV (Seminar/Training /Workshop) (online/offline)	0	0	15	15	1.5
Total of 6th Semester						44	23.5
Total Credit in 3rd year : 50							

NB: * Indicates Sessional Paper

4TH YEAR-7TH SEMESTER

A. THEORY (7th Sem)							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
PC-BT701	Professional Core	Food Biotechnology (PC-BT701)	3	0	0	3	3
PE-BT701	Professional Core Elective	Renewable Energy Technology (PE-BT701A) / Genomics and Proteomics (PE-BT701B) / Medical Informatics (PE-BT701C) / Bioprocess and Process Instrumentation (PE-BT701D)	3	0	0	3	3
PE-BT702	Professional Core Elective	Biomaterials (PE-BT702A) / Biosensor and Diagnostics (PE-BT702B) / Medical & Pharmaceutical Biotechnology (PE-BT702C)	2	0	0	2	2
OE-BT701	Open Elective Courses	Biosafety (OE-BT701A) / Soft Skill (OE-BT701B) / Research Methodology (OE-BT701C)	2	0	0	2	2
VAC (BT) 001	Value Added Course	Instrumentation and Techniques in Nanobiotechnology	30	0	0	30	0
VAC (BT) 002	Value Added Course	Advanced Tissue Engineering	30	0	0	30	0
Total of Theory						10	10
B. PRACTICAL (7th Sem)							
Code	**Field**	**Practical/ Sessional**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
HM-BT791	Humanities and social Science and Management course	Group Discussion	0	0	1	1	0.5
PC-BT791	Professional Core	Food Biotechnology Lab (PC-BT791)	0	0	2	2	1
Total of Practical						3	1.5
C. SESSIONAL (7th Sem)							
PW-BT781	Project	Project work-I (In-House/Industry/ Research Institute)	0	0	4	4	2
SI-BT781	Summer Internship	Summer Internship-V (Seminar/Training /Workshop) (online/offline)	0	0	15	15	1.5
Total of Sessional						19	3.5
Total of 7th Semester						32	15

4TH YEAR-8TH SEMESTER

A. Theory (8th Sem)							
Code	**Field**	**Theory**	**Contact Hours/Week**				**Cr. Points**
			L	**T**	**P**	**Total**	
VAC (BT) 003	Value Added Course	Synthetic Seed Production	30	0	0	30	0
VAC (BT) 004	Value Added Course	Protein Purification Techniques	30	0	0	30	0
B. SESSIONAL (8th Sem)							
PW-BT881	Project	Project work-II (In-House/Industry/ Research Institute)	0	0	18	18	9
SI-BT881	Summer Internship	Summer Internship-VI (Seminar/Training /Workshop) (online/offline)	0	0	15	15	1.5
Total of Sessional						33	10.5
Total of 8th Semester						33	10.5
Total Credit in 4th year : 25.5							

Code	Field		Different year	Total Credit	Additional Credits
BS	Basic Science Courses		1st year :	38	8
ES	Engineering Science Courses		2nd year :	46.5	4
PC	Professional Core Courses		3rd year :	50	4
PE	Professional Core Electives		4th year :	25.5	4
HM	Humanities, Social Sciences including Management		Total:	160	20
OE	Open Elective course	Additional 20 credits are required for the Degree of Bachelor of Technology with Honours. These additional 20 credits to be acquired with online courses (MOOCs) as per AICTE for obtaining B.Tech Honours degree which are distributed over four years in the following way: For first year : 8 credits For second year : 4 credits For third year : 4 credits For fourth year : 4 credits			
MC	Mandatory Course				
SI	Summer Internship				
PW	Project				

Paper Name: Mathematics-I	Category: Basic Science Course
Paper Code: BS-M101	Semester: First
L-T-P: 3-1-0	Credit: 4

Total Lecture: 45L

Course Objectives

- Providing the core concepts of higher Engineering Mathematics and describing the techniques, this works as an essential tool to solve the problems in their field of applications.
- To provide an overview of Differential Equations, Laplace Transform and Complex Analysis to engineers.

Module-1[8L] Matrix& Determinant:

Inverse and rank of a matrix; Elementary row and column operations over a matrix; System of linear equations and its consistency; Rank and nullity; Determinants; minors and cofactors; Eigen values and eigen vectors; Diagonalization of matrices; Cayley Hamilton theorem; Orthogonal transformation.

Module-2[9L] Differential Calculus:

Successive derivative, Leibnitz‟s Theorem; Rolle‟s Theorem, Mean value theorem, Taylor‟s and Maclaurin‟s theorems with remainders;

Sequence and Series:

Basic concept of Convergence of sequence and series; Tests for convergence: Comparison test, Cauchy‟s Root test, D‟ Alembert‟s Ratio test(statements and related problems on these tests), Raabe‟s test; Alternating series; Leibnitz‟s Test (statement only); Absolute convergence and Conditional convergence.

Module-3[8L] Integral calculus:

Improper integrals; Beta and Gamma functions and their properties; Convergence of improper integrals; Applications of definite integrals to evaluate surface areas and volumes of revolutions. Differentiation under integral sign.

Module-4[10L]

Calculus of function of several variables:

Introduction to functions of several variables;Limit and continuity, Partial derivatives, Homogeneous functions and Euler‟s theorem up to three variables, Chain rules, Differentiation of implicit functions, Total differentials and their applications, Jacobians up to three variables Maxima, minima;Saddle points of functions; Lagrange Multiplier method and their applications; Concept of line integrals, Double and triple integrals.

Module-5[10L] Vector Calculus:

Scalar and vector triple products with related problems, Equation of straight line, plane and sphere. Vector function of a scalar variable, Differentiation of a vector function, Scalar and vector point

functions, Gradient of a scalar point function, divergence and curl of a vector point function, Directional derivative. Related problems on these topics. Green‟s theorem, Gauss Divergence Theorem and Stoke‟s theorem (Applications only, proofs not required).

Course Outcomes (COs)

CO1. To provide students with skills in algebra and calculus which would enable them to devise engineering solutions for given situations they may encounter in their profession.
CO2. An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice by enhancing the power of knowledge and imagination
CO3. Prepare students for realization of journal papers outcomes, and expose them to the world of research. Illustrate the current research works and publications of the subjects in different fields adopted by the students as per course curriculum in various journals and literature.
CO4. To explore and enhance research potential explain how the ideas those are adopted can be implemented through projects and demonstrate various models, recent project proposals executing the knowledge adopted from the course.
CO5. An ability to function on multi-disciplinary teams. Lighten on the latest and modern developments in the fields.
CO6. Explain about ethical awareness and impact in the field of environmental, social and safety of the finished products. Describe the pollution, legal aspects and impacts may arise in large scale production.

Learning Resources

1. Advanced Engineering Mathematics , by Erwin Kreyszig is published by Wiley India
2. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
3. Higher Engineering Mathematics: John Bird (4th Edition, 1st Indian Reprint 2006, Elsevier)
4. Engineering Mathematics: S. S. Sastry (PHI, 4PthP Edition, 2008)
5. Advanced Engineering Mathematics, 3E: M.C. Potter, J.L. Goldberg and E.F. Abonfadel (OUP), Indian Edition.

Paper Name: Mathematics-II	**Category: Basic Science Course**
Paper Code: BS-M201	**Semester: Second**
L-T-P: 3-1-0	**Credit: 4**

Total Lecture: 45L

Course Objectives

- Providing the core concepts of higher Engineering Mathematics and describing the Techniques, this works as an essential tool to solve the problems in their field of applications.
- To provide an overview of Differential Equations, Laplace Transform and Complex Analysis to engineers.

Module -1[10L]

Ordinary differential equation (ODE)- First order and first degree: Exact equations, Necessary and sufficient condition for exactness of a first order and first degree ODE (statement only), Rules for

finding Integrating factors, Linear and non-linear differential equation, Bernoulli‟s equation. General solution of ODE of first order and higher degree (different forms with special reference to Clairaut‟s equation).
Second order and first degree: General linear ODE of order two with constant coefficients, C.F. & P.I., D-operator methods for finding P.I., Method of variation of parameters, Cauchy-Euler equations.

Module -2[5L]

Basics of Graph Theory: Graphs, Digraphs, Weighted graph, Connected and disconnected graphs, Complement of a graph, Regular graph, Complete graph, Subgraph,; Walks, Paths, Circuits, Euler Graph, Matrix representation of a graph, Adjacency and incidence matrices of a graph,Graph isomorphism, Bipartite graph.

Module -3[10L]

Laplace Transform: Introduction to integral transformation, functions of exponential order, Definition and existence of LT (initial and final value theorem with applications proofs not required), LT of elementary functions, Properties of Laplace Transformations , Evaluation of sine , cosine and exponential integrals using LT, LT of periodic and step functions.
Definition and properties of inverse LT Convolution Theorem (statement only) and its application to the evaluation of inverse LT, Solution of linear ODEs with constant coefficients (initial value problem) using LT.

Module -4[12L]

Complex Variable: Complex functions, Concept of Limit, Continuity and Differentiability. Analytic functions, Cauchy-Riemann Equations (statement only). Sufficient condition for a function to be analytic. Harmonic function and Conjugate Harmonic function, related problems. Construction of Analytic functions: Milne Thomson method, related problems. Conformal mappings, Bilinear transformation, Mobius transformations and their properties.

Complex Integration: Concept of simple curve, closed curve, smooth curve & contour. Some elementary properties of complex Integrals. Line integrals along a piecewise smooth curve. Cauchy‟s theorem (statement only). Cauchy-Goursat theorem (statement only). Cauchy‟s integral formula, Cauchy‟s integral formula for the derivative of an analytic function, Cauchy‟s integral formula for the successive derivatives of an analytic function.

Module -5[8L]

Zeros and Singularities of an Analytic Function & Residue Theorem.

Zero of an Analytic function, order of zero, Singularities of an analytic function. Isolated and non-isolated singularity, essential singularities. Poles: simple pole, pole of order m. Examples on determination of singularities and their nature. Taylor‟s series, Laurent‟s series.

Residue, Cauchy‟s Residue theorem (statement only), problems on finding the residue of a given function, evaluation of definite integrals:

$$\int_0^{\infty} \frac{\sin x}{x}\,dx, \int_0^{2\pi} \frac{d\theta}{a+b\cos\theta+c\sin\theta}, \quad \int_C \frac{P(z)}{Q(z)}\,dz$$

(elementary cases, P(z) & Q(z) are polynomials of 2nd order or less). Evaluation of certain improper integrals using theBromwich contour.

Course Outcomes(COs)

CO1. Recall the earlier mathematical thoughts, such as idea of derivative, integration, ordinary differential equations and complex algebra.
CO2. Exhibit the idea of ordinary differential equation of first and higher order. Recognize the conceptof graph theory and Laplace transform and complex variable.
CO3. Apply the knowledge of Laplace transform to reduce the complexity of differential equation. Use different graphical algorithm to find optimal solutions.
CO4. Analyze the ideas of mentioned mathematical tools so that it can be implemented to real time engineering problems
CO5. Justify and make gradation of above mentioned mathematical tools and determine the right approach to solve multidisciplinary engineering problems.
CO6. Build up logical and analytical skills to create a new idea appreciated by academics, research & emerging trends in industry.

Learning Resources

1. Probability and Statistics for Engineers, Miller & Freund R.A.Johnson, Prentice Hall ofIndia
2. Advanced Engineering Mathematics, Erwin Kreyszig, (Wiley Eastern)
3. Graph Theory: V. K. Balakrishnan, (Schaum"s Outline, TMH)
4. Engineering Mathematics: B.S. Grewal (S. Chand & Co.)
5. Introductory Course in Differential Equations: Daniel A. Murray (Longmans & Green).
6. Graph Theory: N. Deo (Prentice-Hall of India)
7. Numerical Analysis and Computational Procedures, Sahajahan Ali Mollah, Books & AlliedLtd
8. Fundamentals of Mathematical Statistics, Gupta & Kapoor, (Sultan Chand &Sons).
9. Schaum's Outlines: Laplace Transforms ,Murray R. Spiegel,

Paper Name: Physics –I	**Category: Basic Science Course**
Paper Code: BS-PH 101 / BS-PH 201	**Semester: First / Second**
L-T-P: 3-1-0	**Credit: 4**

Total Lecture: 42L

Course Objectives

- To introduce the rudimental and relevant concepts of physics to different branches of Engineering and Technology.
- To compile all the knowledge acquired from the course and to apply in industry, academia, and research keeping in the mind about ethical awareness and impact in the field of environmental (pollution), social (legal) and safety.

Module-1 [10L]Vector Calculus

Gradient of a Scalar function, Divergence and Curl of Vector field, Vector Integration –Line-, surface and volume integration - Divergence and Stoke‟s Theorem

Oscillations And Waves

Simple Harmonic Oscillation- Motion of simple and compound pendulum –Energy Considerations - Coupled oscillations, approximate solutions, linear and transverse oscillations.
Damped Oscillations – Over damped - critical damping –oscillatory damping – Relaxation time & log decrement. Forced oscillation – Electromechanical Analogy between Mechanical Oscillator with Electrical circuit – Mechanical Impedance - Transient and Steady state oscillations – Resonance - Power considerations - Low and high frequency responses –Bandwidth – Quality factor - Sharpness of Resonance

Module -2 [11L]

Interference – Division of wave front and division of amplitude - Two-and Multiple Beam Interference, Interference in parallel and wedge shaped films - Newton‟s rings - determination of wave length and thickness - Thin film Interference - Anti-reflection Coating – its application.

Diffraction – Fresnel and Fraunhofer diffraction - Single Slit, Double Slit and N-Slit Diffraction (Qualitative discussion only)

Polarization – Introductory discussion of Polarization – States of Polarization – Brewster‟s law –Malus Law – Phase Retardation Plate –Optical Activity

Lasers – Characteristics of Laser – Classification of Laser - construction and working - Einstein‟s coefficients – Example of Gas Laser, Solid state laser and semiconductor lasers - Applications of Laser

Module -3 [5L] Statistical Mechanics

Phase Space (μ- and Γ- phase space) – Macro states and Microstates – Density of States - Statistical Ensemble and Thermodynamic Probability
Classical Statistical systems (Maxwell - Boltzman statistics) and quantum statistical systems (Fermi-Dirac and Bose-Einstein Statistics) and their applications

Module -4 [10L] Quantum Mechanics

Blackbody Radiation – Stefan-Boltzmann law - Wein‟s displacement law - Wein‟s distribution law - Rayleigh-Jeans law - Ultraviolet catastrophe - Planck‟s Radiation law, Compton Effect, Dual Nature of Matter – De‟ Broglie hypothesis – Heisenberg‟s Uncertainty Principle – Group velocity and Phase velocity, Wave function – Postulates of Quantum Mechanics – Quantum Mechanical operator –Eigen function and Eigen value - Schrödinger‟s time dependent and time independent wave equation – Particle in 1D box –Particle in 3D box – Concept of degeneracy

Module -5[6L] Dielectric Polarization

Fundamentals of Dielectric polarization – Macroscopic and microscopic field – Electronic, Ionic,

Orientational and Space charge polarization (Qualitative overview) - dielectric loss- Loss tangent - Application of dielectric materials

Magnetic Properties

Fundamentals of magnetic properties – Classification (Dia, Para, Ferro, Anti-ferro, Ferri, Super-para) of magnetic materials – Curie temperature – Magnetic domain – Hysteresis – hard and soft magnetic materials –Applications of Magnetic materials

Course Outcomes(COs)

CO1. Describe how different electronic tools, various parameters & variables of fundamental physics related to the programme. To overcome & eliminate different constraints those may arises by solving the physical and numerical problems.
CO2. Overall enhancement of innovative problems solving ability by enhancing the power of knowledge and imagination.
CO3. Describe the current research works and publications of the subjects in different fields adopted by the students as per course curriculum in various journals and literature.
CO4. Describe how the ideas those are adopted can be implemented through projects and demonstrate various models, recent project proposals to execute the knowledge adopted fromthe course.
CO5. Define how the ideas can be share with the multi - disciplinary personals. Lighten on the latest and modern developments in the fields.
CO6. Explain about ethical awareness and impact in the field of environmental, social and safety of the finished products. Describe the pollution, legal aspects and impacts may arise in large scale production.

Learning Resources

1. Vector Analysis – M.R.Spiegel
2. Waves and Oscillation – N.k.Bajaj
3. Introduction to Classical Mechanics R Takwale, P Puranik, McGraw Hill Education
4. Principles of Physics, 10ed, David Halliday, Robert Resnick Jearl Walker , Wiley
5. Optics –A.K.Ghatak McGraw Hill Education India Private Limited
6. Modern Physics for Scientists and Engineers, J. R. Taylor, C.D. Zafiratos and M. A. Dubson, 2nd Ed., Pearson (2007)
7. Modern Quantum Mechanics, J. J. Sakurai, Cambridge University Press
8. Solid State Physics, S.O.Pillai

Paper Name: Chemistry-I	**Category: Basic Science Course**
Paper Code: BS-CH-101 / BS-CH-201	**Semester: First / Second**
L-T-P: 3-1-0	**Credit: 4**

Total Lecture: 42L

Course Objective

- To develop the interest among the students regarding chemistry and their applications in engineering
- To develop confidence among students about chemistry, how the knowledge of chemistry is

applied in technological field.

Module I [11L] Thermodynamics: (*6L)*

Preliminary information on First Law of Thermodynamics (Principle, Molar Heat Capacity; Relationof C_p and C_V (for Ideal and Real Gas); Joule‟s Experiment, Joule-Thompson Co-efficient, Throttling, Adiabatic Relationship); Second Law, Engine; Carnot‟s Cycle; Entropy, Entropy change; Entropy of system/surrounding/Universe; Free Energy, Free energy expression; Gibbs-Helmholtz equation; Clausius-Clapeyron equation; Maxwell relations.

Electrochemistry: *(2L)*

Cell construction; Primary and Secondary Cell; Nernst Equation; Relation with ΔG, ΔH and ΔS; pH of Cell; Batteries; Fuel Cell

Chemical Kinetics: (*3L)*

Rate equation; Collision and Activation Theory; Temperature dependency; Complex Reaction; Parallel reaction; Consecutive reaction; Chain Reaction; Homogeneous and Heterogeneous Catalyst; Acid base catalysis; Enzyme Catalysis; Michaelis Menten equation.

Module II [8L] Atomic structure:(*3L)*

Preliminary Accounts on Bohr-Sommerfeld model of the atom (Electronic configuration and Quantum numbers; Shapes of *s, p, d, f* orbitals - Pauli‟s exclusion principle - Hund‟s Rule of maximum multiplicity – Aufbau principle). Emission and absorption spectra, line and band spectra; Hydrogen spectrum – Lyman, Balmer, Paschen, Brackett and Pfund series; de-Broglie‟s hypothesis; Heisenberg‟s uncertainty principle – wave nature of electron – Schrodinger wave equation (No derivation). Eigenfunctions and eigenvalues.

Chemical bonding and Coordination Chemistry: (*5L)*

Elementary information on Chemical bondingincluding VBT, Shapes of molecules with hybridization, Valency shell electron pair repulsion (VSEPR) theory. Molecular orbital of diatomic molecules (e.g. H_2, O_2, N_2, CO, HF, CN^-, NO^+). Pi-molecular orbital of butadiene and benzene. Crystal field theory of coordination compounds- magnetism, spin and orbital contribution, quenching of magnetic moment: d-d transitions, color. Metallic bond – concept of conductor, semiconductor, insulator; photoelectric effect.

Module III [7L]

Organic Spectroscopy (7L)

UV-Visible Spectroscopy: Types of electronic transitions, chromophores and auxochromes; Bathochromic and Hypsochromic shifts; intensity of absorptions (Hyper-/Hypochromic effects); application of Woodward‟s Rules for calculation of λ_{max} for the following systems: conjugated dienes, relative positions of λ_{max} considering conjugative effect, steric effect, solvent effect.
IR Spectroscopy: Introduction; modes of molecular vibrations (fundamental and nonfundamental); IR active molecules**.**
NMR Spectroscopy: Basic principles of Proton Magnetic Resonance; NMR active molecules; equivalent and non-equivalent protons with examples; chemical shift. Significance of the terms: up-

/downfield, shielded and deshielded protons. Fluorescence, phosphorescence and their application.
Mass Spectroscopy: Introduction; Principles, Ion sources**,** Fragmentation and analysis of massspectra.

Module IV [6L]Polymer (*3L)*

Molecular weight of Polymers (number average, weight average, viscosity average), Polymerization processes (addition and condensation), Mechanism of addition polymerization (free radical, cationic, anionic, coordination), Poly Dispersity Index (PDI), Degree of Polymerization, Stereo-regularity of polymers (crystallinity and amorphicity). Vulcanization. Conducting, semi-conducting polymers and doping.

Corrosion (3L)

Types of corrosion (dry, wet),Pitting corrosion, Crevice corrosion, Galvanic series, Stress corrosion cracking, Corrosion of polymers. Protection from Corrosion (Surface treatments, Reactive coatings, Anodization, Biofilm coatings) Sacrificial anode protection, Rust removal, Passivation, Water treatment (waste, surface), Alkalinity, Scale-sludge.

Module V [6L] Stereochemistry *(4L)*

Different types of isomerism;concept of chirality and optical activity (upto two carbon atoms); elements of symmetry [plane (σ), center (i) and alternating axis (Sn) of symmetry]; interconversion of Fischer and Newman representations; threo and erythro, D and L, CIP Rules: R/S (upto 2 chiral carbon atoms),E/Z nomenclature. Conformational analysis of ethane, *n*-butane.

Structure and reactivity of Organic molecule (*2L)*

Molecular Effects: Inductive, resonance, hyperconjugation, steric effects. Oxidation and reduction reactions for organic compounds. Some name reactions: Aldol, Cannizzaro, Michael, Claisen-Schmidt, Wittig reactions.

Module VI [4L]

Elementary Chemical Biology:

Origin of Life and Chemical Elements; Role of concentration of ions/small molecules in the growth profile of cells; Trace and Ultratrace elements; Basic Biomolecules, Elementary reactions in thebiological system and roles of metal ions. Function of Fe (with special reference to Hemoglobin and Myoglobine) and Cu (with special reference to Hemocyanin) in Biological system. Toxicity of Hg, As, Pb, F, P(V).Synthesis of some commonly used drug molecules (Aspirin, Paracetamol, Salbutamol and Ibuprofen). Synthesis of some commonly used Pesticides and Insecticides in Agriculture: DDT, Gammaxene/Lindane (organochlorine group), Parathion (organophosphate group) and Carbaryl (carbamate group).

Course Outcomes(COs)

CO1. To memorize the elementary topics of chemistry such as chemical thermodynamics, atomic structures, electromagnetic spectroscopy, corrosion chemistry, electrochemistry, organic reactions and synthesis of drug molecules.

CO2. To acquire knowledge on the fundamental concepts of chemical thermodynamics, atomic structures, electromagnetic spectroscopy, corrosion chemistry, electrochemistry, organic reactions, polymers and synthesis of drug molecules.
CO3. Making use of concepts of drug molecules, polymer chemistry, corrosion chemistry and battery technology to meet day to day necessities including application of the organic synthesis, Maxwell‟s equations, spontaneity and equilibrium reactions etc.
CO4. analyse versatileand novel problems and sorting them out,covering all the topics of the entire course.
CO5. rationalize, explain and corroborate several chemical problems, determine the most plausible approach of solving real life interdisciplinary chemical complications.
CO6. To construct apurposeful and efficient model through which learners can be able to develop and solve trivial as well as up to date problems recognized by academia, researchers and industries.

Learning Resources

1. P.C.Rakshit, , Physical Chemistry Sarat Book House
2. S. Pahari, , Physical Chemistry New Central Book Agency
3. P. W. Atkins, & Paula, J. de Atkins‟, Physical Chemistry, Oxford UniversityPress
4. J. D. Lee, Concise Inorganic Chemistry, 5th Ed., Wiley India Pvt. Ltd.
5. F.A. Cotton, G. Wilkinson, and P.L. Gaus, Basic Inorganic Chemistry 3rdEd.; Wiley India.
6. J. E. Huheey, E. A. Keiter, & R. L. Keiter, Inorganic Chemistry, Principles ofStructure and Reactivity 4th Ed., Harper Collins 1993, Pearson,2006.
7. J. Clayden, N. Greeves, S. Warren, Organic Chemistry, Second edition, Oxford University Press.
8. S. Sen Gupta, Reaction Mechanisms in Organic Chemistry, Oxford University Press
9. L. Finar, Organic Chemistry (Volume 1) Pearson Education.
10. R. N. Morrison, & R. N. Boyd, Organic Chemistry, Dorling Kindersley (India) Pvt. Ltd. (Pearson Education).
11. D. Nasipuri, Stereochemistry of Organic Compounds, Wiley Eastern Limited.
12. E. L. Eliel, & S. H. Wilen, Stereochemistry of Organic Compounds, Wiley: London, 1994.
13. B. K. Sharma,Industrial Chemistry (including Chemical Engineering), GOEL Publishing House

Paper Name: Programming for Problem Solving	**Category: Engineering Science Course**
Paper Code: ES-CS-101/ES-CS -201	**Semester: First / Second**
L-T-P: 3-1-0	**Credit: 4**

Total Lecture: 40LCourse Objectives

- To introduce to students to the field of programming using language.
- To enhance their analyzing and problem solving skills**.**

Module 1 [12L]

Unit 1: Introduction to Programming (4 L)

Introduction to components of a computer system (disks, memory, processor, where a programis stored and executed, operating system, compilers etc.)

Idea of Algorithm: steps to solve logical and numerical problems. Representation of Algorithm: Flowchart/Pseudocode with examples.
From algorithms to programs; source code, variables (with data types) variables and memory locations, Syntax and Logical Errors in compilation, object and executable code

Unit 2: Arithmetic expressions and precedence (**2 L**)**Unit 3:** Conditional Branching and Loops (**6 L**)

Writing and evaluation of conditionals and consequent branchingIteration and loops

Module 2 [12L]

Unit 1: Arrays (**6 L**)

Arrays (1-D, 2-D), Character arrays and Strings
Unit 2: Basic Algorithms (**6 L**)

Searching, Basic Sorting Algorithms (Bubble, Insertion and Selection), Finding roots of equations, notion of order of complexity through example programs (no formal definition required)

Module 3 [9L]

Unit 1: Function (**5 L**)

Functions (including using built in libraries), Parameter passing in functions, call by value, Passing arrays to functions: idea of call by reference

Unit 2: Recursion (**4 L**)

Recursion, as a different way of solving problems. Example programs, such as Finding Factorial, Fibonacci series, Ackerman function etc. Quick sort or Merge sort.

Module 4 [7 L]

Unit 1: Structure (**4 L**)

Structures, Defining structures and Array of Structures
Unit 2: Pointers (**2 L**)

Idea of pointers, Defining pointers, Use of Pointers in self-referential structures, notion of linked list, dynamic memory allocation, Union (no implementation)
Unit 3: File handling (**1 L)**

Basic idea about read, write, append operation if time is available, otherwise should be done as partof the lab)

Course Outcomes (COs)

CO1. To formulate simple algorithms for arithmetic and logical problems.
CO2. To test and execute the programs and correct syntax and logical errors.
CO3. To implement conditional branching, iteration and recursion.

CO4. To decompose a problem into functions and synthesize a complete program using divide and conquer approach. To use arrays, pointers and structures to formulatealgorithms and programs.
CO5. To apply programming to solve matrix addition and multiplication problems and searching and sorting problems.
CO6. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Learning Resources

1. R. S. Salaria, Computer Concepts and Programming in C, Khanna Publishers
2. Byron Gottfried, Schaum's Outline of Programming with C, McGraw-Hill
3. Balaguruswamy, Programming in ANSI C, Tata McGraw-Hill
4. Brian W. Kernighan and Dennis M. Ritchie, The C Programming Language, Prentice Hallof India

Paper Name: Basic Electrical and Electronics Engineering	**Category: Engineering Science Courses**
Paper Code: ES-EE101 / ES-EE201	**Semester: First / Second**
L-T-P: 3-1-0	**Credit: 4**

Total Lecture: 45L

Course Objectives

- To understand the impact of technology in a global and societal context.
- To provide working knowledge for the analysis of basic DC and AC circuits used in electrical and electronic devices.

Module 1 [3L] Electromagnetism:

Magnetic circuits, Analogous quantities in magnetic and electric circuits, Faradays‟ law, self and mutual inductance, Hysteretic and Eddy current losses, Self and Mutual inductance, B-H loop, Hysteresis and Eddy current loss

Module 2 [10L] Circuits Analysis

DC Network Theorem: Definition of electric circuit, network, linear circuit, non-linear circuit, bi lateral circuit, unilateral circuit. Kirchhoff‟s law. nodal analysis, mesh analysis. Principle of superposition. Source equivalence and conversion, Thevenin‟s theorem, Norton Theorem,
AC fundamental: Production of alternating voltage, waveforms, average and RMS values, peak factor, form factor, phase and phase difference, phasor representation of alternating quantities, phasor diagram, behavior of AC series circuits, power factor, power in AC circuit.

Module 3 [6L]Transformers

Single phase transformer: Core and shell type construction, ideal and practical transformer,
EMF equation, no load and on load, operation, phasor diagram and equivalent circuit, losses of a transformer, open and short circuit tests, regulation and efficiency calculation, Auto-transformer.

Module 4 [10L] Electrical Machines

DC Machine: Construction, working, torque speed characteristic and speed control of separately excited dc motor.
AC Machine: Construction, Generation of rotating magnetic fields and working of a three-phase induction motor, Torque-slip characteristic, Brief idea about Single Phase Induction Motor and Synchronous generators

Module 6 [8L]Transistors

Transistor Biasing and Bias stability: calculation of stability factor with variation of Ico Different operating modes; CE, CB, CC and their properties; small signal low frequency operation of transistors; equivalent circuits h parameters as a two port network. Transistors as amplifier: expression of voltage gain, current gain, input impedance and output impedance, frequency response for CE amplifier with and without source impedance(qualitative)

Module 7 [5L]

Field Effect Transistor

Construction and characteristics of JFET (N channel only), Transfer characteristics; construction and characteristics of MOSFET (N channel only), depletion and enhancement type; CS, CG, CD configuration

Module 8 [3L] Operational Amplifier

Concept of virtual earth, inverting and non-inverting mode of operation, voltage summing, difference, constant gain multiplier, voltage follower, comparator, integrator, differentiator.

Course Outcomes(COs)

CO1. To acquire knowledge of different theorems for electric and magnetic circuits analysis. Explain the working principle, construction, applications of Transformer, DC machines, AC machines. Concept of 3 phase power, JFET, MOSFET, OPAMP, sinusoidal voltages and currents in different machines and circuits. Explain fundamental laws and theorems governing the working different electrical machines and circuits. Able to identify the procedures for calculations of different circuit parameters.
CO2. Use the concepts of applying mathematics and science principles, trigonometry, complex algebra, phasor operations to provide solution of different simple problems; critical circuit problems related to electrical systems.
CO3. Analyze series circuits, flow of currents, algebraic sum of voltages (voltage drops) in any closed path in a circuit to examine the behavior of electric circuits and performance characteristics and efficiency of electrical machines.
CO4. Evaluate and judge whether the solutions obtained are correct and matches the required parameters and characteristics.
CO5. Use the knowledge acquired to investigate unknown problems and design and assemble to find a solution to the problem.

Learning Resources

1. Basic Electrical engineering, D.P Kothari & I.J Nagrath, TMH, Second Edition
2. Basic Electrical Engineering, V.N Mittle & Arvind Mittal, TMH, Second Edition

3. Basic Electrical Engineering, Nath & Chakraborti
4. Electrical Technology, Vol-I,Vol-II, Surinder Pal Bali, Pearson Publication
5. A Text Book of Electrical Technology, Vol. I & II, B.L. Theraja, A.K. Theraja, S.Chand &Company
6. Electrical Engineering Fundamentals, Vincent Del Toro, Prentice-Hall
7. Advance Electrical Technology, H.Cotton, Reem Publication
8. Basic Electrical Engineering, R.A. Natarajan, P.R. Babu, Sictech Publishers
9. Basic Electrical Engineering, N.K. Mondal, Dhanpat Rai

Name: English Language andTechnical Communication	**Category: Humanities and Social Sciences including Management course**
Paper Code: HM-HU 101/HM-HU201	**Semester: First / Second**
L-T-P: 2-0-0	**Credit: 2**

Total Lecture: 32LCourse Objectives

- To acquire language skills,
- To develop linguistic and communicative competencies for Engineering students.
- To study academic subjects more effectively using the theoretical and practical components of English syllabus, and hence will develop study skills and communication skills in formal and informal situations.

Module 1: Theories of Communication [6L]

Theories and Principles of Communication: Definition, Process, Model (Schematic diagram of Shannon and Weaver‟s Model of Communication), Types of Communication – Verbal and Non-verbal communication, Flows of communication

Barriers to communication

Workplace/ Business Communication which can have the following items:

a) Scope of Oral Communication

b) Oral Business Communication: Introducing oneself in a professional setup - brevity, context, understatement, body language –

Task: Introducing others - introducing a junior professional to a senior professional, introducing an employee to a customer, introducing a colleague from your firm to anemployee of another firm.

c) Telephone (audio and video) communication: choice of words, body language, paralinguistic elements of speech, enunciation, brevity, clarification, effective closure

Module 2: Applied Grammar [9L]

Common Errors in English

- Subject-verb agreement
- Tenses
- Noun-pronoun agreement
- Articles and Prepositions
- Misplaced or dangling modifiers

- Redundancies
- Cliché Transformation of Sentences
- Active and Passive voice
- Direct and Indirect speech
- Degrees of Comparison

Use of phrases and clauses in sentences
Synthesis of Sentences: Simple, Complex and Compound

Module 3 Vocabulary Building [3L]

The concept of word formation: Compounding, Backformation, Clipping and Blending Root words from foreign languages and their use in English
Acquaintance with prefixes and suffixes from foreign languages in English to form derivatives. Synonym, antonym, phrasal verbs, one word substitution and standard abbreviation

Module 4 Basic Writing Skills [4L]

Documenting: definition, meaning, basic concept of documenting (print and online media), types of technical documents
Importance of proper punctuation
Creating coherence: Arranging paragraphs & Sentences in logical order Creating Cohesion: Organizing principles of paragraphs in documents Techniques for writing precisely

Module 5 Professional Writing Skills [10L]

Technical Report Writing: Types and formats
Comprehension, Précis and Expansion Writing, Essay Writing, Writing SOPs and Project Proposals. Business Letters; Cover letter & CV
Office Correspondence:

- Notice
- Agenda
- Minutes
- Memo
- E-mail

Course Outcomes (COs)

CO1. Understanding the mechanism of interpretation through language learning by practicing reading, writing and comprehension skills.
CO2. Understanding complex engineering problems by a sound grammatically correct knowledge of the English Language & honing writing, and reading skills for software research, solutions, marketing etc.
CO3. Equipping learners to solve various problems related to aptitude test through the practice of various Verbal reasoning and grammar practice.
CO4. Development of analytical thinking through practice of analytical essays, businesscorrespondence.
CO5. Learning effective communication strategies for handling criticism and adverse remarks and also knowing strategies of effective intervention, kinesics and courtesies and different components of soft skills.

CO6. Awareness about the society, public health and safety, growth and changes in society, culture and environment through comprehension, technical report writing practice.

Learning Resources

1. Connect: A Course in Communicative English by Debashis Bandyopadhyay and Malathy Krishnan. Cambridge University Press. 2018.
2. Communication Skills. Sanjay Kumar and Pushp Lata. Oxford University Press. 2015.
3. Communication Skills for Professionals. Nira Konar, Prentice Hall of India 2nd edition, New Delhi,2011
4. High School English Grammar by Wren and Martin
5. Common Errors in English by S.Prasad & K.P.Thakur,Bharti Bhhawan Publishers
6. Business Correspondence and Report Writing – R.C. Sharma and Krishna Mohon, Tata McGraw-Hill Publishing company Ltd., New Delhi
7. English Vocabulary in Use- McCarthy
8. Communicative English – E. Sureshkumar and P. Sreehari – Orient Blackswan , 2007
9. Speaking Effectively**,** Developing Speaking Skills for Business English, Jeremy Comfort-Cambridge University Press, 1994
10. Practical English Usage. Michael Swan. OUP. 1995.
11. Remedial English Grammar. F.T. Wood. Macmillan.2007
12. A Practical English Grammar – A.J. Thomson, A.V. Martinet – Oxford University Press
13. Guide to writing as an Engineer, John Willey - David F.Beer and David McMurrey,. New York, 2004

Paper Name: Physics Labotary –I	**Category: Basic Science Course**
Paper Code: (BS-PH-191 & BS-PH-291)	**Semester: First / Second**
L-T-P: 0-0-3	**Credit: 1.5**

Periods: 36P

Course Objectives

- To provide exposure to the students with hand on experience for data acquisition, precession, statistical data analysis, graph plotting calculation of fundamental quantities and error estimation of different fundamental physics experiments relevant to various engineering discipline.

All students have to perform total 9 experiments taking at least one from Optics, Electricity & Magnetism, Quantum Mechanics, Miscellaneous experiments and Innovative experiment sections. (One Innovative experiment is mandatory)

List of ExperimentsOptics Experiments

1. Determination of dispersive power of the material of a prism
2. Determination of wavelength of a monochromatic light by Newton‟s ring
3. 3.Determination of wavelength of a monochromatic light by Fresnel‟s bi-prism
4. 4.Determination of wavelength of the given laser source by diffraction method

5. Determination of numerical aperture, angle of acceptance and bending energy losses of an optical fiber

Electricity & Magnetism Experiments

1. Determination of thermo electric power of a given thermocouple.
2. Determination of specific charge (e/m) of electron by J.J. Thompson‟s method.
3. Determination of dielectric constant of a given dielectric material.
4. Determination of Hall coefficient of a semiconductor by four probe method.
5. Determination of resistance of ballistic galvanometer by half deflection method and study of variationof logarithmic decrement with series resistance.
6. Determination of unknown resistance using Carey Foster‟s bridge
7. Study of Transient Response in LR, RC and LCR circuits using Exp EYES
8. Generating sound from electrical energy using Exp EYES

Quantum Physics Experiments

1. Determination of Stefan-Boltzmann constant.
2. Determination of Planck constant using photocell.
3. Determination of Lande-g factor using Electron spin resonance spectrometer.
4. Determination of Rydberg constant by studying Hydrogen spectrum.
5. Determination of Band gap of semiconductor.
6. To study current voltage characteristics, load response, areal characteristic and spectral response of a photovoltaic solar cell.

Miscellaneous Experiments

1. Determination of Young‟s modulus of elasticity of the material of a bar by the method of flexure
2. Determination of bending moment and shear force of a rectangular beam of uniform cross-section
3. Determination of modulus of rigidity of the material of a rod by static method
4. Determination of rigidity modulus of the material of a wire by dynamic method
5. To determine the moment of inertia of a body about an axis passing through its centre of gravity and to determine the modulus of rigidity of the material of the suspended wire
6. Determination of coefficient of viscosity by Poiseuille‟s capillary flow method
7. Measurement of wavelength and velocity of Ultrasonic wave by using Ultrasonic Interferometer.

Innovative Experiments

1. Studies on Bandgap measurement of thin film using UV-VIS spectrophotometer.
2. Basic UV-VIS absorbance study of organic dyes.
3. Basic UV-VIS study of nano-particles (NPs) and quantum dots (Q Dots).
4. Basic photoluminescence study of organic dyes.
5. Basic photoluminescence study of nano-particles (NPs) and quantum dots (Q Dots).
6. Studies on Basics of Vacuum system and Vacuum measurements.

Course Outcomes (COs)

CO1. Describe the various aspects, parameters, scales of experimental tools and design to conduct the experiments in the laboratory.

CO2. Analyze the methods of experiments and interpret the output results. Emphasis on the limitations of theoretical concepts, measuring instruments to perform the experiments and deviation of results from ideal one.
CO3. Describe the needs of publication of the outcome results and correlate the results with published papers in various journals and literature in the respective fields.
CO4. Describe how the ideas those are adopted can be implemented through projects and demonstrate various models, recent project proposals to execute the knowledge adopted from the course.
CO5. Define how the ideas can be share with the multi - disciplinary personals. Lighten on the latest and modern developments in the fields.
CO6. Explain about ethical awareness and impact in the field of environmental, social and safety of the finished products. Describe the pollution, legal aspects and impacts may arise in large scale production.

Learning Resources

1. B.Sc. Practical Physics – C.L.Arora
2. B.Sc. Practical Physics – Harnam Singh and Dr. P.S.Hemne – S.Chand

Paper Name: Chemistry Laboratory –I	**Category: Basic Science Course**
Paper Code: (BS-CH-191 & BS-CH-291)	**Semester: First / Second**
L-T-P: 0-0-3	**Credit: 1.5**

Periods: 36P

Course Objective

- To be able to design, carry out, record and analyze the results of chemical experiments.
- To demonstrate creative and independent thinking in both learning and work environments.
- To be able to use modern instrumentation and classical techniques, to design experimentsand to properly record the results of their experiments.

Name of the Experiments

1. Preparation of Phenyl and Hand Sanitizer owing to its disinfectant and germicidal values.
2. Determination of the partition coefficient of a substance between two immiscible liquids.
3. Complexometric titration for determination of calcium and magnesium hardness of water.
4. Conductometric and pH- metric titration for determination of strength of a given HCl solution against a standard NaOH solution.
5. Determination of dissolved oxygen present in a given water sample.
6. Determination of chloride ion in a given water sample by Argentometric method (using chromate indicator solution)
7. Determination of percentage composition of sugar solution by viscosity measurement method.
8. Saponification/acid value of oil.
9. Preparation of some useful organic compounds: Pthalimide, Aspirin
10. Study on Thin layer chromatography
11. Preparation of some useful polymer: PF resin, MF resin.

Course Outcomes (COs)

CO1. To be able to design, carry out, record and analyze the results of chemical experiments. Students will demonstrate laboratory skills and show understanding in all major laboratory techniques and principles including instrumentation, synthesis, purification, analysis including green chemistry.
CO2. To be skilled in problem solving, critical thinking and analytical reasoning. To operate a range of chemical instrumentation with adequate hands-on experiences.
CO3. To be able to use modern instrumentation and classical techniques, to design experiments and to properly record the results of their experiments.
CO4. To be able to use appropriate literature research and go through journal articles for useful information. Students will show proficiency at scientific communication including posters, presentations, laboratory reports and even journal articles.
CO5. To demonstrate creative and independent thinking in both learning and work environments. Work independently and collaborate effectively with other people in a team. Self-evaluate their own learning progress and develop motivation and learning skills for lifelong learning.
CO6. To learn the value of a professional work ethic including working as part of a diverse team. They will develop the ability to recognize ethical issues related to the impact of technological advances on society.

Learning Resources

1. A. I. Vogel, Elementary Practical Organic Chemistry, Part 2: Qualitative Organic Analysis, CBS Publishers and Distributors.
2. A. K. Nad, B. Mahapatra, A. Ghoshal, An Advanced Curse in Practical Chemistry, NewCentral Book Agency; 3rd edition.
3. University Hand Book of Undergraduate Chemistry Experiments, edited by Mukherjee, G. N. University of Calcutta, 2003.
4. Furniss, B.S., Hannaford, A.J., Smith, P.W.G., Tatchell, A.R. Practical Organic Chemistry, 5th Ed.,Pearson (2012).
5. H. T. Clarke, A Handbook of Organic Analysis (Qualitative and Quantitative), Fourth Edition, CBS Publishers and Distributors (2007).
6. Practical Workbook Chemistry (Honours), UGBS, Chemistry, University of Calcutta, 2015.

Paper Name: Programming for Problem Solving	**Category: Engineering Science Course**
Paper Code: ES-CS-191/ES-CS -291	**Semester: First / Second**
L-T-P: 0-0-3	**Credit:1.5**

Periods: 36P

Course Objectives

- To formulate and test simple algorithms for arithmetic and logical problems,execute the programs and correct syntax and logical errors for implementing conditional branching, iteration and recursion.

The laboratory should be preceded or followed by a tutorial to explain the approach or algorithmto be implemented for the problem given

Tutorial 1: Problem solving using computers:
Lab1: Familiarization with programming environment
Tutorial 2: Variable types and type conversions:
Lab 2: Simple computational problems using arithmetic expressions
Tutorial 3: Branching and logical expressions:
Lab 3: Problems involving if-then-else structures
Tutorial 4: Loops, while and for loops:
Lab 4: Iterative problems e.g., sum of series
Tutorial 5: 1D Arrays: searching, sorting:
Lab 5: 1D Array manipulation
Tutorial 6: 2D arrays and Strings
Lab 6: Matrix problems, String operations
Tutorial 7: Functions, call by value:
Lab 7: Simple functions
Tutorial 8 &9: Numerical methods (Root finding, numerical differentiation, numericalintegration):
Lab 8 and 9: Programming for solving Numerical methods problems
Tutorial 10: Recursion, structure of recursive calls
Lab 10: Recursive functions
Tutorial 11: Pointers, structures and dynamic memory allocation
Lab 11: Pointers and structuresTutorial
12: File handling:
Lab 12: File operations

Course Outcomes (COs)

CO1. To formulate simple algorithms for arithmetic and logical problems.
To translate the algorithms to programs (in C language).
CO2. To test and execute the programs and correct syntax and logical errors.
To implement conditional branching, iteration and recursion.
CO3. To decompose a problem into functions and synthesize a complete program using divide and conquer approach.
CO4. To use arrays, pointers and structures to formulate algorithms and programs.
CO5. To apply programming to solve matrix addition and multiplication problems andsearching and sorting problems.
CO6. To apply programming to solve simple numerical method problems, namely rot finding of function, differentiation of function and simple integration.

Paper Name: Workshop Practice	**Category: Engineering Science Course**
Paper Code: ES-ME191 / ES-ME291	**Semester: First / Second**
L-T-P: 1-0-3	**Credit: 2.5**

Periods: 39P

Course Objectives

- To gives the basic working knowledge required in various engineering based constructions,

function, use and application of different working tools, equipment, and machines as well as the technique of manufacturing a product from its raw material.

[Before practice, background lectures will be delivered on the topics. Tool specifications and their materials will be described. Brief reports on the work done will be submitted by the students and evaluation will be made on the basis of examination of the report and viva, conducted by the teachers.]

Theory

1. Carpentry (Wood Working)

Timber, Seasoning and Preservation, Plywood and Plyboards, Carpentry Tools, Engineering applications. Different Joints

2. Metal Joining

Definitions of welding, brazing and soldering processes, and their applications. Oxy-acetylene gas welding process, equipment and techniques. Types of flames and their applications. Manual metal arc welding technique and equipment. AC and DC welding, electrodes, constituents and functions of electrodes. Welding positions. Types of weld joint. Common welding defects such as cracks, slag inclusion and porosity.

3. Bench work and Fitting

Tools for laying out, chisels, files, hammers, hand hacksaw, their specifications and uses.

4. Metal Cutting

Introduction to machining and common machining operations. Cutting tool materials, geometry of cutting tool, cutting fluid. Definition of machine tools, specification and block diagram of lathe, shaper, milling, drilling machine and grinder. Common lathe operations such as turning, facing and chamfering and parting. Difference between drilling and boring. Use of measuring instruments like micrometer / verniercaliper.

5. Tin Smithy

Sheet metal introduction, tools and operations, Shearing and Bending of sheets, types of joints

Jobs to be made in the Workshop

Group A **(**6 P)

Carpentry Shop: T-Lap joints and Dovetail joint

Group B (6 P)

a. Gas Welding practice on mild steel flat/sheet (upto 3mm thick)
b. Lap joint by Gas Welding (upto 3mm thick)
c. Manual Metal Arc Welding practice (upto 5mm thick)
d. Square butt joint by MMA Welding
e. Lap joint by MMA Welding

Group C

Fittings work: Sawing and Finishing by Filing. (6 P)

Group D

a. Jobs on lathe with turning, facing, chamfering and parting operations (6 P)
b. Job on shaper and milling machine for finishing two sides of a job (6 P)
c. Drilling of holes of size 5 and 12 mm diameters on the jobs / External threads making by dies, Tap size drill hole/ hand tapping operations

Group E

Smithy - making simple products on sheet metal (6 P)

Course Outcomes (COs)

CO1. Define, describe and determine the types and nature of the physical parameters likecutting speed, feed, depth of cut etc applied on mechanical manufacturing systems.
CO2. Classify and explain the effects of the above physical parameters as applied on mechanical manufacturing systems for proper comprehension.
CO3. Train the students in metal joining process like welding, soldering, etc
CO4. Impart skill in fabricating simple components using sheet metal
CO5. Cultivate safety aspects in handling of tools and equipment
CO6. Develop the collective skill and potentiality and leadership quality to work in a group orteam.

Learning Resources

1. Hajra Choudhury S.K., Hajra Choudhury A.K. and Nirjhar Roy S.K., "Elements of WorkshopTechnology", Vol. I 2008 and Vol. II 2010, Media promoters and publishers private limited, Mumbai.
2. Kalpakjian S. and Steven S. Schmid, "Manufacturing Engineering and Technology", 4th edition,Pearson Education India Edition, 2002.
3. Gowri P. Hariharan and A. Suresh Babu,"Manufacturing Technology – I" Pearson Education, 2008.
4. Roy A. Lindberg, "Processes and Materials of Manufacture", 4th edition, Prentice Hall India, 1998.
5. Rao P.N., "Manufacturing Technology", Vol. I and Vol. II, Tata McGrawHill House, 2017.

Paper Name: Engineering Drawing	Category: Engineering Science Course
Paper Code: ES-ME192 / ES-ME292	Semester: First / Second
L-T-P: 1-0-3	Credit: 1.5

Periods: 42P

Course Objectives

- To teach students to communicate using **graphic** techniques.
- To accomplish the principles and standards of mechanical **drawing** and dimensioning.

[Sessional work should be completed in the class. Problems sheet will be provided. Students should attempt to solve the problems given in the Problem Sheet. Home assignments will be given. Evaluation will be made on the basis of seasonal work and viva-voce examination.]

Scales (3P)

Plain scales, Diagonal scales, Vernier scales

Geometrical Construction and Curves (3P)

Conic Section: Parabola, Hyparabola, Ellipse

Projection of Points, Lines, Surfaces (9P)

Orthographic Projection – First angle and third angle projection More no. of problems should bepracticed in first angle projection. Projection of lines inclined to the planes Projection of surfaces Pentagon, Hexagon

Projection of Solids (12P)

Cube, Pyramid, Prism, Cylinder, Cone, Frustums

Isometric View And Isometric Projection (6 P)

(Prism, Pyramid, Cylinder, Cone and examples of simple solid objects / models).

Sectional Views of Solids, True Shape of a Section (6 P)

Development of Surfaces (3 P)

(Cube, Prism, Cylinder, Truncated Cone)

Course Outcomes (COs)

CO1. To represent pictorially different elements and components using basic engineering drawing guidelines.
CO2. To gain significance of scaling pertinent to engineering drawing problems. The incumbents should also have knowledge about analytical curves and their relevance to understand different higher level

mechanical engineering problems.
CO3. To understand the concept of projections for 1D, 2D and 3D object representation.
CO4. To develop an idea and ability to view complex interior sections of a solid object, andthey will also be able to analyze and explain how different surfaces are generated when a solid object is cut along a plane and its surfaces are stretched out.
CO5. To draw isometric to orthographic views and vice versa.
CO6. To apply the comprehensive knowledge by using a suitable computer aided drafting package.

Learning Resources

1. Pradeep Jain, AnkitaMaheswari, A.P. Gautam, Engineering Graphics & Design, Khanna PublishingHouse
2. Bhatt N.D., Panchal V.M. & Ingle P.R., (2014), Engineering Drawing, Charotar PublishingHouse
3. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
4. Shah, M.B. &Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
5. Narayana, K.L. & P Kannaiah (2008), Text book on Engineering Drawing, Scitech Publishers
6. Corresponding set of CAD Software Theory and User Manuals

Paper Name: Language Laboratory	**Category: Humanities and Social Sciences including Management**
Paper Code: HM-HU 191/ HM-HU291	**Semester: First / Second**
L-T-P: 0-0-2	**Credit: 1**

Periods: 22P

Course Objectives

- To provide advanced skills of Technical Communication in English through various activities performed in the Language Lab Practice Sessions to 1st Semester U.G. students of Engineering and Technology.
- To instil confidence in them so that they can competently communicate in English language in all spheres.
- To make them efficient enough to communicate about day-to day events and experiences of life, comprehend lectures delivered in English, read and understand relevant materials written in English and also to write grammatically correct English.
- To make them capable of shedding their fear of communication and public speaking.

List of Experiments

1. Developing active „Listening Skill" and its sub skills through Language Lab Audio device; (Listening to conversations, passages, stories, news bulletin, speeches by famous personalities – Listening for general and specific information etc.,) (3P)

2. Developing „Speaking Skill‟ and its sub skills; (Interpersonal Communication, OralPresentations — Debate –Extempore – Speech Presentation– Conversational Practice – Face to Face / Telephonic Conversation) (5P)

3. Developing „Reading Skills‟ and its sub skills through reading excerpts from plays, poetry, news and various technical/non technical passages using Visual /
Graphics/Diagrams /Chart Display etc. and using Literary text(s):
The Homecoming by Rabindranath Tagore
We‟re Not Afraid to Die... if We‟re Together by Gordon Cook and Alan East(4P)

4. Developing „Writing Skill‟ and its sub skills by using Language Lab Audio –Visual input; Practice Sessions (Analytical essay writing, dialogue writing, story writing, etc.)(3P)

5. Pronunciation: Basic Rules (with emphasis on Accent Neutralisation)Organs of Speech (2P)

6. Introducing „Group Discussion‟ through audio –Visual input and acquainting them with key strategies for success; GD practice sessions (unstructured and structured) (4P)

7. SWOT analysis (1P)

Learning Resources

1. Nira Konar: English Language Laboratories, A Comprehensive Manual, PHI Learning Pvt.Ltd.
2. Dr. D. Sudharani: Manual for English Language Laboratory. Pearson Education (WB edition),2010
3. Board of Editors: Contemporary Communicative English for Technical Communication, Pearson Longman, 2010
4. A Textbook of English Phonetics for Indian Students, T. Balasubramanian, Macmillan IndiaLtd.
5. Communicative English – E. Sureshkumar and P. Sreehari – Orient Blackswan , 2007
6. Speaking Effectively**,** Developing Speaking Skills for Business English, Jeremy Comfort- Cambridge University Press , 1994
7. Pocket Style Manual - Diane Hacker, Bedford Publication, New York, 2003. (ISBN0312406843)

Course Outcome (COs)

CO1. Improving comprehension ability in English & understanding the mechanism of interpretation though language learning.
CO2. Honing conversation skills by learning to substantiate conclusions in grammatically correctEnglish
CO3. Honing „Reading Skills‟ and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non Technical Passages; Learning Global / Contextual / InferentialComprehension for technical competence.
CO4. Learning effective, real life communication skills in English through several language labactivities pertaining to the four basic skills of LSRW
CO5. Learning basic soft skills and leadership qualities
CO6. Engaging the learner in a positive and imaginative environment to hone socio-cultural, ethical and

moral skills.

Paper Name: NSS	Category: Universal Human Value
Paper Code: XC-181	Semester: First / Second
L-T-P: 0-0-2	Credit: 0

Periods: 24P

Course Objectives

- To create awareness for women‟s education, old age education saving of girl child. Medical issue-blood donation and Thalassemia test.
- To realize, synthesize, and evaluate their personal readiness for leadership by group work, communicating effectively and to overcome & eliminate different constraints those may arises in their academic and daily life.

1. Creating Awareness in Social Issues

Blood Donation Camp, Road Safety Awareness, Poster Competition (Saving of Girl child, saving of water and fuel for future, Pollution and control,Global warming,Equal education for girls),Thalassemia awareness Programme, Eye Check-Up Camp.

2. Participating in Mass-Education Programme

a. Poster Presentation on Education for All
b. Elocation competition, SA writing on education for all
c. National Education Day celebration (11^{th} Nov)

3. Proposal for Local Slum Area Development

a. Road and Costal Side Cleaning Programme
b. Local Hospital Area Cleaning Programme (with collaboration Haldia Minicipality)
c. Campus Cleaning Programme

4. Environmental Awareness Programme

a. Resource Conversation (By Poster Competition)
   i. Water
   ii. Energy
b. Poster Competition on Global warming
c. Plantation Programme (5^{th} September)
d. Fire Safety Awareness Programme (With Haldia Fire Station)

5. Relief and Rehabilitation work during Natural Calamities

Course Outcomes (COs)

CO1. To Create awareness for women‟s education, old age education saving of girl child. Medical issue-blood donation and Thalassemia test.

CO2. To Realize, synthesize, and evaluate their personal readiness for leadership by group work, communicating effectively and to overcome & eliminate different constraints those may arises in their academic and daily life.
CO3. To Define and correlate different kind of social, cultural and ethical issue in light of saving of girl child, women education, saving of fuel. Manifest an ethics and service to the nation as a fundamental duty by organizing seminar symposia, work shop, essay writing, poster presentation etc.
CO4. To Apply problem solving skills by taking on volunteer and community service in their professional and social life and show interest to think about eco-friendly projects for the betterment of the society.
CO5. To Recognize the importance of civic engagement and community activism through volunteerism, community and campus service, team projects.
CO6. To Realizing his/her importance and duty, feel interest about ethical awareness and impact in the field of environmental, social and safety of the finished products.

ANNEXURE-I

MANDATORY ADDITIONAL REQUIREMENT (MAR) FOR EARNING B. TECH DEGREE

The additional requirement of MAR points applies to - every student, who is admitted to the 4 years B.Tech program under Autonomy, as per following:

Level of Entry in B.Tech Course	**Total duration for earning Points**	**MinimumPoints**
1st Year from the academic year 2020-21 onwards	1st to 4th Year	100
2nd Year from the academic year 2020-21 onwards (Lateral Entry)	2nd to 4th Year	75

These points must be earned on the basis of active participation in co-curricular and extracurricular activities spanning through all the semesters of study. Every student may choose, as per his/her liking, activities in order to achieve the mandatory points (as per Table- I, depending on his/her entry level), before becoming eligible for award of the Degree. These activities can be spread over the years, as per convenience of the student.

Notes:

- Every student shall participate in the co-curricular and extra-curricular activities and produce documentary proof to the designated Faculty Members appointed by the Head of Department / Principal / Director in the respective college. Thereby the student should earn the required Points before *her* she appears for his/ her Final Examinations.
- A student's result of his/her Final Examinations will be withheld until he/she completes the minimum Activity Points by the end of his/her B.Tech Program.
- In every semester, every student is required to prepare a file containing documentary
- proofs of activities, done by him / her. This file will be duly verified and Activity Points will be

assigned by the teachers as appointed above, at the end of every semester.

- The college will form a 3 members committee and finalize the Activity Points for each
- student before entering them into the Online Point Entry System of the Institute
- Every student has to earn at least 100 / 75 (for lateral) activity points. The points students has earned will be reflected in the student's mark sheet.
- Activity points earned by Lateral Entry students will be multiplied by 1.33.

Table I provides a List of Activity Heads and Sub-Activity Heads along with their capping of the Activity Points that can be earned by the students during the entire B.Tech duration.

Sl. No.	Name of the Activity	Points	Maximum Points Allowed
1.	MOOCS (SWAYAM/NPTEL/Spoken Tutorial) (per course)	20	40
2.	Tech Fest/Teachers Day/Freshers Welcome		
	Organizer	5	10
	Participants	3	6
5.	Rural Reporting	5	10
6.	Tree Plantation (per tree)	1	10
7.	Participation in Relief Camps	20	40
8.	Participation in Debate/Group Discussion/ Tech quiz	10	20
9.	Publication of Wall magazine in institutional level (magazine/article/internet)	10	20
10.	Publication in News Paper, Magazine & Blogs	10	20
11.	Research Publication (per publication)	15	30
12.	Innovative Projects (other than course curriculum)	30	60
13.	Blood donation	8	16
	Blood donation camp Organization	10	20
15.	Participation in Sports/Games		
	College level	5	10
	University Level	10	20
	District Level	12	24
	State Level	15	30
	National/International Level	20	20
21.	Cultural Programme (Dance, Drama, Elocution, Music etc.)	10	20
22.	Member of Professional Society	10	20
23.	Student Chapter	10	20
24.	Relevant Industry Visit & Report	10	20
25.	Photography activities in different Club(Photography club,Cine Club, Gitisansad)	5	10
26.	Participation in Yoga Camp (Certificate to be submitted)	5	10

27.	Self-Entrepreneurship Programme	20	20
28.	Adventure Sports with Certification	10	20
29.	Training to under privileged/Physically challenged	15	30
30.	Community Service & Allied Activities	10	20

ANNEXURE- II
MOOCS LIST FOR B.TECH (HONS) 1ST YR

(Credit based courses are only opt by students from this bucket, which may change time to time as onthe basis of availability of online courses)

Module	Course	Provider	Duration (Weeks)	Credits
Ethics	Ethics in Engineering Practice	NPTEL	**8**	**2**
	Ethics and Law in Data and Analytics	edX	**6**	**2**
	A Life of Happiness and Fulfilment	Coursera	**6**	**2**
	Introduction to Philosophy	Coursera	**5**	**2**
	Ethical Leadership Through Giving Voice	Coursera	**4**	**1**
Soft Skills	Enhancing Soft Skills and Personality	NPTEL	**8**	**2**
	Soft Skill Development	NPTEL	**8**	**2**
	Psychology at Work	Coursera	**6**	**2**
	Communication in the 21st Century Workplace	Coursera	**4**	**1**
	Successful Career Development	Coursera	**7**	**2**
	Working in Teams: A Practical Guide	edX	**4**	**1**
	Communication theory: bridging academia and practice	Coursera	**9**	**3**
	Write Professional Emails in English	Coursera	**5**	**2**
	Effective Writing	NPTEL	**4**	**1**
	Technical Writing	Coursera	**5**	**2**
	Interpersonal Communication for Engineering Leaders	Coursera	**4**	**1**
	Enhancing Soft Skill and Personality	NPTEL	**8**	**2**
	Employment Communication A Lab based course	NPTEL	**8**	**2**
	Speaking Effectively	NPTEL	**8**	**2**
	English Language for Competitive Exams	NPTEL	**12**	**3**
Programming Skills	Introduction to Programming with MATLAB	Coursera	**9**	**3**
	Introduction to Computer Science and Programming Using Python	edX	**9**	**3**
	Introduction to R for Data Science	edX	**4**	**1**
	Java Programming: Solving Problems with Software	Coursera	**4**	**1**
	Responsive Website Basics: Code with HTML, CSS, and JavaScript	Coursera	**4**	**1**
	Joy of computing using Python	NPTEL	**12**	**3**

	Programming, Data Structures and Algorithm Using Python	NPTEL	**8**	**2**
	Web Design for Everybody (Basics of Web Development and Coding) Specialization	Coursera	**15**	**4**
Statistics	Inferential Statistics	Coursera	**7**	**2**
	Introduction to Data Analysis using Excel	edX	**4**	**1**
	Multivariable Calculus	NPTEL	**8**	**2**
Environmental Studies	The Science of Well Being	Coursera	**6**	**2**
	Ecology: Ecosystem Dynamics and Conservation	Coursera	**5**	**2**
	Effective Problem-solving Decision- Making	Coursera	**4**	**1**
	Moralities of Everyday Life	Coursera	**6**	**2**
	Introduction to Logic	Coursera	**10**	**3**
	Digital Security and Human Rights	edX	**3**	**1**

Annexure-III

GUIDELINES REGARDING MANDATORY INDUCTION PROGRAM FOR THE NEW STUDENTS:

Engineering education has evolved globally in a continuous manner to address the twin needs of industry and society. It is now an accepted fact that the institutions imparting technical education should aspire to create manpower who will possess strong technical knowledge and skill, haveleadership qualities and be a team player, capable of coming up with innovative solutions and be alive to societal and community concerns. The aim of the Induction Programme is to acclimatize the students to the environment of their engineering institution, give them a flavour of the exciting new world of education that they are entering, provide them with mentoring schemes, and make themaware of their neighbourhood, society and people. This will allow them to evolve as well rounded individuals.

The following schedule is laid down by the Institute to implement the three week long Induction Programme:

Week 1	1st Half	Day 1	Overall introduction of the new students to the Institution, its different Departments & Faculty Members
	2nd Half	Day 1	Assignment of faculty mentors tothe new students Assessment and allotment for mentoring by senior students preferably from thesecond year
	2 hrs.	Day 2, 3, 4, 5	Lectures by eminent personalities on differentareas such as (a) Introduction to Engineering (b) Various topics of science and technology(c) Innovation and entrepreneurship (d) Creative and performing arts (e) Social issues

	2 hrs.	Day 2, 3, 4, 5	Participation in Games, Yoga, Meditation etc.
	2 hrs.	Day 2, 3, 4, 5	Visit to the different Departments of the Institute
Week 2 (All Days)	2 hrs.		Scheduled class lectures as per time table.
	2 hrs.		Students to be conducted through proficiencymodules to be prepared by respective Colleges for ascertaining English skills & Computer knowledge of the students and to prepare a report on the same

Course Code	HM-BT301					
Category	Humanities and Social Science and ManagementCourse					
Course title	Ethics and Patenting in Biotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: III
	3	0	0	3	36	
Pre-requisites/Co-requisites(if any)	-					

Course Objective:

1. The course helps to build up knowledge regarding ethical practices appropriate to Biotechnology and to apply the ethical norms relevant to the bio industries & field of research.
2. The course focuses to develop the basic concept of intellectual property rights and make the students aware of the protection of intellectual property and related rights.

Course Content:

Module I: [12 Lectures]

Bioethics: Introduction and need of bioethics, its relation with other branches, types of risk associated with modern biotechnology tools.

Ethical conflicts in biological sciences: Bioethics in health care - patient confidentiality, informed consent, euthanasia; Testing of drugs on human volunteers; Ethics in transplantation and stem cell research, Human and animal experimentation, organ transplantation and ethical issues; Xenotransplantion and its ethical and social issues; Animal cloning and human cloning and their ethical aspects; Human Genome project.

Module II: [5 Lectures]

Ethical Issues in agricultural science: Ethical issues regarding genetically modified organisms (foods and crops); Agricultural biotechnology; genetically engineered food, environmental risk, Protection of environment and biodiversity – biopiracy.

Regulations on ethical principles in biomedical/ biotechnological practice: The Nuremberg code, declaration of Helsinki; the Belmont report, co-operational guidelines – WHO, guidelines of DBT (India), Guidelines of an informed consent

Module III: [4 Lectures]

Introduction: Basics of Intellectual Property, Introduction to laws, Theories of IP, Different forms of IP and its application.

Trademark: Basic of Trademark, Trademark registration, History and Evolution of Patent Law: Evolution of patent Laws, History of Indian Patent System, International Conventions and Treaties.

Module IV: [15 Lectures]

Patent: Basics of patent, types of patent, patent criteria and filing procedure, Patent timeline-India and PCT, Patent Prosecution, Patent infringement and management.

Utility Model protection, Basics of copyright, Copyright registration and infringement

Classification of patents: Classification of patents in India, Classification of patents by WIPO,

Budapest Treaty; Patent Cooperation Treaty (PCT) and implications; Patent Cooperation Treaty (PCT) and implications; Patenting Biological products,

Patent owner: Rights and Duties, Ownership of patent, Rights of patent holder and co-owners, Duties of patent holder and co-owners, Transfer of patent Rights, Limitations of patent Rights, Restoration of Patents, Infringement of patent Rights and Offences, Actions against Infringement: Remedies/Relief, Patent Agent

Textbooks:

1. Sateesh M.K, Bioethics & Biosafety, IK Publishers.
2. Traynor PL, Biosafety Management, Virginia Polytechnic Institute Publication.
3. Acharya N K, Text book on Intellectual Property Rights, 4 thEdn, Asia Law house.

Reference books:

1. Sasson A (1993) Biotechnologies in developing countries present and future, UNESCO Publishers.
2. Rao MB (2003) WTO and International Trade, Vikas Publishing House Pvt. Ltd

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/
2. ePgPathshala: http://epgp.inflibnet.ac.in/ahl.php?csrno=3

Course Outcome (CO):

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

1. **Understand** and **identify** different bioethical issues and risks associated with it.
2. **Analyze** and **design** different genetically modified organisms and **examine** its effect on human health and environment.
3. **Understand** the ethical issues regarding agricultural biotechnology
4. **Understand, remember** the guidelines and regulations of ethical principles in biotechnology
5. **Understand and interpret** the Intellectual Property Rights (IPRs), trademark, patent of different forms and its application.
6. **Formulate** and **demonstrate** different business strategies by considering the norms of IPRs.

Course Code	**PC-BT301**					
Category	**Professional Core**					
Course title	**Biological Thermodynamics and Kinetics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	2	**0**	**0**	**2**	**24**	
Pre-requisites/Co-requisites (if any)	- **Engineering mathematics** - **Chemistry-I**					

Course Objective:

The objectives of the course are:

1. To make the students aware of basic principles and laws of thermodynamics along with reaction

kinetics that can be useful in bioreactor operation.

2. To realize the importance of enzyme technology and analysis of complex metabolic networks inside biological system.

Course Content:

Module I: [9 lectures]

Basic Concepts of Thermodynamics:

Review of first and second laws of thermodynamics, Internal energy, heat capacity, enthalpy, Isothermal, Adiabatic process, The Ideal Gas, PVT behaviour of Pure Substances, Virial Equation of State, Application of Virial Equations, Simple model‟s for Vapour/Liquid Equilibrium, Roult‟s Law, Henry‟s law, Modified Raoult‟s Law, The Chemical Potential, Fugacity and Fugacity Coefficient.

Module II: [12 lectures]

Enzyme and Reaction kinetics:

Rate of chemical reaction; Effect of Temperature on Rate Constant, Arrhenius equation, Collision Theory, Transition State Theory, Order and Molecularity of a Chemical reaction, Elementary Reactions, First and Second order reactions, Pseudo-first order reaction.

Derivation of Michaelis-Menten equation, Briggs-Haldane relationship, the determination and significance of kinetic constants, Lineweaver-burk and Eadie-Hofstee plot, principles of enzyme inhibition – Competitive, noncompetitive and uncompetitive. Interpretation of batch reactor data for simple and complex reactions.

Module III: [3 lectures]

Biochemical kinetics:

Stoichiometry of cellular reactions, Reaction kinetics – unstructured and structured models, its example and applications.

Textbook:

1. Smith &Vanness, Thermodynamics for Chemical Engineers, MGH
2. Shuler and Kargi, Bioprocess engineering: Basic concepts, 2nd edition, Prentice Hall publisher
3. Levenspiel,O., Chemical Reaction Engineering, Wiley Eastern Ltd.

Reference books:

1. Richardson, J.F., Peacock, D.G.Coulson& Richardson‟s Chemical Engineering-Volume 3 ed., First Indian ed. Asian Books Pvt. Ltd. 1998
2. Bailey &Olis, Biochemical Engg. Fundamentals, MGH, 1990
3. Physical Chemistry: Castellan, Narosa Publishing.

Web reference:

1. http://nptel.ac.in/courses/102106026/#

Course Outcome:

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

1. **Understand, define** and **recall** the basic laws of thermodynamics and laws regarding energy transfer of the substances hence become familiar with their use and applications in chemical and biological systems.
2. Ability to **explain** thermodynamic properties of substances in gas or liquid state of ideal and real mixture.
3. **Understand** the order and molecularity of a reaction and **distinguish** between various rate constants and reaction order.
4. **Analysis** of batch reactor data for chemical as well as enzyme catalyzed reaction and **use** of different plots to **compare** various kinetic models.
5. **Analyze** complex metabolic flux in biological system.
6. **Develop skills** in data acquisition and **justification** and **discussion** of the results

Course Code	**PC-BT302**					
Category	**Professional Core**					
Course title	**Structure of Biomolecules**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	**-** **Chemistry (10 + 2 level)**					

Course Objective:

The objectives of the course are:

1. After completion of the course, the students should be able to understand the overall structure and functional properties of biological macromolecules in relationship to their biological function.
2. The overall perspective will be the biomolecules and their characteristic properties and organization in carrying out all the living functions which constitute the life.

Course Content:

Module I: [5 Lectures]

Macromolecular Structure and Dynamics

Basic concepts of pH, buffers; strong and weak interactions in biomolecules: Configurations and conformations of macromolecules, Factors that stabilize biomolecular structures - electrostatic interactions, VDW interactions, H-bonding, hydrophobic interaction.

Module II: [5 Lectures]

Structural Chemistry of Carbohydrates and Lipids

Chemistry of Carbohydrates: Classification, Structure (based on Fisher, Haworth projection) and Some Functions; Chemistry of Lipids: Classification, Structure and Function (Fatty acids, Fats and oils, phospholipids, sphingolipids, glycolipids and cholesterol).

Module III: [13 Lectures]

Structural Chemistry of Amino Acids, Proteins and Nucleic acids

Chemistry of Proteins: Structure of amino acids and peptides,pH titration curve of amino acids, primary, secondary, super secondary,tertiaryand quaternary structure of protein; Protein denaturation and renaturation. Chemistry of Nucleic Acids: Nucleosides, Nucleotides and nomenclature, level of structure of DNA and RNA, Denaturation and renaturation of DNA.

Module IV: [13 Lectures]

Spectroscopic and Microscopic Methods for the Analysis of Macromolecules:

UV-VIS absorption and emission spectroscopy for structure determination: Beer-Lambert‟s law, derivation and applications; Fluorescence Spectroscopy: Quantum Yield, Stokes shift, fluorophores, fluorescence lifetime, fluorescence quenching, FRET; Characterization of secondary structure by CD; Microscopy Based on Single Molecule Methods: Electron Microscope, Scanning and Transmission Electron Microscopy (SEM & TEM).

Text Books:

1. Lehninger's Principles of Biochemistry by David L Nelson; A.L. Lehninger and Michael M. Cox, 5thedition, Worth Publishing.
2. Biochemistry by LubertStryer, John L Tymoczko, Jerry M.Berg, 5th edition, W.H. FreemanCompany.
3. Biochemistry by Donald Voet and Judith G. Voet, 3rdedition, Wiley John and Sons.
4. Outline of Biochemistry by Eric.E. Conn and P.K. Stumpf, 5th edition, Wiley India.
5. Principles of Fluorescence Spectroscopy, J.R. Lakowicz; (Springer)
6. Fundamentals of Molecular Spectroscopy - C.N. Banwell, (Tata- McGraw-Hill)
7. Biological Spectroscopy-I.D. Cambell& R.A. Durk, (Benjamin Cummings)

Reference Books:

1. Biophysical Chemistry; C.R. Cantor and P.R. Schimmel; (W.H. Freeman &Co.)
2. Principles of Physical Biochemistry, Keith Van Holde, Chien and Ho. Pearson
3. Physical Biochemistry: D.M. Freifelder; Applications to Biochemistry Biology (Freeman)
4. Biophysics-V. Pattabhi& N. Gautham (Narosa, New Delhi).
5. Introduction to Electron Microscopy: S. Wischnitzer.
6. Electron Microscopy in Biology:J.R.Harris (ed.).

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/104105040/
2. NPTEL: http://nptel.ac.in/courses/104102016/
3. NPTEL: http://nptel.ac.in/courses/102105034/
4. NPTEL: http://nptel.ac.in/courses/104105076/
5. NPTEL: http://nptel.ac.in/courses/104104084/

Course Outcome (CO):

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

1. **Understand the fundamentals** of acid/base equilibrium including pH calculations, buffer behavior, acid/base titrations of some biomolecules and their relationship.
2. **Understand the fundamental** properties and reactivities of biologically important biomolecular interactions with respect to their structural and functional aspects and **to explain** the reaction involved in chemical and biochemical processes**.**
3. **Identify, describe and recognize** the different classes of polymeric biomolecules, monomeric building blocks and the importance of their physical and chemical properties at the atomic level, and **predict** how their behaviour change with environmental conditions.
4. **Understand the importance** of biomolecules and their use in the application of biotechnology, food and pharmaceutical products.
5. **Be skilled in problems solving, critical thinking,** and **analytical** reasoning in the aspect of complex structure of biomolecules in different conditions**.**
6. **Know the various qualitative and quantitative** physical methods available for structure determination and **apply** the **analytical skill and design** new experimental techniques to be used in biotechnology.

Course Code	**PC-BT-303**					
Category	**Professional Core**					
Course title	**Biochemistry**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**36**	
Pre-requisites (if any)	- **Biology (10 + 2 level)** - **Chemistry (10 + 2 level)**					

Course objective:

1. The Course deals with the biochemistry of the main building block molecules namely Carbohydrates, Proteins and Lipids starting from their synthesis (Anabolism) to their final fate like degradation (Catabolism). The Interplay of various enzymes, regulators, cofactors in mediating the metabolic process would be discussed.
2. Apart from that, it sheds light on selective Signal transduction pathways and cell suicide mechanism.
3. This course is an overview on entire bimolecular metabolism with its regulation apt for further academic growth and industrial utilization.

Course Content:

Module I: (10L) Introduction to Enzyme & Carbohydrate Metabolism:

Enzymes: Basic concept of enzyme-substrate reaction, short overview on enzyme kinetics, Enzyme inhibition, Regulation of enzyme activity, allosteric regulation. **Metabolic pathways of carbohydrates and their regulation:** glycolysis, TCA cycle, pentose phosphate pathway, Cori cycle, gluconeogenesis, glycogen metabolism, oxidative phosphorylation**,** electron transport chain, Photosynthesis**:** Photophosphorylation, Calvin cycle.

Module II: (10L) Metabolism of lipid and nucleic acid:

Oxidation of Fatty acid: Biosynthesis of fatty acids, phospholipids, Beta oxidation and omega oxidation of fatty acids – saturated and unsaturated fatty acids–even and odd numbered, Catabolism of phospholipids, **Nucleic acid metabolism:** nucleotide metabolism, purine and pyrimidine degradation, De Novo and Salvage Pathways.

Module III: (8L) Metabolism of Amino acid:

Glucogenic amino acids, ketogenic amino acids, Catabolism of amino acids, general metabolism of amino acids (transamination reaction, oxidative deamination), catabolism of Tyrosine, Leucine, Glutamic acid and Arginine, urea cycle and its regulation, Disorder/ diseases of amino acids metabolism.

Module IV: (8L) Cell Signaling:

Cell signaling and signal transduction pathways: Cell surface receptors, signaling through G-protein coupled receptors, Phosphatidyl inositol pathway, second messengers, Cell death and Apoptosis (Extrinsic and Intrinsic pathway).

Textbook:

1. LubertStryer, Biochemistry, Freeman & Co,

Reference books:

1. NY Lehninger‟s Principles of Biochemistry by Nelson & Cox
2. Voet&Voet, Fundamentals of Biochemistry, John Willey & Sons
3. Harper‟s Illustrated Biochemistry - R.K.Murray et al. (McGraw Hill)
4. Molecular Biology of the Cell-Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, KeithRoberts, Peter Walter, 6th Edition, Garland Science
5. Cell and Molecular Biology: Concepts and Experiments, Gerald Karp, Janet Iwasa, Wallace Marshall,8th Edition, Wiley
6. Molecular Cell Biology, Harvey Lodish, Arnold Berk, S Lawrence Zipursky, Paul Matsudaira, DavidBaltimore, and James Darnell. 6th edition, New York: W. H. Freeman.
7. The Cell: A Molecular Approach, Geoffrey M. Cooper & Robert E. Hausman, 6th edition, Sunderland(MA): Sinauer Associates
8. Outline of Biochemistry - Conn & Stump (John Willey & Sons)
9. https://onlinecourses.nptel.ac.in (Biochemistry Course)

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/104105076/
2. ePgPathshala: http://epgp.inflibnet.ac.in/view_f.php?category=982

Course Outcome:

After completion of the course, Students can be able to

1. Define, remember, repeat and duplicate the essence of metabolism so that students have access in higher education/Industry.

2. Conceptualizing metabolic chemistry of carbohydrates and understanding their roles in the regulation of metabolism.
3. They will have fundamental skills to understand and interpret their knowledge on lipid metabolism.
4. Understand and define the metabolism of amino acids and nucleic acid in Biochemistry.
5. Learn the basics of signal transduction and apoptosis in detail and exhibit their creative potential in investigating and developing new ideas in Biochemistry based projects.
6. Applying the theoretical knowledge, the students will be able to understand the basics of Biochemistry lab.

Course Code	**PE-BT301**					
Category	**Professional Core Elective**					
Course title	**Industrial Stoichiometry**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	**-**			**Elementary Physics and Chemistry**		

Course Objective:

The objectives of the course are:

1. To understand the unit conversions and numerical calculations involving numbers in scientific notation and quantitative expression of the composition in the mixture.
2. To identify and interpret the chemical reactions with the concept of material balance as an application of the law of conservation of mass.

Course Content:

Module I: 8L

Concept of unit, dimension. Expression of concentration, weight fraction, mole fraction, Conversion of equations, Use of loglog and semi-log graph paper, Graphical differentiation, and graphical integration.

Module II: 10L Material balance:

Procedure for material balance calculations, Material balance without chemical reactions: filtration, batch mixing, crystallization, distillation, Material balance with chemical reaction: Material Balance with recycle, bypass and purge streams.

Module III: 9L Energy Balance:

General energy balance equation for steady and unsteady state processes, Without Chemical Reaction, With Chemical Reaction, Enthalpy calculation procedures, Special cases e.g., spray dryer, Distillation Column, Enthalpy change due to reaction: Heat of combustion, Heat of reaction for processes with biomass production, Energy-balance equation for cell culture, for fermentation processes.

Module IV: 9L

Combined Material and Energy Balances

Simultaneous material and energy balances, selected industrial process calculations for chemical and bioprocesses.

BEYOND SYLLABI COVERAGE

Details of graphical methods that would be linked with Bioreactor Design and Analysis

Textbook:

1. Stoichiometry and process calculations, K.V. Narayanan B. Lakshmikutty

Reference books:

1. Bhatt &Vora, Stoichiometry, 4th Ed., TM
2. Hougen and Watson, Chemical Process Principles (Part one): 2nd ed, John Wiley

Course Outcome (CO):

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

1. **Apply** the basic knowledge of science and technology to understand the unit conversions and numerical calculations involving numbers in scientific notation and quantitative expression of the composition in the mixture.
2. **Apply** the knowledge of energy, work, heat relationships, the concept of chemical equilibrium, and basic chemical reactions to **identify, formulate** the solution of simultaneous equations using graphical method, Treatment, and Interpretation of data, Error analysis in connection with computation.
3. **Identify** practical Bioengineering problems and **design and develop solutions** using the concept of material balance.
4. **Identify and interpret the chemical reactions** with the concept of material balance as an application of the law of conservation of mass.
5. **Design and conduct the experiment** by using the concept of energy balance equation for steady and unsteady state processes
6. **Get** the opportunity to apply the knowledge of simultaneous material and energy balances to **investigate the complex industrial problems** process calculations and have the preparation and ability to engage in independent and **life-long learning** in the broad context of technological changes.

Course Code	**BS-BT301**					
Category	**Basic Science Course**					
Course title	**Microbiology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	**Chemistry (10 + 2 level)** **Biology (10+ level)**					

Course Objective:

The objectives of the course are:

1. To make the students aware of the structures, nutritional patterns, growth parameters, mode of reproduction, cultivation techniques from different samples, pathogenesis and classification of different types of microbes including bacteria, virus, fungi, algae.
2. Also they can understand the role of micro-organisms in environment, in food industry, in medical fields and also in maintaining the balance in eco system in agricultural field etc.

Course Content:

Module I**: 8L**: General Microbiology

History, development and scope of Microbiology; Position of microorganisms in biological world; General features of Eukaryotic and Prokaryotic microbes; Virology: General characteristics, importances and life cycle of viruses: lytic cycle (T4) and lysogenic (lambda).

Module II: 8L: Bacterial Morphology, Growth and Metabolism

Morphology of bacteria: Slime layer, Capsule, Cell wall, Ribosome, Cytoplasmic membrane, Cytoplasmic inclusion bodies, Endospore, Flagella, Pilus, Fimbriae, Bacterial Chromosome; Bacterial Nutritional types and Growth phases; Batch culture. Continuous culture. Synchronous culture. Control of microbes- Sterilisation, disinfection, antiseptic, tyndallisation, pasteurization; Antibiotics and chemotherapeutic agents; Bacterial metabolism-Aerobic and anaerobic respiration, fermentation (alcoholic, mixed acid, acetic acid, lactic acid), EntnerDuodruffs pathway, Basic concept of biochemical nitrogen fixation.

Module III: 12L: Techniques in Microbiology

Microscopy: General principles of optics in relation to microscopy; Principles and applications of Compound Microscope: Light Microscope; Dark field Mircroscope; Bright field Microscope; Phase Contrast Microscope; Fluorescent Microscope; Electron Microscope; Stains & Staining techniques: Cultivation of bacteria– Types of growth media; pure culture methods; Anaerobic and aerobic culture of bacteria.

Module IV: 8L: Environmental and Medical Microbiology

Air Microbiology: Different types of microorganism in the air, sampling techniques, airborne pathogens. Microbiology of water: Microbiological analysis of water: B.O.D. & C.O.D. Coliform test; IMViC test, determination of MPN; Soil Microbiology: different microbial groups in soil, Rhizosphere, Phyllosphere, Brief account of microbial interactions; Common Microbial Diseases: Normal microflora of the human body and host pathogen interaction (i) Bacterial - Tuberculosis, Leprosy, Tetanus, Cholera, Typhoid (ii) Viral – Flu, Polio, AIDS. (iii) Fungal - Candidiasis. (iv) Protozoan -Malaria, Amoebiasis and leishmaniasis.

Textbook:

1. Stanier, RY., et al., General Microbiology, 5th ed. Macmillan Press.
2. Pelczar. M., et al., Microbiology, 5th ed., 2000, Tata-McGraw Hill
3. Atlas, RM., Principles of Microbiology, 2nd ed., 1997, McGraw-Hill
4. Salle, AJ., Fundamental Principles of Bacteriology, 7th ed.,1999, Tata- McGraw Hill
5. Prescott, LM., Microbiology, 6th ed. 2005, McGraw-Hill.

6. Brock Biology of Microorganisms Paperback–14th ed, Madigan Michael T . , Martinko John M . ,Bender Kelly S. , Pearson.

Reference books:

1. Hans G. Schlegel, General Microbiology, 7th ed, Cambridge Low Price Edns
2. R.C Dubey and D. K Maheshwari -A Text Book of Microbiology, 3rd ed, S. Chand andCompany.
3. C.B Powar and H.F Daginawala- General Microbiology (Vol I & II) 3rd ed, Himalaya Publishing House.

Course Outcome (CO):

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

1. **Understand, identify** and **analyze** the structures, characteristics of different micro-organisms.
2. **Demonstrate, explain** and **apply** the techniques, tools and methodologies utilized in fundamental microbiological experiments.
3. **Analyze** and **compare** microbial growth patterns, metabolism and basic genetics with higher organisms and infer how microorganisms are used as model systems to study basic biology, genetics, metabolism and ecology.
4. **Extend** their knowledge in **understanding** the ways to control microbial growth realizing the role of microorganisms in pathogenicity, body defences, immunology and most importantly in disease transmission and food poisoning.
5. **Cite** the vital role of microorganisms in biotechnology, fermentation, medicine, food production and preservation, and even in maintaining the ecological balance in an environment with examples.
6. Able to **make use of** the ethical code of conduct prescribed by national and international organizations and address the emerging ethical, legal, and social concerns in the field of biological and biomedical sciences.

Course Code	**PC-BT391**					
Category	**Professional Core**					
Course title	**Biomolecular Analysis Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/Co-requisites (if any)	**Chemistry (10 + 2 level)**					

Course Objective:

The objectives of the course are:

1. To enable the students to acquire knowledge on different techniques for the study of physical and chemical structure of biomolecules.
2. To enable the students to know the methods and apply those in research and development in the area of biomedical analysis as well as biomedical methods and technology.

Course Content:

1. Preparing Buffers at a Specific Molarity and pH.

2. To determine amino acid as a buffer: Amino acid analysis, isoelectric point determination, bufferpreparation, pH measurements.
3. To determine an unknown protein concentration by plotting a standard graph of BSA using UV-Visspectrophotometer and validating the Beer-Lambert‟s Law.
4. Separation of amino acids: TLC/Paper Chromatography.
5. Separation of Lipid/sugar: TLC/Paper Chromatography.
6. Estimation of cholesterol by Zak‟s method.
7. Estimation of DNA by chemical method (by diphenyl amine or DPA method).
8. Estimation of RNA by chemical method (by orcinol method).
9. Determination of Na and K from samples.
10. Separation of proteins by Sodium Dodecyl Sulphate–Polyacrylamide Gel Electrophoresis (SDS-PAGE).
11. Estimation of Saponification Value of Fats/Oils.
12. Estimation of Iodine Value of Fats and Oils

Textbooks:

1. Lehninger Principles of Biochemistry by Nelson and Cox, McMillan publishers
2. Biochemistry by Lubert Stryer. W. H. Freeman & Company, NY
3. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), CUP, Cambridge University Press.
4. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill Book Company.

Course Outcome (CO):

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

1. **Demonstrate, explain** pH, pKa, pKbpI, and buffers preparation in different condition.
2. **Understand and determine** the process of determination of protein/lipid/nucleic acid/sugars etc from unknown solution quantitatively.
3. **Deal** with the study of structural and functional aspects of biomolecules.
4. **Understand and explain** the separation of different biomolecules and their partialcharacterization.
5. **Demonstrate** and **explain** the working principle of different qualititative testing for fats/oils and soil samples.
6. **Understand and develop** their skills in accuracy and precession during the analysis of different biomolecules.

Course Code	HM-BT391					
Category	Humanities and Social Science and ManagementCourse					
Course title	Technical Report Writing and Language Lab Practices					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: III
	0	0	2	1	24	
Pre-requisites/Co-requisites (if any)	Basic knowledge about English grammar,writing and communication					

Course Objective:

Objectives of this Course:

1. To inculcate a sense of confidence in the students.
2. To help them become good communicators both socially and professionally.
3. To assist them to enhance their power of Technical Communication.

Course Content:

Module I: Technical Communication (2P)

The Theory of Communication – Definition and ScopeBarriers of Communication
Current models of Communication (viz. Transectional Model) Verbal and Non-verbal communication-Definition and Types

Module II: Technical Communication (4P)

Editorial Letter, Business letter
Job related Communication (Job Application-solicited and unsolicited, Writing CV, Drafting Job Acceptance letter and Resignation letter)
Organizational Communication

Module III [2P]

Enhancing Speaking and Listening Skills through Language Lab Audio device

Module IV [4P]

Developing Speaking and Presentation Skills with the aid of Language Lab Audio-Visual Input, through Group Discussion, Conversation Practice, Extempore, Role Play, Poster Presentation, Act Impromptu, Powerpoint presentation etc. (5 L)

Recommended books:

1. Ashraf Rizvi (2005): *Effective Tech Communication*. Tata McGraw-Hill Education
2. Meenakshi Raman &Sangeeta Sharma (2015): Technical Communication Principles and Practice (3rd edition). Oxford University Press.
3. Dr.NiraKonar (2011): *English Language Laboratories: A Comprehensive Manual*. Prentice Hall IndiaLearning Private Limited.

Course Outcome (CO):

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

1. **Improving** comprehension ability in English & understanding the mechanism of interpretation through language learning.
2. **Honing** conversation skills by learning to substantiate conclusions in grammatically correct English
3. **Honing** „Reading Skills‟ and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non Technical Passages; Learning Global / Contextual / Inferential Comprehension for technical competence.
4. **Learning** effective, real life communication skills in English though several language lab activities pertaining to the four basic skills of LSRW
5. **Learning** basic soft skills and leadership qualities
6. **Engaging** the learner in a positive and imaginative environment to hone socio-cultural, ethical and moral skills.

Course Code	**PC-BT392**					
Category	**Professional Core**					
Course title	**Biochemistry Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: III**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/Co-requisites (if any)	- **Chemistry (10 + 2 level)** - **Biochemistry Theory**					

Course Objective:

1. The Course boosts students with practical hands-on training for several fundamental conceptslike spectroscopy, its application. Based on it, the course teaches them estimation of protein, enzyme activity, kinetics and inhibition.
2. Apart from that, it trains the students with basic partition procedures like thin layer chromatography and paper chromatography to separate amino acids/sugars.
3. This course gives an overview on basic techniques like buffer preparation, pH estimation, weighing reagents/chemicals, instrument maintenance that is fundamental and applicable for subsequent all laboratory classes of various courses.

Course Content:

1. Spectrophotometry: Verification of Lambert-Beer‟s law
2. Estimation of protein by Lowry method
3. Estimation of specific activity of an enzyme (amylase)
4. Determination of pH optima of amylase
5. Estimation of temperature optima of amylase
6. Enzyme Kinetics - (Determination of Km and Vmax) of amylase
7. Enzyme Inhibition – determining the nature of inhibition

8. Separation of amino acids - Thin layer chromatography.
9. Separation of amino acids - Paper chromatography.
10. Partial purification of Amylase using Ammonium sulphate fractionation-Dialysis-Estimation of specific activity of the enzyme

Textbooks:

1. Lehninger Principles of Biochemistry by Nelson and Cox, McMillan publishers
2. Biochemistry by LubertStryer. W. H. Freeman & Company, NY
3. Principles and techniques of Practical Biochemistry: K. Wilson and J. Walker (1994), CUP, Cambridge University Press.
4. An introduction to Practical Biochemistry by David T. Plummer (1988), McGraw- Hill Book Company.

Course Outcomes:

After completion of the course, Students can be able to
1. Remember and define the fundamental concepts of spectroscopy with practical application (during enzyme assay, chemical estimation of Biomolecules.
2. Understand and explain the calculation, data analysis and graph preparation during enzyme assays.
3. Apply various techniques, and implement theoretical knowledge to separate amino acids, using various techniques like paper and thin layer chromatography.
4. Compare theoretical knowledge with lab practicals testing enzyme kinetics, inhibition with effective hands on training.
5. Develop decision making potential, team spirit, project management, effective utilization of fund, good coordination keeping in mind various environmental facts,ethics and monetary issues.
6. Create lifelong learning practice boosting new and original work and develop an inquisitive mind.

Course Code	**BS-BT391**					
Category	**Basic Science Course**					
Course title	**Microbiology Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:III**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/Co-requisites (if any)	**Knowledge of Biology**					

Course Objective:

The objectives of the course are:
1. To teach the students microbiological techniques and to show them the impact of microbeson our daily lives and their central roles in nature.
2. To make them proficient at laboratory skills and safety procedures along with collection and analysis of data, making careful observations and drawing appropriate conclusions.

Course content:

1. Basic Laboratory techniques in Microbiology: a) Sterilization techniques b) Preparation ofculture

media: Complex media (Nutrient Broth; NA slant; Lactose broth); Chemically defined, Synthetic media (Czapekdox broth / agar) c) Culture transfer techniques d) Techniques for isolationof pure cultures.

2. Microscopy and micrometry: Demonstration of different parts of a compound microscope and measurement of microorganisms.
3. Isolation, enumeration and purification of microbes from a given sample
4. Staining Techniques : a) Simple staining b) Gram staining c) Spore staining
5. Biochemical Characterization of Bacteria : a) Oxidation/Fermentation Test b) Catalase test c) IMViC test d) Oxidase test e) Casein and Starch Hydrolysis test
6. Antibiotic Assay : Antimicrobial Sensitivity Test (Disc Diffusion Method)
7. Growth Kinetics (Bacterial Growth Curve)
8. Coliform test: standard qualitative procedure: presumptive/MPN tests, confirmed and completed tests for faecal coliforms

Reference :

1. Laboratory Manual
2. Microbiology: A Laboratory Manual, Cappuccino, Sherman, Low Price Edition.

COURSE OUTCOMES:

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

1. Demonstrate and make use of aseptic techniques including laboratory safety rules and procedures and can properly handle microorganisms and other biohazards.

2. Analyze and experiment with different samples (water, soil, blood, milk, any food or others) to know their microbial load and also can predict the identity of the microbes present.

3. Make use of microscopic techniques along with some biochemical assays to **illustrate, identify, compare** and even **categorize** different microbial samples.

4. Formulate cultural media for cultivation of different bacteria, test their growth patterns andshow the effects of the environment (Temperature, pH, salinity etc) on growth.

5. Formulate, compile and present a well-organized and concise report of the experimental findings, **evaluate** clinical data and **interpret** results.

6. Develop communication skills in the presentation of scientific material and **evaluate,understand and interpret** the methods described in the related scientific journal articles.

Course Code	**SI-BT381**					
Category	**Summer Internship**					
Course title	**Summer Internship-I Seminar/Training /Workshop(online/offline)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: III**
	0	**0**	**20**	**2**	**90**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

1. The aim of this course is to use the internship experience to enable students to develop their

engineering skills and practice.

2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.
3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. **Demonstrate** the knowledge of Applied Sciences substrate with Allied field of engineering/technology.
2. **Understand** the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. **Communicate** effectively in both verbal and written form through critical thinking process which will assist them in the preparation of their proposal and dissertation
4. **Pursue** new and enriched understandings of the texts through sustained inquiry andreevaluate initial hypotheses in light of evidence.
5. **Express, articulate, discuss and defend well** formed arguments within a group or to an audience or to different engineering communities
6. **Understanding** of lifelong learning processes through critical reflection of internship experiences.

Course Code	OE-BT401					
Category	Open Elective Course					
Course title	Numerical Methods and Biostatistics					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: IV
	3	1	0	4	40	
Pre-requisites/Co-requisites (if any)	- -Linear Algebra, Calculus, Two years of high school Mathematics, Statistics and probability in daily life					

Course Objectives:

This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering. The goal is to provide a basic understanding of the derivation, analysis and use of these numerical methods along with a rudimentary understanding of finite precision arithmetic. This will help you choose and apply the appropriate numerical techniques for your problem, interpret the results and assess accuracy.

In Biostatistics course students will learn how to effectively collect data, describe data, and use data to make inferences and conclusions about real world phenomena.

Course Contents:

Module1 (6 L):

Approximation in numerical computation & Calculus of Finite Differences: Different types of errors and propagation of errors. Forward Differences, Backward differences, Fundamental theorem of difference calculus, Different types of Operator, Evaluation of missing terms in given data.

Module 2 (8 L) :

Interpolation: Newton forward/backward interpolation, Newton‟s divided difference Interpolation.

Numerical differentiation: Numerical differentiation based on interpolation formulae

Numerical integration: Trapezoidal rule, Simpson‟s 1/3 rule

Numerical solution of ordinary differential equation: Euler‟s method, Runge-Kutta methods.

Module 3 (6 L):

Numerical solution of a system of linear equations:

Gauss elimination method, LU Factorization method, Gauss-Seidel iterative method.

Numerical solution of Algebraic equation:

Bisection method, Regula-Falsi method, Newton-Raphson method.

Module 4 (20 L):

Biostatistics: Preliminary concept, Data, Central tendency, Measures of variation, Discrete and

continuous probability distributions, Poisson, normal and binomial distributions, mathematical expectancy; Correlation and regression analysis, curve fitting, T test, chi-square Analysis.

Text Books:

1. Numerical Methods and Programming: Bikash Chandra Bhui & Dipak Chatterjee.
2. Numerical Methods Theory and Practical: K Das
3. Introduction to Biostatistics: Dr.Pranab Kumar Banerjee
4. Statistical Methods: N.G. Das

References:

1. Balagurusamy: Numerical Methods, Scitech.
2. N. Dutta: Computer Programming & Numerical Analysis, Universities Press.
3. 3.Rastogi V. B: Fundamental of Biostatistics
4. Harvey Motulsky: Essential Biostatistics

Course Outcomes:

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

1. **Calculate** different type of errors & establish the relationship of different operators
2. **Find** interpolation, differentiation, integration and **solve** a differential equation using an appropriate numerical method
3. **Solve** a linear system of equations using an appropriate numerical method
4. **Find** roots of non-linear equations using an appropriate numerical method
5. **Construct** central tendency of science/engineering data & interpret the role of such data and employ appropriate regression models to determine statistical relationships
6. **Apply** basic statistical inference techniques, including confidence intervals, hypothesistesting and analysis of variance, to science/engineering problems.

Course Code	**OE-BT402**					
Category	**Open Elective Course**					
Course title	**Data Structure and Algorithms**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:IV**
	3	**0**	**0**	**3**	**36**	
Pre- requisites/Co-requisites (if any)	**-**	**Numerical Methods**				

Course Objective:

The objectives of the course are:

1. To compose the students aware of the concepts data structure like Stack, Queue, Circular Queue and D- queue, linearly linked lists, Circularly linked lists, Doubly linked lists and also their applications.
2. To be familiar with Binary Trees, Binary Search Trees, Height-balanced and Weight-balanced trees.
3. To recognize the magnitude of Breadth first search (BFS), Depth first search (DFS), Prim‟s and Kruskal‟s Algorithm and different types of sorting techniques in IT industry.

Course Content:

Module I: 9L

Basic Terminologies: Elementary Data Organizations, Concepts of a)Data Structure & Operations: insertion, deletion, traversal b) Abstract Data Type and Data Type. Linear Data Structures: Sequential representations, Arrays and Lists, Stacks, Queues , Circular Queue and D- queues and their applications. Link Representation: Linearly linked lists, Circularly linked lists, Doubly linked lists and applications.

Module II: 9L

Basic terminologies, Algorithms for creating, manipulating& applications of Non-linear Data Structure: Trees – Binary Trees, Binary Search Trees, Insertion and Deletion algorithms, Height- balanced and Weight-balanced trees.

Module III: 9L

Graph Representations, Breadth first search (BFS) and Depth first search (DFS), Graph Theoretic Algorithms – Incidence Matrix, Adjacency Matrix, Algorithms for Minimal Spanning Tree (Prim‟s and Kruskal‟s Algorithm).

Module IV: 9L

Objective and properties of different sorting algorithms: Bubble sort, Selection sort, Insertion sort, Quick sort, Merge sort. File structures: Record & Table Structures.

Textbook:

1. Aho Alfred V, Hopperoft John E., Ullman Jeffrey D. , “Data Structures and algorithms”, Pearson

Reference books:

1. Horowitz Ellis &SartajSahani , “Fundamentals of Data Structures” , Galgotria Pub.
2. Tenenbaum A. S., “Data Structures using C”,Pearson
3. N. Deo, Graph Theory -, PHI.

Course Outcome (CO):

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

1. **Define** and understanding introductory concepts of data structure, abstract data types andarray
2. **Illustrate** the concept and implementation of stack, queue, dequeue, circular queue
3. **Understanding** linear data structures with its applications and operations on differentLinked lists.
4. **Describe** non-linear data structure such as trees, height-balanced and graph.
5. **Analyze and evaluate** various searching and sorting algorithms, problem analysis and representation of graphs such as BFS and DFS.
6. **Analyze and evaluate** the importance of data structure and be able to correlate future programming structure, and its market issues specific to complex engineering problems.

Course Code	MC-BT401					
Category	Mandatory Course (Non Credit)					
Course title	Environmental Science/ Engg.					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester:IV
	2	0	0	0	24	
Pre-requisites	Biology, Chemistry					

Course Objective:

The objectives of the course are:

1. To gain knowledge on the importance of environmental education and ecosystem.
2. To acquire knowledge about environmental pollution - sources, effects and control measures of environmental pollution.
3. To understand the treatment of wastewater and solid waste management.
4. To generate valuable resources for the human society.
5. To cultivate the importance of environmental awareness.

Course Content:

Module I: [5 Lectures]

Environment: Basic concepts; components of the environment Role of Biotech in environmental protection; Control and management of biological processes, principles of environmental impact assessment

Ecosystem: Components of ecosystem; Ecosystem management; Genetic, species and ecosystem diversity – bio diversity hot spots; threats to biodiversity; Conservation of bio diversity

Module II: [10 Lectures]

Air Pollution and Control: Atmospheric composition, climate, weather, sources and effects of pollutants, primary and secondary pollutants, green house effect, depletion of ozone layer, Acid rain, standards and control measures.

Water/Wastewater Quality Enhancement: Sources and effects of water pollutants,

Physical Unit Processes: Screening; Commutation; Grit Removal; Equalization; Sedimentation; **Chemical Unit Processes:** Coagulation-Flocculation; Filtration; Disinfections; Aeration; Precipitation; Softening; Adsorption and Ion exchange; Membrane processes.

Biological Unit Processes: Aerobic treatment; Suspended growth aerobic treatment processes; Activated sludge process and its modifications; Attached growth aerobic processes; Trickling filters and Rotating biological contactors

Anaerobic: Anaerobic reactors for treatment of waste water

Module III: [4 Lectures]

Land Pollution: Lithosphere, pollutants (municipal, industrial, commercial, agricultural, hazardous solid wastes); their origin and effects, collection and disposal of solid waste, recovery and conversion methods.

Noise Pollution: Sources, effects, standards and control.

Module IV: [5 Lectures]

Awareness Activities: Small group meetings about waste management, Promotion of recycle use, Generation of less waste, Cleanliness drive, Avoiding electricity waste, Plantation, Slogan making event, Poster making event.

Textbooks:

1. Principles of Environmental Engineering, Gilbert Masters
2. Introduction to Environmental Biotechnology, Milton Wainwright
3. Environmental Biotechnology, Pradipta Kumar Mohapatra
4. Environmental Science, S.C. Santra
5. Environmental Engineering, Davis &Cornwel, McGraw Hill.
6. Environmental Pollution Control Engineering, CS Rao, New Age International
7. Ecology and Environment, PD Sharma PD, Rastogi Publications, Delhi

Web Reference:

1. http://nptel.ac.in/courses/103107084/
2. http://nptel.ac.in/courses/105106119/
3. http://nptel.ac.in/courses/105105048/
4. http://nptel.ac.in/courses/103107084/
5. http://nptel.ac.in/courses/105104102/

Course Outcome (CO):

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

1. Understand the concept of environment and elaborate the organization of ecosystem, its components.
2. Identify, understand, and distinguish the different environmental pollution associated with environmental degradation.
3. Describe the principles and techniques supporting the application of Biotechnology to the environment.
4. Design, formulate and develop different control mechanisms, devices to minimize the environmental pollution.
5. Identify, analyze the industrial activities on environmental pollution and its control mechanism.
6. Create and promote various environmental awareness programs in the society.

Course Code	**ES-BT401**					
Category	**Engineering Science**					
Course title	**Transfer Operation-I**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: IV**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	**- Engineering Thermodynamics and fluidMechanics**					

Course Objective:

The objectives of the course are:

1. To make the students aware of the principles and the basic concepts on fluid Mechanics, Heat transfer and Mechanical operations along with its‟ applications in the main course of Engineering and also to be confident at the end of the course in all above mentioned areas.
2. To realize the importance and applicability of Transfer operation –I subject in the other allied area/field of the main course.

Course Content:

Module I: [9 Lectures]

Basic concepts of Fluid Mechanics:

Basic equations of Fluid Flow, Similarity of mass, momentum, and energy transfer, Navier-Stoke‟s equation, flow analysis using N-S equation for flow down in inclined plane. HagenPoiseuille equation, Bernoulli Equation: significance and applications, Friction in flow through packed beds, fundamentals of fluidisation.

Module II:[6 Lectures]

Flow measurements and machineries:

Flow through pipes and open channels, Orifice and Venturi meters, Pitot Tube, Weirs, Rotameters and other types of meters, Transportation of fluids, Pipe Fittings and valves, Pumps – classification, centrifugal and positive displacement type - peristaltic. Blowers and Compressors (oil-free).

Module III:[9Lectures]

Heat transfer:

Classification of heat flow processes, conduction, Thermal conductivity. Unsteady state heattransfer by conduction: one dimensional heat flow equation with constant surface temperature.

Heat flow in fluids by conduction and convection. Counter current and parallel flow. Enthalpy balance in heat exchange equipment. Individual heat transfer coefficients, overall coefficient, Radiation: Fundamental facts , emission of radiation, laws of blackbody radiation, Kirchoff‟s law, overview :radiation between surfaces, attenuation.

Module IV [12 Lectures]

Mechanical Operations & Transport Phenomena:

Principles of comminution, Types of comminuting equipment, Laws of Energy and power requirement, Crushers, Grinders, Mixing and Agitations, Power consumption in mixing, Screening, Types of screen, Screening efficiency Filtration: Principle, Constant pressure and constant rate filtration; Settling classifiers, Floatation, Centrifugal Separations.

Textbook:

1. Unit Operations of Chemical Engineering: McCabe, Smith &Harriot, TMH, 5th edition
2. Unit Operations of Chemical Engineering, Mechanical Operations:Prof. R. S. Hiremath,Prof. A.P. Kulkarni,EPH.

Reference books:

1. Geankopolis, Transport Processes & Unit operations: 3rd edition, PHI.
2. Coulson & Richardson, Chemical Engineering, Vol-I &II:, Butterworth Heinemann
3. D.Q. Kern, Heat Transfer, MGH
3. Badger, W.L., Banchero, J.T., Introduction to Chemical Engineering, MGH
4. Foust, A.S., Wenzel, L.A, et.al. Principles of Unit Operations, 2nd edition, JWS
5. Perry, Chilton & Green, Chemical Engineers‟ Handbook, MGH
6. R. Byron Bird, Warren E. Stewart and Edwin N. Lightfoot: Transport phenomenon, John Wiley & Sons Inc. Asian students Edition.6.

Web Reference:

1. NPTEL: https://onlinecourses.nptel.ac.in/noc18_ch05/preview
2. NPTEL: https://onlinecourses.nptel.ac.in/noc18_me25/preview

Course Outcome (CO):

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

1. **Understand** fundamental of fluid mechanics, heat transfer, mechanical operation and also to gain basic knowledge on working principle of flow measuring devices..

2. **Identify, select** and **apply** the basic principles of transfer operation and solve engineering problems through teamwork.

3. **Learn** and **understand** the skills towards the problems related to transfer operation I and inturn the approach to solve it by applying basic concepts.

4. **Understand**, **identify** and **illustrate** the different modern tools & techniques based on fundamental of fluid mechanics, heat transfer, and mechanical operation.

5. **Understand** the professional ethics and responsibility in aspects of safety and environmental protection

6. **Communicate** effectively through technical writing and viva voce.

Course Code	**PC-BT402**					
Category	**Professional Core**					
Course title	**Molecular Biology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: IV**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	- **Chemistry (10 + 2 level)** - **Biochemistry**					

Course Objective:

The objectives of the course are:

1. The Objective of the course is to teach students about the basic machinery of Molecular Biology Dogma in details (all the steps, preconditions, role of various enzymes, factors, regulators, inhibitors) etc.

2. Replication, Transcription and translation processes would be discussed in detail in both Prokaryotic and Eukaryotic systems.
3. Mutation, DNA repair, regulation of gene expression in prokaryotes in the light of *lac* operon, *ara* and *trp* operons would be taught.
4. Splicing along with all RNA modifications, RNA editing, etc would be discussed.

Course Content:

Module-I (10L) Introduction to Molecular Biology, Replication & repair:

Chromatin structure, Central Dogma of molecular biology, **Replication:** Mechanism, Model, structure and function of different Enzymes in DNA replication. Initiation, Elongation & Termination of replication; Inhibitors of DNA replication, DNA damage (Physical and chemical induced mutagenicity), Ames test, **DNA Repair:** Nucleotide excision repair, base excision repair, mismatch repair, photo-reactivation repair, recombination repair and SOS repair.

Module-II (9L) Transcription:

Components of transcriptional machinery in prokaryotes and eukaryotes: Structure of mRNA, promoter, RNA polymerases and transcription factors, terminators. **Process of transcription in prokaryotes and eukaryotes:** Initiation, Elongation & Termination of transcription (Rho dependent and independent). **Post transcriptional processing of RNA**: capping, splicing (different types), polyadenylation and RNA editing, mRNA stability, Inhibitors of transcription, Ribozyme.

Module-III (7 L) Translation:

Components of translational machinery: Structure and function of ORF, tRNA, rRNA, aminoacyl synthetases, Ribosomes, RBS, **Process of Translation:** Initiation, Elongation & Termination, Concept of genetic code and Wobble hypothesis, Post translational modifications of protein, Inhibitors of translation.

Module-IV (10 L) Regulation of Gene Expressions:

Gene regulation in prokaryotes: Concept of operon model, (*lac*, *trp* and *ara* operon), Phage regulatory strategy and anti termination in lambda phage, negative and positive regulation, inducer, repressor, corepressor, activators, enhancers, DNA binding protein-protein interacting domain of gene regulatory protein. **Gene regulation in eukaryotes:** DNA looping model, hormonal control of gene expression (steroid and non steroid).

Text books:

1. Molecular Biology of the Gene – by Watson
2. Gene IX -by B. Lewin.
3. Essentials of molecular Biology, by Malacinski and Freifelder Jones and Bartlelt Publishers

Reference Book:

1. Molecular and Cellular Biology- by Stefen Wolfe
2. Genomes, by T. A. Brown, John Wiley and Sons PTE Ltd.
3. Cell and molecular Biology, Concepts and experiments by Gerald Karp, John Wiley and Sons
4. The Cell - A molecular approach, by Gm Cooper Asm Press

Course Outcome:

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

1. Helping the students to **remember** DNA structure and replication.
2. Train the students to **understand transcription** in details.
3. Develop students to memorise and describe **translation.**
4. Students can **understand gene regulations.**
5. The students will **evaluate** and **justify** mathematical calculation, and drawing conclusion on the result.
6. Students will **produce** original contribution in work with publication in international peer reviewed journals.

Course Code	**PC-BT403**					
Category	**Professional Core**					
Course title	**Industrial Biotechnology and EnzymeTechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: IV**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/Co-requisites (if any)	- **Microbiology** - **Basic chemistry**					

Course Objective:

The objective of the course is:

To develop skills of the Students in the area of Basic Industrial Biotechnology. This will be very helpful in understanding courses like Bioprocess technology, genetic engineering. etc.

Course Content:

Module I: [5 lectures]

INTRODUCTION TO INDUSTRIAL BIOPROCESS

Historical overview of industrial fermentation process. A brief survey of processes, products relating to modern biotechnology. Process flow diagram.

Module II: [10 lectures]

COMMERCIAL STRAIN DEVELOPMENT & MICROBIAL PROCESSES

Cellular control regulating production of microbial metabolites, Primary and secondary metabolite, Induced mutation technique, Analogue resistant mutant, Genetically engineered strain--Protoplast fusion technique. Microbial production of Citric acid, Penicillin/Tetracycline/Streptomycin production, Alkaline Protease, Xanthan gum, Alcohol, bakers yeast, Single Cell Protein.

Module III: [7lectures]

INTRODUCTION TO FERMENTATION TECHNOLOGY

Brief overview of a Bioreactor and its different parts, Surface, submerged and solid state fermentations,

Media sterilization, air sterilization, Media optimization and Downstream processing.

Module IV: [7 lectures]

APPLICATION OF ENZYME AND ENZYME TECHNOLOGY

Brief Enzyme Overview; Classification & Nomenclature, Units of Activity, Environmental Effects on Enzyme Activity, Stability of enzyme, Strain selection (thermophilic, halophilic, alkalophilic producer strain), Protein engineering to improve enzyme stability, Chemical modification of enzyme to improve physico-chemical properties, Enzyme applications – (Industrial, medical and analytical).

Module V: [7 lectures]

ENZYME IMMOBILIZATION TECHNOLOGY

Physical and Chemical techniques for enzyme Immobilization –adsorption, matrix entrapment, encapsulation, cross-linking, covalent binding – examples. Advantages and disadvantages of different Immobilization techniques. Overview of applications of immobilized enzyme systems, Design of Immobilized Enzyme Reactors: Packed- bed, Fluidized-bed and Membrane reactors.

Text Books:

1. Stanbury and Whitaker, Principles of Fermentation Technology, 2nd edition
2. L.E. Cassida.Jr, Industrial Microbiology, New Age International Publisher
3. Prescott‟s and Dunn‟s, A. Industrial Microbiology, 4th edition. CBS Publishers, New Dehli, India, 1987

References:

1. Shuler and Kargi, Bioprocess engineering: Basic concepts, 2nd edition, Prentice Hallpublisher
2. Bailey &Olis, Biochemical Engineering Fundamentals, MGH.

Web reference:

1. https://onlinecourses.nptel.ac.in/noc18_bt05/announcements?force=true

Course Outcome (CO):

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

1. **Understand** and **explain** the basic principles of fermentation technology followed by statistical optimization of media components and its downstream processing for purificationof the product.
2. **Be familiar** with different mutation techniques **applied** for enhanced metabolite yield.
3. **Apply** the molecular techniques for manipulation of metabolic pathways to **select** the thermostable enzyme with higher activity.
4. **Compare** between different enzyme immobilization techniques and its application asbiosensors in industry.
5. **Analysis** of packed bed and membrane reactor data for enzyme catalyzed reaction and use of different plots to **design** appropriate kinetic model

Course Code	OE-BT491					
Category	Open Elective Course					
Course title	Numerical Methods and Biostatistics Lab					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: IV
	0	0	2	1	24	
Co-requisites and Pre requisites (if any)	-Numerical Methods and BiostatisticsTheory -Knowledge of any Programminglanguage.					

Course Objectives:

This course is an introduction to a broad range of numerical methods for solving mathematical problems that arise in Science and Engineering. The goal is to provide a basic understanding of the derivation, analysis and use of these numerical methods along with a rudimentary understanding of finite precision arithmetic. This will help you choose and apply the appropriate numerical techniques for your problem, interpret the results and assess accuracy.

In Biostatistics course students will learn how to effectively collect data, describe data, and use datato make inferences and conclusions about real world phenomena.

Course Content:

1. Assignments on Interpolation.
2. Assignments on numerical Integration
3. Assignments on numerical solution of Algebraic Equation.
4. Calculate descriptive statistics and draw different type of graphs

Text Books:

1. Numerical Methods and Programming: Bikash Chandra Bhui&DipakChatterjee.
2. Numerical Methods Theory and Practical: K Das
3. Introduction to Biostatistics: Dr.Pranab Kumar Banerjee
4. Statistical Methods: N.G. Das

References:

1. Balagurusamy: Numerical Methods, Scitech.
2. N. Dutta: Computer Programming & Numerical Analysis, Universities Press. 3.Rastogi V. B: Fundamental of Biostatistics
4. Harvey Motulsky: Essential Biostatistics

Course Outcomes:

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

Demonstrate understanding and implementation of numerical solution algorithms applied to the

1. Code a numerical method in a modern computer language.

2. Select appropriate numerical methods to apply to various types of problems in engineering and science inconsideration of the mathematical operations involved, accuracy requirements and available computational resources.

3. **Demonstrate** understanding and implementation of numerical solution algorithms appliedto the course content.
4. **Make** appropriate use of statistical software.
5. **Analyze** quantitative and qualitative data using biostatistical methods and software.
6. **Communicate** the results of statistical analyses accurately and effectively.

Course Code	**OE-BT492**					
Category	**Open Elective Course**					
Course title	**Data Structure and Algorithms Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: IV**
	0	**0**	**2**	**1**	**24**	
Pre-requisites/Co-requisites (if any)	**-** **Numerical Methods**					

Course Objective:
The objectives of the course are:
1. To understand the application of different types of data structures for programming at theend of the course.
2. To distinguish the sorting with searching in IT industry.

Course Content:

Implementation of Array Operations: (using C/C++ languages)
Stacks and Queues: Adding, Deleting elements, Circular Queue: Adding and Deleting elements. Implementation of linked lists: Inserting, Deleting , Display
Sorting and Searching Algorithms,
Prim‟s, Kruskal‟s and Dijkstra‟s Algorithm.
Implementing Breadth first search (BFS) and Depth first search (DFS).

Course Outcome (CO):
After successful completion of this course, the student will be able to:
1. **Define** different operations on data structure such as insertion, deletion, merging using arrays.
2. **Demonstrate** implementation of stacks and queues: insertion, deletion of elements, circular queue: insertion, deletion of elements using array.
3. **Construction and implementation** of linked lists: inserting, deleting and traversal
4. **Analyze** implementation of stacks & queues using linked lists.
5. **Implementation** of binary tree traversal.
6. **Design and implement** of different searching and sorting algorithms.

Course Code	ES-BT491					
Category	Engineering Science					
Course title	Transfer Operation I Lab					
Scheme andCredits	L	T	P	Cr. Points	Lec. Hrs.	Semester: IV
	0	0	2	1	24	
Pre- requisites/Co-requisites (if any)	Transfer Operation I Theory					

Course Objective:

1. To explore the fundamental principles of fluid mechanics through experimentation.
2. To learn the fundamental principles of operation of grinding equipments.
3. To train the students practically to utilize the knowledge of various heat transfer processes.

Course content:

At least six experiments should be performed

1. To study the working characteristics of a Ball Mill.
2. To study the working characteristics of a Hammer Mill.
3. Experiments on flow measuring device: Rotameter.
4. Flow measuring device:Venturi meter
5. Flow measuring device: Orifice meter
6. Experiments on Reynold‟s Apparatus-Determination of flow regime.
7. Determination of Pressure drop for flow through packed bed & verification of Ergun Equation.
8. Determination of thermal conductivity of a metal bar using Fourier's equation.
9. To Determine the Overall heat transfer coefficient of a concentric pipe heat exchanger based on the inside diameter of the tube.

Course Outcome (CO):

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

1. **Identify**, name, and characterize different flow patterns and regimes.
2. **Understand** the operations of various types of flowmeters used to measure the internal flow, & their applications.
3. **Understand** the performance and calculation of a packed beds and their application in chemical/biochemical industries.
4. **Explain** the working characteristics of Ball Mill and Hammer Mill, their application and calculation related with their performance.
5. **Estimate** the thermal conductivity of a metal bar and its importance in heat flow.
6. **Understand** the performance difference of a concentric pipe heat exchanger operating under various flow patterns.

Course Code	PC-BT491					
Category	Professional Core					
Course title	Molecular Biology Lab					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: IV
	0	0	2	1	24	
Pre-requisites/Co-requisites (if any)	Chemistry (10 + 2 level) Biochemistry Molecular Biology					

Course Objective:

1. The Course is helpful for the students with theoretical knowledge on Molecular Biology making them familiar with the conventional isolation techniques of genetic materials. Based on it, the course teaches them to isolate and estimate DNA, RNA, plasmids etc.
2. Apart from that, it trains the students with basic principles of autoclaving, gel electrophoresis, working with various genetic materials, like RNA, DNA, plasmid and enzymes like DNAse, mutagenesis experiments.
3. This course paves the pathway for building confidence among the students to work independently in various summer training programs and B.Tech level research projects of higher semesters.

COURSE CONTENT:

1. Spectroscopic analysis of DNA/RNA
2. Isolation of Genomic DNA from blood, plant cell and bacteria (any one)
3. Isolation of RNA
4. Isolation of Plasmids
5. Preparation of Agarose Gel and electrophoresis
6. Induced mutation by Chemical agent
7. Induced mutation by physical agent like Ultraviolet light
8. Mini Project: Relevant to the techniques taught

Books:

Molecular Cloning: A Laboratory Manual by Russel and Sambrook (2001)

Course Outcome (CO):

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

1. Students can define the key principles of Molecular Biology with practical application (during mutagenesis assay, isolation of genetic materials, running gels etc.).
2. Students will be able to understand various practical aspects of Molecular Biology through effective hands-on training. They can describe and explain major experiments of the discipline.
3. They can operate instruments skilfully being familiar with various Molecular Biology techniques, solving and interpreting data.
4. They will be able to collaborate with scientists of diverse backgrounds.
5. Students can appraise and support/argue some experimental results. This will encourage lifelong learning, boosting a feeling of research and ignite an inquisitive mind.

6. Students will develop team spirit, project management, effective utilization of fund, good coordination keeping in mind various environmental facts, molecular biology ethics and monetary issues.

Course Code	**SI-BT481**					
Category	**Summer Internship**					
Course title	**Summer Internship-II (Assessment by Seminar/VivaVoce (online/offline)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: IV**
	0	**0**	**20**	**2**	**90**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

1. The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice.
2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.
3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. Demonstrate the knowledge of Applied Sciences substrate with Allied field of engineering/ technology.
2. Understand the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. Communicate effectively in both verbal and written form through critical thinking process which will assist them in the preparation of their proposal and dissertation
4. Pursue new and enriched understandings of the texts through sustained inquiry and re-evaluate initial hypotheses in light of evidence.
5. Express, articulate, discuss and defend well formed arguments within a group or to an audience or to different engineering communities
6. Understanding of lifelong learning processes through critical reflection of internship experiences.

Course Code	HM-BT501					
Category	Humanities and social Science and Managementcourse					
Course title	Fundamentals of Management for Engineers					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: V
	3	0	0	3	36	
Pre-requisites/ Co-requisites (if any)	- Mathematics (10+2)					

Course Objective:

The objectives of the course are:

1. To make the students understand the fundamental principles and practices of management, its function, behavior, hierarchy and importance in an organization.
2. To emphasize the different functional areas of management: finance, production, marketing, and human resource.
3. To address the student the role of information technology in management.

Course Content:

Module I: [10 Lectures]

Organizational Behaviour and General Management:

School of Management Thought (Taylor‟s Scientific Management, Fayol‟s Administrative Theory, Elton Mayo‟s Human Relation Approach).Motivation Theories (Maslow‟s, ERG, Herzberg‟s), Management as an Art and Science, Functions of Management, Managerial Hierarchy and Decisions, Types of Organization (Line Organization, Line and Staff Organization, Functional Organization), Role of a Professional Manager, Importance of Management. Leadership and Management- Relationship between the two, Functions of Leadership, Leadership Styles,Managerial Grid, Group Behaviour Behaviour-Reasons of Forming Groups, functions of Groups, Group Formation Stages, Group Cohesiveness, Managerial Communication- Types, Functions and Barriers, Organisation Culture- Importance, Sources of Developing Organisational Culture, Types and Dysfunctions.

Module II: [8 Lectures] Manufacturing Management:

Production as a Conversion Process, Productivity, Types of Production System (Project, Jobbing, Batch, Mass & Flow, Process), Types of Plant Layout (Functional, Product, Fixed Position), Production Planning and Control, Inventory Control (Standard EOQ Model, EOQ with Price discount), Statistical Quality Control (Acceptance Sampling, OC Curve and Control Charts), Johnson‟s Rule for (n×2) and (n×3) Machines, Forecasting (Qualitative Methods, Quantitative Methods - Moving Average,Exponential Smoothing, Trend Analysis, Linear Regression).

Module IV: [8 Lectures] Marketing Management:

Marketing Concepts (Need, Want, Demand, Production Concept, Product Concept, Selling Concept, Marketing Concept, Societal Concept), Difference between Selling and Marketing; Elements of Marketing Mix- the 4 P‟s. Market Segmentation (STP Concept, Need for Segmentation, Bases of Segmentation, Types of Segmentation),Product life cycle, Advertisement and Sales Promotion, Simple

Marketing Strategies (SWOT Analysis, BCG Matrix).

Module V: [6 Lectures]

Human Resource Management:

Human Resource Planning, Recruitment and Selection, Training and Development, Performance Appraisal, Wage and Salary Administration, Industrial Relations, Trade Union, Collective Bargaining.

Module VI: [4 Lectures]

Computer Application in Management

Overview of Computer Based Information Systems at different Managerial Levels (Transaction Processing System, Management Information System, Decision Support System, Executive Support System, Interrelationship between TPS, MIS, DSS, ESS), Enterprise Resource Planning

Textbooks:

1. L. C. Jhamb, S. Jhamb (2010). Industrial Management-I, 9th Ed., Everest Publishing House
2. L. C. Jhamb, (2010). Industrial Management-II, 10th Ed., Everest Publishing House
3. D. K. Bhattacharyya, (2010). Industrial Management, 1st Ed., Vikash Publishing House Pvt. Ltd.
4. N. Kango, D. Gera, P. Bawa (2010). Industrial Management, 1st Ed., Kalyani Publishers.A. Bhat,
5. A. Kumar (2008). Management Principles, Processes, and Practices, Oxford UniversityPress.

Reference Books:

1. S. N. Chary, Production and Operation Management, Tata McGraw Hill
2. Phillip Kotler, Marketing Management, Prentice Hall/Pearson Education.
3. S. Pande, S. Basak (2012), Human Resource Management - Text and Cases, Dorling Kindersley (India) Pvt. Ltd.
4. S. P. Robbins, Organizational Behaviour, Prentice Hall
5. K. C. Loudon, J. P. Loudon (2006). Management Information Systems - Managing the Digital Firm, 9th Ed., Prentice-Hall of India Pvt. Ltd. (Pearson Education)
6. M. M. Jana, N. K. Samanta (2007). An Overview of Information Technology and its Application in Business, New Central Book Agency (P) Ltd.
7. Khan & Jain, Management Accounting, Tata McGraw-Hill.
8. B. Banerjee (2007) Cost Accounting - Theory and Practice, 12th Ed., Prentice-Hall of India Pvt. Ltd.
9. K. Aswathappa, Human Resource Management, Tata McGraw Hill

Course Outcome (CO):

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

1. **Learn** general principles, practices, and process of management; and fundamentals of organizational behavior in playing an effective managerial role in an organization.
2. **Able to determine** the perfect leadership style to be implemented in various organizational situations and to develop strong group cohesiveness while working in teams.
3. **Demonstrate and analyze** the fundamentals of production management and can make effective

and efficient decisions for production planning and control.

4. Capable to frame optimum marketing policies to initiate, and maximize sales of the firm.

5. Obtain an overview of digital firms through the applications of computers in automating the business processes of a traditional firm.

Course Code	**PC-BT501**					
Category	**Professional Core**					
Course title	**Genetics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: V**
	3	**1**	**0**	**4**	**48**	
Pre-requisites (if any)	**Biology (10+2 Level) Microbiology (BS-BT301) Molecular Biology (PC-BT402)**					

Course Objective:

The objectives of the course are:

1. Course will cover principles of prokaryotic and eukaryotic cell genetics.
2. Provide an understanding of Gene structure and function, Mutation, Chromosome aberrations and Evolution.
3. Students will acquire knowledge of Population genetics and its applications.

Course Content:

Module I: (12L) Cytogenetic, Mendelism and its extensions

Beginning of genetics; Cell structure and cell division; Mendel's laws; Chromosomal theory of inheritance; Multiple alleles, Gene interactions: Type with example from plant and animals. Penetrance and expressivity, Pleiotropy; Polygenic inheritance,Sex determination; Linkage; Recombination and genetic mapping in eukaryotes; pedigree analysis; Extra chromosomal inheritance

Module II: (12L)

Organisation of DNA in chromosome; Genetic code; Genetic fine structure analysis (rII locus), Allelic complementation, Split genes, Transposable genetic elements, Overlapping genes, Pseudogenes, Cancer and cell cycle; Structural and numerical changes in chromosomes: euploidy and aneuploidy, and their genetic implications; Concepts of Eugenics, Epigenetics, Genetic disorders and Behavioral genetics

Module III: (12L) Microbial Genetics:

Horizontal gene transfer in bacteria (Conjugation, transformation and transduction); Genetic aspects of extra chromosomal elements: plasmids and transposons site-specific recombination; Recombination and complementation analysis; gene mapping

Virus genetics: Bacteriophages Lytic and Lysogeny cycles, the λ Paradigm

Module IV: (12L) Mutation, Evolution and Population Genetics

Difference between DNA lesions and mutation; mechanisms of mutations; various kinds of DNA mutations (point mutation, insertion, deletion, nonsense, nonsense suppressor, frameshift and reversion);

Ames Test; Hardy-Weinberg equilibrium, changes of gene frequency; heritability and its measurements, Developmental Genetics; Inbreeding and heterosis, Speciation and evolution

Textbook:

1. Strickberger, Genetics, 3rd edition, McMillan, 1985.
2. Snustad& Simmons, Principles of Genetics, 4th Edition, Wiley, 2005.
3. Verma, P.S. and Agarwal, V.K. (2004). Cell Biology, Genetics, Molecular Biology, Evolution andEcology. S. Chand & Co. Ltd., New Delhi.

Reference Books:

1. Griffiths et al, Modern genetic analysis, 2nd Edition, Freeman, 2002.
2. Microbial Genetics, 2nd edition, Stanley R. Maloy, John E. Cronan, David Freifelder. Pub: Jones and Bartlett Publisher Inc.
3. Lewin, Genes IX, 9th Edition , Jones & Bartlett, 2007.
4. Molecular Genetics of Bacteria by Jeremy W. Dale and Simon F. Park, Wiley-Blackwell, 5th Edition 2010.

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/
2. ePgPathshala:http://epgp.inflibnet.ac.in/ahl.php?csrno=3

Course Outcome (CO):

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

1. **Describe**, detailed understanding of the principles of Mendelian inheritance and extensions.
2. **List** the structure and function of the DNA molecule to its functional role in encoding genetic material.
3. **Describe** normal chromosome number, structure, and behaviour in organisms, and understand the reason and effect of various aberrations in chromosome.
4. **Understand** bacterial mechanism of horizontal gene transfer methods.
5. **Understand** how to identify and classify mutations in DNA.
6. **Apply** the Hardy-Weinberg Law in analysing population genetics for gene frequency, sex linkage, equilibrium, and heterozygote frequency.

Course Code	**PC-BT502**					
Category	**Professional Core**					
Course title	**Bioinformatics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: V**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/co-requisites (if any)	*There are no enforced requisite courses forBioinformatics. However, some knowledge of molecular biology, any computer programming language and database & networking would be advantageous.*					

Course Objectives:

1. To educate the interdisciplinary nature of advances in bioinformatics
2. To provide basic understanding of how biological data is stored and retrieved from various biologicaldatabases.
3. To develop an understanding of algorithms of sequence alignment and scoring algorithms.
4. This course teaches will teach Perl and UNIX command

Course Content:

Module 1 (6L):

Definition and application bioinformatics to biological research, Different type of Databases.

Module 2 (10L):

Sequence alingment: local and global alignment, pair wise and multiple alignment, sequence alignment algorithm: Needleman and Wunsch algorithm, Smith-Waterman, Scoring Matrix. Database Similarity Search

Phylogenetics analysis through multiple sequence alignment, Gene prediction, Motif identification- Pfam, Prosite.

Module 3 (8L):

Protein Secondary and tertiary structure prediction, Chou Fasman & GOR method, Hidden markov model and neural network, Homology Modelling, Structure visualization methods (eg: RASMOL, CHIME) Introduction to energy minimization, QSAR and their relation in drug design.

Module 4 (12L):

Perl programming.

Textbooks:

1. Xiong.J, Essential Bioinformatics, Cambridge University Press
2. Ghosh and Mallick, Bioinformatics-Principles and applications Oxford University Press.
3. James Tisdall, Beginning Perl for Bioinformatics, SPD

Reference books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis, 2nd Edition, CSHL Press, 2004.
2. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss,2003.
3. Cynthia Gibas and Per Jambeck, Introduction to Bioinformatics computer Skills, 2001 SPD
4. Atwood, Introduction to Bioinformatics, Person Education
5. Smith, D.W, Biocomputing : informatics and Genome Project,., 1994, Academic Press, NY.
6. Baxevanis, A.D, Quellette. B.F.F, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, , John Wiely& Sons.
7. Andrew Leach, Molecular Modelling: Principles and Applications,Pearson Education.

Web Reference: http://www.ncbi.nlm.nih.gov/ http://www.expasy.org/ http://www.uniprot.org/

http://www.rcsb.org/pdb

Course Outcomes:

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

1. **Understand** the theoretical basis behind bioinformatics**.**
2. **Search** databases accessible on the WWW for literature relating to molecular biology and biotechnology
3. **Manipulate** DNA and protein sequences using stand-alone PC programs and programs available onthe WWW and understand the programming language PERL.
4. **Find** homologues, analyze sequences, construct and interpret evolutionary trees.
5. **Analyze** protein sequences, identify proteins, and retrieve protein structures from databases. **Viewand interpret** these structures. **Understand** homology modeling and computational drug design.
6. **Able to query** biological data, **interpret and model** biological information and **apply this** to thesolution of biological problems in any arena involving molecular data.

Course Code	**ES-BT501**					
Category	**Engineering Science**					
Course title	**Transfer Operation II**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: V**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	**-Transfer Operation I**					

Course Objective:

The purpose of this course is to introduce the undergraduate students with the most important separation equipments in the process industry, and provide proper understanding of unit operations.

Course Content:

Module I: [9 Lectures]

Introduction to Mass Transfer: Molecular diffusion in fluids, Diffusivity, Mass Transfer Coefficients, Interphase Mass Transfer, Gas Absorption, countercurrent multistage operation, Packed Tower.

Module II: [9 Lectures]

Distillation:

Vapour-liquid equilibrium, Rayleigh‟s Equation, Flash and Differential distillation, continuous rectification, McCabe-Thiele Method, bubble cap and sieve distillation column.

Module III: [9 Lectures]

Extraction, Drying and Crystallization: Liquid–liquid equilibrium. Liquid extraction, Stage wise contact; Liquid-solid equilibria, Leaching; Batch drying and mechanism of batch drying, Principle and operation of a spray drier, Preliminary idea of Crystallization.

Module IV: [9 Lectures] Advanced Separation Processes:

Dialysis, ultrafiltration, reverse osmosis, pervaporation, electrodialysis and membrane separation.

Textbooks:

1. Unit Operations of Chemical Engineering: McCabe, Smith &Harriot, TMH, 5thedition

Reference book:

1. Transport Processes & Unit operations:Geankopolis, PHI, 3rd edition
2. Chemical Engineering, Vol-I & II: Coulson & Richardson, Butterworth Heinemann
3. Treybal, R.E., Mass-Transfer Operations, MGH
4. Perry, Chilton & Green, Chemical Engineers‟ Handbook, MGH

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/103103035/e

Course Outcome (CO):

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

1. **Understand** the molecular diffusion in fluids along with the mass transfer co-efficient.
2. **Understand** the concept of interphase mass transfer mechanism and fundamentals of absorption tower and packed tower.
3. **Understand** the role of Vapour-liquid equilibrium in different types of distillation and illustrate the McCabe-Thiele Method.
4. **Understand** the liquid–liquid equilibrium in extraction and liquid-solid equilibrium in leaching.
5. **Understand**, **identify and illustrate** the mechanism of drying and the working principle of different types drier also understand the fundamentals of crystallization**.**
6. **Understand** the fundamentals of advance separation process.

Course Code	**OE-BT501**					
Category	**Open Elective Course**					
Course title	**Data Base Management System and ComputerNetworking**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: V**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	**Data Structure and Algorithm**					

Course Objective:

The objectives of the course are:

1. To make the students aware of the concepts, practices and application of the database, DBMS, SQL and Computer Networking at the end of the course in the above mentioned area.
2. To recognize the magnitude of DBMS with Computer networking in the IT industry.

Course Content:

Module I: [10 Lectures]Introduction

Database System Concepts and Architecture, File System Vs DBMS, Scheme and Instances, Data Abstraction, Data Independence, Database Languages, Database Manager, Database Administrator, Database Users.

Data Models- Entity Relationship model, Relational Data model, Entity Relationship diagrams, Relational Database Design

Module II: [10 Lectures] RELATIONAL DATABASE DESIGN

Different anomalies in designing a Database, Functional dependency and Armstrong's axioms, Normalization using functional dependencies, Decomposition, 1NF-2NF-3NF-BCNF.

Transaction processing: ACID property, Locking protocols, Concept of database recovery

Module III: [4 Lectures] Structured Query Language

Queries of Data Definitions and Data Manipulation in SQL, Introduction to PL/SQL.

Module IV: [12 Lectures]

Computer Networking: LAN/MAN/WAN, Various Connection Topology, OSI 7 layer Model, Transmission Media, Inter Networking, IP, TCP/UDP, Electronic Mails, TELNET, File Transfer Protocol (FTP), WWW, HTTP, URLs, Search Engines, Firewalls.

Textbooks:

1. Henry F. Korth and Silberschatz Abraham, "Database System Concepts, 4th ed, Mc.Graw Hill, Computer Science Series.

Reference books:

1. "Database System Concepts", 6th Edition by Abraham Silberschatz, Henry F. Korth, S. Sudarshan, McGraw-Hill.
2. "Principles of Database and Knowledge – Base Systems", Vol 1 by J. D. Ullman, Computer Science Press.
3. Database Management Systems, R.P. Mahapatra, Khanna Publishing House, New Delhi
4. "Fundamentals of Database Systems", 5th Edition by R. Elmasri and S. Navathe,
5. Pearson Education "Foundations of Databases", Reprint by Serge Abiteboul, Richard Hull, Victor Vianu, Addison-Wesley

Web Reference:

1. https://onlinecourses.nptel.ac.in/noc18_cs15

Course Outcome (CO):

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

1. **Define and understand** the fundamentals of Database management System and traditional file system.
2. **Understand and explain** the concepts of Data Model.

3. **Make use** of the tools to implement Entity Relationship diagrams.
4. **Utilize and take** part in the normalization of the real world database to remove redundancies.
5. **Elaborate** the importance of Locking protocols and Database recovery
6. **Discuss** the importance of Computer Networking, Topologies, OSI 7 layer Model, various layer protocols.

Course Code	**PE-BT501**					
Category	**Professional Core Elective**					
Course title	**Bioreactor Design And Analysis**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: V**
	3	**1**	**0**	**4**	**48**	
Pre-requisites/ Co-requisites (if any)	- **Thermodynamics and Kinetics forBiotechnology** - **Industrial Microbiology and EnzymeTechnology**					

Course Objective:
The objectives of the course are:
1. To apply the knowledge of reaction kinetics to understand the basics of reactor design.
2. To understand the relationship between biological phenomena and engineering design for effective bioreactor operations to achieve production

Course Content:

Module I: (11L) Basic Principles:

Principles of kinetics for chemical and biochemical reactions, searching for a Mechanism, Predictability of Reaction Rate, Fundamentals of homogeneous reactions for batch, plug flow, semi-batch, stirred tank/ mixed reactors. Ideal and non-ideal multiphase bioreactors.

Module II: (17L)

Biochemical Reaction Systems: Enzyme fermentation: Mechanistic Models for Simple Enzyme Kinetics, Experimentally Determining Rate Parameters for Michaelis–Menten Type Kinetics, Reactor consideration (batch, PFR and MFR) for enzyme fermentation.
Microbial fermentation: Quantifying Growth Kinetics, Substrate-Limiting Microbial Fermentation for batch, PFR and MFR, Mass transfer in biochemical processes.

Module III: (13L)

Operating considerations: Modifying Batch and Continuous Reactors, Immobilized Cell Systems, Active and Passive Immobilization of Cells, Biological Films, Diffusional Limitations in Immobilized Cell Systems, Bioreactor Considerations in Immobilized Cell.
Selection, scale-up, operation, and control of bioreactors: Scale-up, scale-down, bioreactor instrumentation and control, instrumentation for measurements of active fermentation.Some considerations on aeration, agitation, and heat transfer. Scale-up and its difficulties,

Module IV: (7L)

Unconventional bioreactors: Hollow fiber reactor, membrane reactor, perfusion reactor, air lift reactor, bubble column reactor for animal and plant cell culture.

BEYOND SYLLABI COVERAGE

Introduction to different software for designing of experiment, parameter optimization, the kinetics of the different biological process, and data representation.

Textbook:

1. Levenspiel, O., Chemical Reaction Engineering, Wiley Eastern Ltd.
2. Michael L. Shuler and FikretKargi, Bioprocess Engineering : Basic Concepts (3rd Edition)

Reference Books :

1. Bailey &Olis, Biochemical Engg. Fudamentals, MGH, 1990
2. Atkinson, B., Biological Reactors, Pion Ltd., London, 1974
3. "Bioreactors in Biotechnology", Ellis Horwood series, 1991. A. H. SCRAGG

Web Reference:

1. http://nptel.ac.in/courses/102106053/

Course Outcome (CO):

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

1. **Apply** the knowledge of reaction kinetics to understand the basics of reactor design.
2. Apply the knowledge of reaction kinetics principles to **identify and formulate problems** in chemical and biochemical reaction engineering and find appropriate solutions.
3. **Design/development of solutions** of chemical and biochemical reaction kinetics data
4. Able to analyze and **interpret the data of complex problem** on non-ideal reactor analysis.
5. Ability to use **modern engineering and computational tools**, including prediction and modeling to different engineering activities,
6. Understand the relationship between **biological phenomena and engineering design** for effective bioreactor operations to achieve production goals for **societal issues** and the **ability to learn** in the broad context of technological changes.

Course Code	**PC-BT-591**					
Category	**Professional Core**					
Course title	**Genetics Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: V**
	0	**0**	**3**	**1.5**	**36**	
Co-requisites	**Genetics Theory**					

Course Objective:

The objectives of the course are:

1. Course will cover the mathematical, statistical, and computational basis of genetic analyses.
2. To identify and describe the process of cell division (meiosis and mitosis), as well as predict the

outcomes of these process.

Course Content:

1. Laboratory exercises in Chi-square.
2. Preparation of different stages of Mitosis and Meiosis
3. Karyotype analysis and Ideogram preparation of plant/human chromosomes.
4. Study of chromosomal aberrations in plant cells.
5. Barr body preparation from female buccal smear.
6. Meiosis study in testis of grasshopper
7. Preparation of Pedigree chart of some common phenotypic characters of human
8. Hardy-Weinberg Genetic equilibrium: Study of gene & genotype; frequencies. (PTC Tasters & nontasters)
9. Linkage and chromosome mapping
10. Design of Experiment (RBD)
11. T test
12. Analysis of variances (ANOVA)

Course Outcome (CO):

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

1. **Analyze** genetic data using statistical procedures.
2. **Construct** cytological slides for mitotic and meiosis.
3. **Demonstrate** various types of chromosomal aberrations and barr body.
4. **Design** pedigree chart of common human traits.
5. **Calculate** problems based on Hardy-Weinberg equilibrium.

Course Code	**PC-BT592**					
Category	**Professional Core**					
Course title	**Bioinformatics Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: V**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/ Co-requisites (if any)	**Bioinformatics Theory**					

Course Objectives:

1. To educate the interdisciplinary nature of advances in bioinformatics
2. To provide basic understanding of how biological data is stored and retrieved from various biologicaldatabases.
3. To develop an understanding of algorithms of sequence alignment and scoring algorithms.
4. This course teaches will teach Perl and UNIX command

Course Content:

1. Handling of Biological databases eg: NCBI, EMBL, PDB,
2. Local and Global sequence alignment.
3. Database Similarity Searches.

4. Multiple Sequence Alignment.
5. Phylogenetic Analysis.
6. Gene prediction
7. Prediction of secondary and tertiary structure of proteins;
8. Perl programming,

Textbooks:

1. Xiong.J, Essential Bioinformatics, Cambridge University Press
2. Ghosh and Mallick, Bioinformatics-Principles and applications Oxford University Press.
3. James Tisdall, Beginning Perl for Bioinformatics, SPD

Reference books:

1. Cynthia Gibas and Per Jambeck, Introduction to Bioinformatics computer Skills, 2001 SPD
2. Atwood, Introduction to Bioinformatics, Person Education
3 Smith, D.W, Biocomputing: informatics and Genome Project,.,1994, Academic Press, NY.
4. Baxevanis, A.D, Quellette. B.F.F, Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins, , John Wiely& Sons.
5. Andrew Leach, Molecular Modelling: Principles and Applications,Pearson Education.

Course Outcome:

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

1. Describe the contents and properties of the most important bioinformatics databases.

2. Searches, and Analyze and Discuss the results in pairwise sequence alignment by Dotmatrix, dynamic programming and word method.

3. Find homologues, analyze sequences, construct and interpret evolutionary trees.

4. Annotate gene by Computational methods.

5. Develop programming skill in PERL.

6. Predict the secondary and tertiary structures of protein sequences.

Course Code	**ES-BT591**					
Category	**Engineering Science**					
Course title	**Transfer Operation II Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: V**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/ Co-requisites (if any)	**Transfer Operation II Theory**					

Course Objectives:

The objectives of the course are:

1. The purpose of this course is to introduce undergraduate students with the most important separation technology/equipments in the process industry.
2. The course provides the students about the proper understanding of unit operations.

Course Content:

1. Study of Simple batch distillation to verify Rayleigh‟s equation.
2. To determine specific cake resistance and filter medium resistance in plate and frame filtration.
3. To determine the gas-liquid mass transfer coefficient.
4. To study the drying characteristic curves under constant drying condition in rotary dryer.
5. To study the drying characteristic curves under constant drying condition in tray dryer.

Course Outcome:

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

1. Understand the molecular diffusion in fluids along with the mass transfer coefficient.
2. Understand the role of Vapour-liquid equilibrium in distillation and verify Rayleigh's equation.
3. Understand and determine specific cake resistance and filter medium resistance in plate and frame filtration.
4. Understand, identify and illustrate the mechanism of drying and the working principle of rotary dryer.
5. Understand, identify and illustrate the mechanism of drying and the working principle of tray dryer.
6. Explain the fundamentals of different working principles related to mass transfer operations.

Course Code	**OE-BT591**					
Category	**Open Elective Course**					
Course title	**Data Base Management System Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: V**
	0	**0**	**3**	**1.5**	**36**	
Pre-requisites/ Co-requisites (if any)	**DBMS Theory**					

Course Objective:

The objectives of the course are:

1. To compose the students aware of the concepts, practices and application of the database,DBMS, SQL and Computer Networking at the end of the course in above mentioned area.
2. To recognize the magnitude of DBMS with Computer networking in IT industry.

Course Content:

Structured Query Language

1. Creating Database, Table and Record Handling

Creating a Table, Specifying Constraints, INSERT, DELETE, UPDATE, DROP, ALTER statements

2. Retrieving Data from a Database

The SELECT statement Using the WHERE clause, Using Logical Operators in the WHERE clause, Using IN, BETWEEN, LIKE, ORDER BY, GROUP BY and HAVING Clause, Using Aggregate Functions

3. Introduction to PL/SQL (Basic Programs)

4. Sharing resources in a LAN, Internet Connection, Web – browsing, Search Engines, Downloading

Reference book:

1. Oracle 9i Complete Reference – Oracle Press.

Course Outcome (CO):

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

1. **Outline** the underlying concepts of table creation in database technologies.
2. **Define and demonstrate** DDL and DML commands.
3. **Experiment** with SQL to construct and apply to execute database query using SQL clauses.
4. **List and test** the group function on a database using a RDBMS
5. **Explain** Programming in PL/SQL.
6. **Compose** the use of computer networking for modern software development.

Course Code	**SI-BT581**					
Category	**Summer Internship**					
Course title	**Summer Internship-III (Seminar/Training /Workshop) (online/offline)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: V**
	0	**0**	**15**	**1.5**	**68**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

1. The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice.
2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.
3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. Demonstrate the knowledge of Applied Sciences substrate with Allied field of engineering/technology.
2. **Understand** the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. **Communicate** effectively in both verbal and written form through critical thinking process which will assist them in the preparation of their proposal and dissertation
4. **Pursue** new and enriched understandings of the texts through sustained inquiry and reevaluate

initial hypotheses in light of evidence.

5. Express, articulate, discuss and defend well formed arguments within a group or to anaudience or to different engineering communities

6. Understanding of lifelong learning processes through critical reflection of internshipexperiences.

Course Code	HM-BT601					
Category	Humanities and Social Science and ManagementCourse					
Course title	Project Management and Entrepreneurship					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VI
	2	0	0	2	24	
Pre-requisites/ Co-requisites (if any)	- Fundamentals of Management, ElementaryMathematics					

Course Objective:

The objectives of the course are:

1. To impart among students, the concept of project, its characteristics, and its management subject togiven constraints to successfully deliver the agreed outcomes of the project.

2. To imbibe students with the knowledge of effective project planning, project evaluating, and projectscheduling with optimal resource allocation.

3. To impart among students, the legal aspect and quality aspect of project management.

4. To familiarize the students with the concept of entrepreneurship, its theoretical and practical approach.

Course Content:

MODULE-I [8 Lectures]

Project Management Concepts: Concept and Characteristics of a Project, Types of Projects, Project Management (Need, Knowledge Areas, Project Manager, Project Management Triangle, Project Scope and Scope Creep, Importance of Project Management).

Project Management Life Cycle: Project Management Life Cycle Phases, Project Management Process (Project Process, Process Group, Process Interactions, Customization, Process Group and Knowledge Area Matrix)

Project Planning: Planning Need, Importance of Planning, Planning Process, Work Breakdown Structure and Organization Breakdown Structure, Roles, Responsibility and Teamwork, Feasibility Studies. Gnatt Chart and Line of Balance.

MODULE-II [8 Lectures]

Project Evaluation: Investment Analysis of Projects (Time Value of Money, Interest Rates, Compounding/Discounting, Payback Period, Average Rate of Return, Net Present Value, Profitability Index, Internal Rate of Return), Sources of Finance.

Project Scheduling: Importance of Project Scheduling, Scheduling Techniques (Gantt Chart and Line of Balance, Network Analysis – CPM/PERT, Slack and Float).

Project Cost Control: Direct and Indirect Cost, Normal Cost and Crash Cost, Time– Cost Trade-off Analysis - Optimum Project Duration, Resource Allocation and Leveling.

MODULE-III [4 Lectures]

Legal and Quality Aspects of Project Management: Project Contract (Types of Contract, Sub-Contracting, Tenders, Payment to Contractors), Project Audit.

IT in Projects: Overview of types of Software for Projects, Major Features of Project Management Software like MS Project, Criterion for Software Selection.

MODULE-IV [4 Lectures]

Entrepreneurship: Meaning & Concept of Entrepreneurship, Conditions needed for Entrepreneurship (Social Factors, Economic Factors, Psychological Factors, Legal Factors, Education & Technical Knowhow, Financial Assistance), Qualities of a Prospective Entrepreneur.

Entrepreneurial Motivation: McClelland‟s N-Ach Theory (Need for Affiliation, Need for Power, Need for Achievement), Self–Analysis, Personal Efficacy, Culture & Values, Risk-taking Behaviour, Technology Backup.

Entrepreneurial Skills: Creativity, Problem Solving, Decision Making, Communication, Leadership Quality.

Textbooks:

1. P. Gopalkrishnan and R. M. Moorthy; Text Book of Project Management, Macmillan
2. K. Nagarajan; Project Management, New Age International Publishers; 5th Edn.
3. P. Chandra; Projects; Tata McGraw Hill; 6th Edn
4. J. M. Nicholas; Project Management for Business and Technology – Principles and Practice; Prentice Hall India; 2nd Edn.
5. H. Maylor; Project Management; Pearson; 3rd Edn.
6. D. F. Kuratko and R. M. Hodgetts; Entrepreneurship; Thomson Learning; 7th Edn.
7. R. Roy; Entrepreneurship; Oxford University Press.

Reference Books:

1) S. A. Kelkar; Software Project Management: A concise Study; Prentice Hall India; 2nd Edn.
2) F. K. Levy, J. D. Wiest; A Management Guide to PERT/CPM with GERT/PDM/DCPM and othernetworks; Prentice Hall India, 2nd Edn.
3) J. Mantel, J. R. Meredith, S. M. Shafer, M. M. Sutton, M. R. Gopalan; Project Management: CoreText Book, Wiley India, 1st Indian Edn.
4) L. C. Jhamb; Industrial Management-II; Everest Publishing House; 10th Edn.
5) S. N. Chary; Production and Operation Management; Tata McGraw Hill
6) Clements, Gido; Effective Project Management; Thomson Learning
7) C. F. Gray, E. W. Larson; Project Management; Tata McGraw Hill; 3rd Edn.

Course Outcome (CO):

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

1. **Learn** general concept of a project and project management, the importance of project life cycle and essential elements of project planning.
2. **Analysis** of project evaluation, project scheduling as well as project cost control through application of financial and mathematical tools.
3. **Learn** details of legal and quality aspects of project management to face various issues.
4. **Study and demonstrate** the features of different project management softwares with special emphasis on “MS Project” and can able to select the best PMS subject to desired requirements.

5. **Develop skills** of entrepreneurship both theoretical and practical approach and can take initiative of starting a new business.
6. **Align** the successful approach of entrepreneurship in undertaking large investment projects for the necessity and benefit of the society.

Course Code	**PC-BT601**					
Category	**Professional Core**					
Course title	**Recombinant DNA Technology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VI**
	3	**0**	**0**	**3**	**36**	
Pre-requisites (if any)	- **Microbiology (PC-BT402)** - **Genetics (PC-BT501)** - **Molecular Biology (PC-BT-402)**					

Course Objective:

The objectives of the course are:

1. To be familiar with the tools that forms the basis for recombinant DNA technology.
2. To demonstrate use of modern techniques for manipulation and analysis of genomic sequences.
3. To make students learn the application of recombinant DNA technology in the field of biomedical, agriculture and environment.

Course Content:

Module I: 10L Tools of Recombinant DNA technology

DNA Structure and properties; Enzymes used in recombinant DNA technology; Linkers and Adaptors; Radioactive and non-radioactive probes

Cloning and expression vectors: Plasmids; Bacteriophages; M13 vectors; Bluescript vectors, Phagemids; Lambda vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; retroviral vectors; Expression vectors: pET-based vectors; Plant based vectors, Shuttle vectors; Host cell (microbes and animal cells)

Module II: 10L Techniques in Recombinant DNA Technology

Radioactive and non-radioactive labeling of DNA, Hybridization techniques: Northern, Southern,Eastern and Colony hybridization, Fluorescence in situ hybridization (FISH)

DNA sequencing methods (Maxum& Gilbert, Sangers, 454 pyro-sequencing, Next Generation sequencing techniques (Illumina); Site directed mutagenesis

Mod-III: 6L Gene Cloning Methods

Steps in Isolation and purification of Nucleic Acid (DNA and RNA); Polymerase chain reactions (PCR) and types (Allelic specific, multiplex, nested, PCR-OLA, inverse PCR); Construction of libraries (Genomic and cDNA); Steps in expression cloning; Chromosome walking and Jumping; Gene transfer methods: Vector and vectorless; Gene tagging; Screening recombinant gene and gene product

Module IV: 10L Application of rDNA technology

Genetic engineering for therapeutic and agricultural applications; Gene knockouts and Gene therapy, Gene silencing (siRNA, miRNA), Non-transgenic gene editing, crispr cas9 mechanism; Large scale Gene expression analysis (Microarray for DNA and protein). Molecular markers (RAPD, AFLP, SNP) for trait identification; Biosafety; Human Genome Project; Examples of few successful Transgenic organisms

Textbook:

1. Old and Primrose, Principles of Gene Manipulation, 3rd Ed, Blackwell ScientificPublishers.2
2. J. Sambrook and D. W. Russel, Cloning Methods: A laboratory Manual, Vols 1-3 CSHL 2001.
3. T. A Brown, Genomes, 3rd Ed, Garland Science 2006.

Reference books:

1. B. R. Glick and J.J. Pasternak ; Molecular Biotecnology: Principles and Applications of RecombinantDNA, ASM press
2. Watson, J.D., Gilman, M., Witkowski, J., Zoller, M. - Recombinant DNA, Scientific American Books, New York, 1992.
3. Brown, T.A., Genetics a Molecular Approach, 4th Ed. Chapman and Hall, 1992

Course outcome:

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

1. **Understand, define** and explain the tools in recombinant DNA technology.
2. **Understand** techniques in recombinant DNA technology.
3. Designing cloning experiments for applications in various genomic and proteomics studies.
4. **Identify**, **select** and **implement** the PCR and its types in molecular biology and recombinant DNA technology.
5. **Apply** knowledge of genetic engineering in current applications of biotechnology.
6. **Comprehend** and **analyze** the impact of Human Genome Project in genetic engineering programme.

Course Code	**PC-BT602**					
Category	**Professional Core**					
Course title	**Immunology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VI**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	- **Microbiology** - **Biochemistry** - **Genetics**					

Course Objective:

The objectives of the course are:

1. To gain knowledge about the components of the human immune response that work together for

the protection of the host.

2. To understand the occurrence of diseases as either an outcome of deficiency of immune-components or excess activity as hypersensitivity along with the exposure of immune-based diagnostic techniques.

COURSE CONTENT:

Module 1: 10L Introduction to Immunology

The origin of Immunology: History and evolution of immune system; Concept of Innate and Adaptive immunity; Humoral and cell-mediated immunity; Active and Passive form of immunity; Structure, Functions and Properties of Immune Cells and Immune Organs.

Module II: 10L Antigens and Antibodies

Characteristics of an antigen; Haptens; T & B cell epitopes; T-dependent and T-independent antigens; Adjuvants; Structure, Types, Functions and Properties of antibodies; Antigenic determinants on antibodies; Molecular basis of antibody and T cell receptor diversity: VDJ rearrangements, somatic hypermutation, Class switching; synthesis of antibody and secretion; Monoclonal and Chimeric antibodies; Basic concept of Antigen antibody reaction.

Module III: 10LMajor Histocompatibility Complex and Generation of Immune Response

Organization of MHC locus (Mice & Human); Structure and Functions of MHC I & II molecules; HLA, laws of graft rejection, graft versus host reaction; Antigen processing and presentation; Generation of Humoral and Cell Mediated Immune Response; Killing Mechanisms by CTL and NK cells, Introduction totolerance; Complement System**:** Components of the Complement system, Activation pathways; Biological consequences of complement Activation.

Module IV: 6L Immunological Disorders and Vaccinology

Types of Autoimmunity and Hypersensitivity with examples; Immunodeficiencies - Animal models (Nude and SCID mice); Vaccine technology: Rationale of vaccine design based on clinical requirements, Role and types of vaccines with examples: Conventional vaccines; Sub unit vaccines; Recombinant DNA and protein based vaccines; plant-based vaccines and reverse vaccinology; conjugate vaccines.

Text Book:

1. Essential Immunology, Roitt, I.M., 9th Ed. (1997), Blackwell Scientific, Oxford, UK
2. Immunology, Kuby, J. 3rd Ed. (1997), Freeman, W.H,Oxford,UK
3. The Elements of Immunology, 1/e, (2009) FahimHalim Khan, Pearson Education.
4. Immunology and Immune Technology by A. Chaktraborty, Oxford Univ. Pub.

Reference books:

1. K.A. Abbas, Immunology, 4th ed, W.B. Saunders& Co.
2. Immunology: An Introduction. TizardCengage Learning India (P) Limited
3. Weir, Immunology, 8th ed, W.B. Saunders& Co.
4. Immunobiology, The Immune system in Health and Disease, Seventh Edition by Janeway,Travers

et al, Garland Publishing, 2008

Web Reference:

1. NPTEL :http://nptel.ac.in/courses/104108055/

COURSE OUTCOME:

By the end of this course student will be able to:

1. Conceptualize and **infer how** the innate and adaptive immune responses coordinate to fight invading pathogens.
2. Apply the knowledge of basic Immunology to **identify** problems and formulate **solutions** for the protection of human health.
3. **Understand** the theories of different immunological techniques and **apply** them efficiently in **solving** problems related to scientific research, health care, forensic sciences, drug industries for **formulation** of newer medicines etc.
4. **Explore** strategies to **improve** existing vaccines and how to approach these.
5. **Determine** and **design** what immunomodulatory strategies can be used to enhance immune responses or to suppress unwanted immune responses during different immune disorders.
6. **Interpret** and **analyze** results of scientific experiments involving *in vivo* models used in different researches including tumor and cancer biology, autoimmune diseases, immunodeficiency diseases.

Course Code	**PC-BT603**					
Category	**Professional Core**					
Course title	**Plant Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VI**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	- **Biochemistry** - **Microbiology** - **Genetics**					

Course Objective:

The objectives of the course are:

1. To make the students aware of the principles, practices and application of the plant tissue culture, plant genomics, genetic transformation and molecular breeding of plants being confident at the end of the course in all above mentioned areas.
2. To realize the importance of plant biotechnology with its applicative value in pharmaceutical and food industry, agriculture and ecology.

Course Content:

Module I: [6 Lectures]

Plant tissue culture – an overview: Brief history of plant tissue culture research, Basic principles of

plant tissue culture, Importance of plant tissue culture & biotechnology, Laboratory organization

Plant tissue culture media: Types of culture media, Composition of media, Role of plant growth regulators, Media preparation and sterilization methods

Module II: [12 Lectures]

***In vitro* culture techniques:** Micropropagation, Organogenesis, Somatic embryogenesis, Somaclonal variation, Callus culture, Cell suspension culture and its significance, Protoplast culture and fusion, Somatic hybridization, Production of synthetic seeds, Cryopreservation

Module III: [5 Lectures]

Secondary metabolite production: Primary and secondary metabolic products of plant, Secondary metabolites of plant origin and its type, Role of plant tissue culture techniques involved in commercially production of secondary metabolites, Factors affecting the production and its optimization, Elicitors, Hairy root culture, Use of Bioreactor in plant secondary metabolite production. Biotransformation

Module IV [13 Lectures]

Plant genomes: Structure and organization of plant genome and gene expression-regulation, Chloroplast and Mitochondrial genome (Arabidopsis should be taken as the model for study of plant genome).

Plant transformation techniques: Direct transformation (Gene gun, Electroporation, Microinjection etc.), Plant transformation with Ti plasmid of *Agrobacterium tumifacians*, Ti plasmid derived vector systems

Vectors for Plant Transformation: Co-integrated & Binary vector, Choice of promoters for expression of transgenic plant, Selectable marker, Screenable marker

Application of genetic transformation: Strategies for the development of herbicide resistance & Insect resistance plant, Plant enriched food products (Golden rice) and Molecular farming as well as marker free transgenic

Textbooks:

1. Chawla, H. S. (2000). Introduction to plant biotechnology. Enfield, NH: Science.
2. Razdan, M. K. (2003). Introduction to plant tissue culture. Enfield, NH: Science.
3. Slater, A., Scott, N. W., & Fowler, M. R. (2003). Plant biotechnology: The genetic manipulation ofplants.

Reference books:

1. Buchanan, B. B., Gruissem, W., & Jones, R. L. (2015). Biochemistry & molecular biology ofplants.Chichester, West Sussex: John Wiley & Sons.
2. Slater, A., Scott, N. W., & Fowler, M. R. (2008). Plant biotechnology: An Introduction to GeneticEngineering. Oxford: Oxford University Press.
3. Primrose, S. B., &Twyman, R. M. (2006). Principles of gene manipulation and genomics. Malden,MA: Blackwell Pub.
4. Brown, T. A. (2006). Gene cloning and DNA analysis: An introduction. Oxford: Blackwell Pub.

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/
2. ePgPathshala:http://epgp.inflibnet.ac.in/ahl.php?csrno=3

Course Outcome (CO):

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

1. **Understand** the **use** of different plant tissue culture (PTC) techniques for PTC Industries as well as research.

2. **Identify**, **select** and **construct** different plant tissue culture media for various PTC techniques.

3. **Understand** the role of PTC in secondary metabolite production and **identify** the appropriate bioreactor for commercial secondary metabolite production.

4. **Understand** the structure and organization of genes & complexity of plant genome and able to **identify** the tools for gene identification.

5. **Understand**, **identify and illustrate** the different modern tools & techniques of plant genetic manipulation for crop improvement and sustainable agriculture.

6. **Analyze** the impact of plant biotechnology on future crop production and also able to **judge** the intellectual property, environmental, societal issues specific to transgenic crops.

Course Code	**PC-BT604**					
Category	**Professional Core**					
Course title	**Downstream Processing**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:VI**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (ifany)	- **Structure of Biomolecules** - **Biochemistry** - **Microbiology** **Industrial Microbiology and EnzymeTechnology**					

Course Objective:

The objectives of the course are:

1. To understand the importance of the downstream processing, economics and process design criteria for various classes of bio products.
2. To make the student understand the importance of downstream processing like Cell disruption, Filtration, Sedimentation and Extraction, Product Resolution, Product Crystallization and Drying and process economics.

Course Content:

Module I: [6 Lectures]

Introduction to Downstream Processing

Basic concepts of downstream processing, RIPP/CIPP scheme, Importance of downstream processing/bioseparation in biotechnological processes, Requirements of bioproduct purification, some case studies/flow sheets, Analysis of purity, Mass balance, Non-mechanical and mechanical cell disruption methods, empirical equations.

Module II: [6 Lectures]

Solid-Liquid Separation Techniques for Biomass and Particulate/Debris

Pre-treatment strategies, Flocculation, Foam-fractionation, Mechanical separations: Filtration at constant pressure and at constant rate, empirical equations for batch and continuous filtration, dead-end and cross-flow filtration; Centrifugation-principles, design characteristics; ultracentrifugation: principle and applications; centrifugal filtration and its applications.

Module III: [10 Lectures]Isolation of Products

Adsorption: Adsorption-desorption processes, isotherms, batch adsorption, packed bed adsorption; Extraction: batch and continuous extraction, aqueous two-phase extraction; Precipitation: Principle, Precipitation mediated by pH, salts, organic solvents, polymers; Membrane based separations: Theory of micro and ultra filtration, reverse osmosis, concentration polarization, rejection, flux expression, design-applications of some membrane separation equipments and membrane modules.

Module IV: [14 Lectures]

Purification of Bioproduct and Formulation

Chromatography: Common theory and principle of high and low pressure chromatography, Some chromatography methods: Hydrophobic interaction, Ion exchange, Gel filtration, Chromatofocusing, Affinity; HPLC. Electrophoretic separation: NATIVE, SDS-PAGE (Polyacrylamide) and Agarose Gel, methods, case studies.

Text Book:

1. Bio-process Engg. Schuler &Kargi, PHI
2. Bioseparations - principles and techniques, B Sivasankar, Prentice Hall of India, N Delhi, 2005, pp280
3. Bioseparation& Bioprocessing (2nd Ed.) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)
4. Biotransformations& Bioprocesses, Mukesh D, Gaikar V and Anil Kumar Marcell Dekker, NewYork, (Feb 2004).
5. "Bioseparation Science and Engineering"Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P.Petrides, Oxford University press, 2003.

Reference Books:

1. Principles of Bioseparations Engineering by Raja Ghosh. World Scientific Publishing Co
2. Biochemical Engg. Fundamentals, Bailey &Olis, McGraw-Hill, 1990
3. Membrane Handbook, Ho, W.S.W. & K. K. Sirkar, Van Nostrand Reinhold, N.Y. (1992)
4. Bioseparation: Downstream processing for Biotechnology, Belter, P.A. and Cussler, E.L. Hu,

W.S(1988), Wiley, New York.
5. Bioseparation Engineering: Principles, Practice and Economics, Ladisch, M.R., (2001), Wiley, Interscience.
6. Unit Operation of Chemical Engineering, McCabe, W. L., Smith, J. C. and Harriott, P., McGraw-Hill

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102106022/
2. NPTEL: http://nptel.ac.in/courses/102106048/
3. NPTEL: http://nptel.ac.in/courses/102103044/
4. NPTEL: http://nptel.ac.in/courses/104104066/
5. NPTEL: http://nptel.ac.in/courses/102107028/

Course Outcome (CO):

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

1. **Comprehend the necessity** of downstream processing/bioseparation processes in biotechnology.
2. **Accomplish the knowledge** on primary isolation and concentration of desired product.
3. **Acquire the knowledge** to implement suitable techniques for product purification.
4. **Analyze the quality** and characteristics of the purified product.
5. **Ability to formulate** the product to meet marketable standards.
6. **Explain, recommend and demonstrate** the suitable downstream processing/bioseparation approaches comprising of new concepts and emerging technologies that are likely to benefit product recovery for small and large scale in the future.

Course Code	**PE-BT602**					
Category	**Professional Core Elective**					
Course title	**Animal Cell Culture & Animal Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:VI**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	- **Microbiology** - **Molecular Biology** - **Recombinant DNA Technology**					

Course Objective:

The goal of Animal Cell Culture & Animal Biotechnology course is for students to acquire the necessary theoretical skills for both the arena. First, it provides detailed insights regarding the isolation of animal cells for *in vitro* studies, maintenance of animal cells *in vitro*, manipulation of animal cells *in vitro*, application of molecular techniques to *in vitro* situations.

The second objective of this course is to introduce students to cutting edge biotechnologies that can be used for animal and human health and research. In this course we will analyze and discuss the primary literature on stem cells, cloning, large animal models for disease and development of therapies and treatments. This class will cover basic cellular and molecular biology techniques involved in animal biotechnology and their applications in a real world research setting.

Course Content:

Module I: 10L Basics of Animal Cell Culture and its Application:

History of animal cell culture and development, Laboratory requirements for tissue culture, Culture media and growth conditions, Cell type and characterization, Origin of animal cell line, Development of primary culture, Development of cell line by enzymatic disaggregation, Continuous cell lines.
Cryopreservation of cells and transport of cultures, Cell cloning and selection, Transfection and transformation of cells, Common cell culture contaminants, Marker gene characterization. Application of animal cell culture in: Cytotoxicity and viability assays; Transient recombinant protein expression in mammalian cells; Production of pharmaceutical proteins; *in vitro* testing of drugs; Testing of toxicity of environmental pollutants in cell culture. Overview of Cell Culture Engineering for the Insect Cell-Baculovirus Expression Vector System.

Module II: 8L Growth and scale up of animal cell:

Scale and complexity, Mixing and aeration, Rotating chambers, Perfused suspension cultures, Fluidized bed reactors for suspension culture.
Scale-up in monolayers, Multisurface propagators, Multiarray disks, spirals and tubes; Roller culture, Micro-carrier attached growth, Cell culture in continuous, perfusion and hollow fibre reactor; Microencapsulation, Growth monitoring, Mass transfer in mammalian cell culture.

Module III: 9L Animal Biotechnology

Animal breeds; Embryo transfer: Artificial insemination, Superovulation, Embryo transfer, *in vitro* fertilization, Pregnancy diagnosis, Sexing of embryos, Embryo splitting; Cryopreservation of embryo. Transgenic animal production; Methods of transgene delivery; Integration of foreign genes and their validation; Gene targeting; Methods and strategies; Improving transgene integration efficiency; transgenic animals and stem Cells; Transgenesis and Xenotransplants, Transgenic fish; Animal as bioreactors.

Module IV: 9L Application of Animal Biotechnology:

Organ Culture: Methods, behavior of organ explants and utility of organ culture, whole embryo culture. Regenerative medicine. Gene therapy. Stem cell: types, properties and their applications in animal cloning, therapeutics.

Textbook:

1. J.M. Davis. Basic Cell Culture Second Edition, Oxford University Press. (First Indian Edition, 2005)
2. Animal cell culture by R.I. Freshney.
3. In vitro cultivation of Animal cells by Dr. C.K. Leach, Butterworth and Heinnmamm Ltd.1994.
4. Animal Cell Biotechnology: Methods and protocols – Nigel Jenkins (Ed), Humana press, New Jersy,1999.

Reference books:

1. Balasubramanian, Bryce, Dharmalingam, Green and Jayaraman (Eds.), Concepts in

Biotechnology,University Press, 1996.
2. Das. H.K. Text Book of Biotechnology, First Edition 2004, Wiley Dreamtech.
3. B. Hafez and E.S.E Hafez, Reproduction in farm animals, 7th Edition, Wiley Blackwell, 2000.
4. G.E. Seidel, Jr. and S.M. Seidel, Training manual for embryo transfer in cattle (FAO Animal Production and Health Paper-77), 1st Edition, W.D. Hoard and sons FAO, 1991.
5. I. Gordon, Laboratory production of cattle embryos, 2nd edition, CAB International, 2003.

COURSE OUTCOMES:

At the end of the course, a student will be able to:

1. **Explain** the various components of cell and tissue culture media as well as establishment and optimization of media for particular purposes in different species and cell lines.
2. **Explain, design, analyze** and **perform** the common cell culture techniques, cytotoxicity and viability assays for toxicological and pharmacological studies.
3. **Design** the experiment for development of primary established cell culture and characterize the various cell lines used in mammalian tissue culture in relation to their origins and uses.
4. **Describe, analyze** and **design** the criteria in consideration for scale up of cell culture as well as the appropriate cell model for a large scale process involved in the production of human and animal viral vaccines and pharmaceutical proteins.
5. **Explain, assess** and **design** the strategies involved in embryo transfer & In vitro fertilization, transgenic animal technology, vaccinology, stem cell therapeutics and regenerative medicine as well as analyze important social & environmental problems regarding genetically modified cell and organ models and identify ways to contribute to the solutions, including professional, economic and ethical considerations in social, industrial, medical & agricultural fields.
6. **Explain, assess** and **coalesce** the multidisciplinary need of animal biotechnology with the solution provided by the optimized and modernized animal tissue culture techniques at lab scale, pilot scale and ultimately industrial scale level as well as be able to **communicate** efficiently by preparing proper technical plans through meticulous reports at the end followed by sound oral explanations.

Course Code	**PC-BT691**					
Category	**Professional Core**					
Course title	**Recombinant DNA Technology Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester:VI**
	0	**0**	**2**	**1**	**24**	
Pre-requisites/ Co-requisites (ifany)	- **Microbiology** - **Genetics** - **Molecular Biology**					

Course Objective:

The objectives of the course are:

1. Students will learn practical knowledge of selected Molecular Biological techniques.
2. Course covers the basic techniques of recombinant DNA technologies including PCR.

Course content:

1. DNA isolation (genomic and extra chromosomal) and estimation
2. Restriction enzyme digestion of plasmid DNA or lambda DNA
3. Gel purification of RE digested DNA
4. Ligation of DNA fragments with cloning vector pUC18 or pBR322.
5. Preparation of competent cells and Transformation into *E.coli* with plasmid vector.
6. Primer design for PCR
7. Amplification of DNA by PCR (Allele-specific, RAPD)
8. Metagenomics

Course Outcome (CO):

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

1. **Demonstrate** and **explain** restriction enzyme digestion of plasmid DNA or lambda DNA.

2. **Understand** the process of gel purification of RE digested DNA fragment.

3. **Understand** the process ligation of DNA fragments with cloning vector pUC18 or pBR322.

4. **Learn, demonstrate** and **explain** the methodology of competent cell preparation and Transformation into *E.coli* with recombinant vector.

5. **Understand** and **explain p**rimer design for PCR and amplification of DNA by PCR.

6. **Demonstrate** and **explain** the working principle of Southern Hybridization.

Course Code	**PC-BT692**					
Category	**Professional Core**					
Course title	**Immunology Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester:VI**
	0	**0**	**2**	**1**	**24**	
requisites/ Co-requisites(if any)	**Microbiology**					

The objectives of the course are:

To develop a working knowledge of the principles and procedures of serology and introduction to some basic immunologic techniques commonly used in immunology research laboratories.

COURSE COTENT:

1) Staining of Blood film (Total RBC count, Total WBC count, Differential count)
2) Identification of human Blood group.
3) Determination of Erythrocyte Sedimentation Rate (ESR) for detection of infection (inflammation) inbody.
4) Separation of serum from the blood sample (demonstration).
5) Perform immunodiffusion by Ouchterlony method
6) Perform Dot ELISA- qualitative.
7) Perform WIDAL test
8) Perform Immunoelectrophoresis.

Reference:

Laboratory Manual

COURSE OUTCOMES:

1. **Illustrate** components of the immune system and **explain** their functional interactions and physiology as it relates to immunity, disease states and disorders.
2. **Plan and organize** a variety of serologic assays using basic principles of antigen-antibody reactions.
3. **Apply** major methodology used to diagnose immunological disorders including agglutination, preceipitation, electrophoretic techniques, Immunoassays (ELISA, Western blot).
4. **Formulate, compile** and present a well-organized and concise report of the experimental findings, **evaluate** clinical data, **interpret** results, and **compare and correlate** abnormal results with disease states.
5. **Develop** communication skills in the presentation of scientific material and **evaluate, understand and interpret** the methods described in the related scientific journal articles.
6. **Demonstrate** laboratory practice standards in safety, professional behavior and ethical conduct and maintain a safe laboratory environment

Course Code	**PC-BT693**					
Category	**Professional Core**					
Course title	**Plant Biotechnology Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: VI**
	0	**0**	**2**	**1**	**24**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

1. To learn different aseptic techniques for establishment of an aseptic *in vitro* culture.
2. To study and prepare the different composition of plant tissue culture media (e.g. MS, B5, N6, WPMetc.).
3. To develop the skills in the different plant tissue culture techniques (Callus culture, Shoot tip culture,Anther culture etc.)
4. To learn the protocols of plant gene transfer technology.

Course Content:

1. Introduction to plant tissue culture laboratory and its organization
2. Different aseptic culture techniques for establishment and maintenance of cultures
3. Preparation of stock solutions of various plant tissue culture medium (e.g. MS, B5, N6, WPM etc.)and plant growth regulator
4. Germination of seeds *in vitro*
5. Effect of Plant growth regulators in Plant Tissue culture (shoot, root, callus induction)
6. Plant regeneration from embryo/ meristem/ callus culture
7. Demonstration of *Agrobacterium* mediated plant transformation (crown gall/ hairy root/ GUS genetransfer)

8. Isolation of plant genomic DNA
9. Establishment cell suspension culture
10. Isolation of Protoplasts

Reference books:

1. J. Reinert, M.M. Yeoman (1982) Plant cell and tissue culture: a laboratory manual. Published: Berlin, Springer-Verlag.
2. H.S. Chawla (2003) Plant Biotechnology: Laboratory Manual for Plant Biotechnology. Oxford& IBH Publishing Co. Pvt Ltd., New Delhi.

Course Outcome (CO):

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

1. **Define and recall** the various components of plant tissue culture.
2. **Describe, discuss and explain** various aseptic culture techniques for establishment of plant tissue culture.
3. **Calculate** the composition of various plant tissue culture media and prepare it (e.g. MS, B5, N6, WPM etc.).
4. **Design** the experiments to develop the mass propagation of plants from different explants (e.g. rooting, shooting, callus development etc).
5. **Understand and explain** the various modern tools used in *in vitro* culture techniques for large scale propagation of plants in PTC-Industry.
6. **Establish** a lab for *in vitro* plants tissue culture as well as the lab for mass propagation of plants.

Course Code	**PC-BT694**					
Category	**Professional Core**					
Course title	**Fermentation Technology and Downstream Processing Lab**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: VI**
	0	**0**	**2**	**1**	**24**	
Pre-requisites/ Co-requisites (ifany)	- **Basic concepts in Chemistry and Biology** - **Structure of Biomolecules** - **Biochemistry** - **Microbiology** **Industrial Microbiology and EnzymeTechnology**					

Course Objective:

The objectives of the course are:

1. This course helps the students to acquire knowledge about fundamentals practical knowledge of fermentation technology.
2. Provides an opportunity to gain practical experience on product recovery and purification techniques.
3. Gives an opportunity to experimentally check the theoretical concepts related to Bioseparation Technology.

4. Provides a basic understanding of the types of fermentation process, bioprocess the preparation of media etc.

Course Content:

1. Batch Fermentation, Recovery (solvent mediated extraction) and Assay of Antibiotics (Penicillin/Streptomycin)
2. Production of Alcohol (Fermentation and Recovery)
   i. Using Sugarcane Juice (Batch)
   ii. Using Immobilized Microbes (Batch and Continuous)
3. Batch Fermentation (Surface and submerged) of Organic Acid (e.g. Citric acid)
4. Batch (Liquid and Solid state) Fermentation of Bacterial/Fungal Enzymes (Proteases or any enzyme of the institutions choice).
5. Live demonstration of Bioreactor and its different parts.
6. Cell disruption/homogenization by mechanical/non-mechanical methods-product isolation by centrifugation and reconstitution.
7. Precipitation and concentration of products like proteins/enzymes/DNA mediated by salt/solvent-recovery by centrifugation, reconstitution and dialysis.
8. Separation of proteins/enzymes/DNA by electrophoresis.
9. Chromatographic separation of product like proteins/enzymes (GFC/IEX) and demonstration of HPLC.

Text Books:

1. Bio-process Engg. Schuler &Kargi, PHI
2. Bioseparations - principles and techniques, B Sivasankar, Prentice Hall of India, N Delhi, 2005, pp280
3. Bioseparation& Bioprocessing (2nd Ed.) 2-Volume set, Ed SUBRAMANIAN Ganapathy, Wiley-VCH, (09-2007)
4. Biotransformations& Bioprocesses, Mukesh D, Gaikar V and Anil Kumar Marcell Dekker, NewYork, (Feb 2004).
5. "Bioseparation Science and Engineering"Roger G. Harrison, Paul Todd, Scott R. Rudge, Demetri P.Petrides, Oxford University press, 2003.
Interscience.
6. Unit Operation of Chemical Engineering, McCabe, W. L., Smith, J. C. and Harriott, P., McGraw-Hill

Course Outcome (CO):

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

1. **Educate the students** about microorganisms, development of media, and **to impart knowledge** about enzyme kinetics, fermenters, and industrial biotechnology.
2. **Make the students understand** the fermentation process using modern tools and its combination of bioprocess engineering.
3. **Provides an opportunity to experimentally** verify the theoretical concepts already studied.
4. **Understand** the theoretical principles in a more explicit and concentrated manner.

5. **Get exposure** on various Bioseparation process such as Cell disruption techniques, Product enrichment techniques and Product purification methods.
6. **Describe** current knowledge in biological and biochemical technology and to **assess** power requirements in bioreactors; modeling of bioprocesses.

Course Code	**HM-BT691**					
Category	**Humanities and Social Science and Management Course**					
Course title	**Technical and Popular science article writing and Seminar Presentation (Based on Reviewarticle by PPT)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester:VI**
	0	**0**	**2**	**1**	**24**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objectives:

The objectives of the course are:

1. How research papers are written.
2. How to read such papers critically and efficiently
3. How to summaries and review them.
4. How to judge the value of different contributions
5. How to identify promising new directions.

Course Outcomes:

1. Find the best examples of research papers in Biotechnology which have had impact – in whateverterms you think are important.
2. Identify the most promising recent research papers, likely to find application in the future.
3. Choose a thesis topic which will change the world.
4. Become a seasoned, critical, cynical reader of scientific literature.
5. Expand knowledge in preparation of effective PowerPoint presentation.
6. Develop communication skills and personality.

Course Code	**MC-BT691A**					
Category	**Mandatory Course (Non Credit)**					
Course title	**Sports & Yoga**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: VI**
	0	**0**	**2**	**0**	**24**	
Pre-requisites/ Co-requisites (ifany)						

COURSE OBJECTIVES:

1. To enable the student to have good health

2. To practice mental hygiene
3. To possess emotional stability.
4. To develop physical talents to their maximum potential.

COURSE CONTENTS:

Module 1: 10 Hours

·Aims & Objectives of sports in Education
·Following subtopics related to any one Game/Sport of choice of student out of:
Athletics, Badminton, Basketball, Chess, Cricket, Kabaddi, Lawn Tennis, Swimming, Table Tennis, Volleyball, etc.

i) History of the Game/Sport.
ii) Latest General Rules of the Game/Sport.
iii) Specifications of Play Fields and Related SportsEquipment.
iv) Important Tournaments and Venues.
v) Sports Personalities.
vi) Proper Sports Gear and its Importance.

Module 2: 6 Hours

·Definitions of Eight parts of yog. (Ashtanga)
·Yam and Niyam.
Do`s and Don‟t‟s in life.

i) Ahinsa, satya, astheya, bramhacharya and aparigraha
ii) Shaucha, santosh, tapa, swadhyay, ishwarpranidhan

Module 3: 8 Hours

-Asan and Pranayam

i) Various yog poses and their benefits for mind & body
ii) Regularization of breathing techniques and its effects-Types of pranayam

SUGGESTED READING

1. Modern Trends and Physical Education by Prof. Ajmer Singh.
2. Light on Yoga By B.K.S. Iyengar.

COURSE OUTCOMES:

Students will be able to

1. Learn techniques for increasing concentration and decreasing anxiety which leads to stronger academic performance.
2. Learn breathing exercises and healthy fitness activities
3. Improve personal fitness through participation in sports and yogic activities
4. Develop healthy mind in a healthy body thus improving social health also

5. Improve efficiency.

Course Code	MC-BT691B					
Category	Mandatory Course (Non Credit)					
Course title	Personality Development Through Life EnlightenmentSkills					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VI
	0	0	2	0	24	
Pre-requisites/ Co-requisites (ifany)						

COURSE OBJECTIVES:

1. To learn to achieve the highest goal happily
2. To become a person with stable mind, pleasing personality and determination
3. To awaken wisdom in students

COURSE CONTENTS:

Module 1: 8 Hours

Neetisatakam-Holistic development of personality

·Verses- 19,20,21,22 (wisdom)
·Verses- 29, 31, 32 (pride & heroism)
·Verses- 26,28,63,65 (virtue)
·Verses- 52, 53, 59 (dont‟s)
·Verses- 71,73,75,78 (do‟s)

Module 2: 8 Hours

- Approach to day to day work and duties.
- **Shrimad Bhagwad Gita:**
- Chapter 2-Verses 17, 41, 47,48,56, 62,68
- Chapter 3-Verses 13, 21, 27, 35, 36, 37, 42
- Chapter 4-Verses 18, 38,39

Module 3: 8 Hours

Shrimad Bhagwad Gita:

- Chapter 6-Verses 5,13,17, 23, 35,
- Chapter 12 -Verses 13, 14, 15, 16,17, 18
- Chapter18 – Verses 37,38, 45, 46, 48, 63

SUGGESTED READING

1. “Srimad Bhagavad Gita” by Swami Swarupananda Advaita Ashram (Publication Department), Kolkata
2. Bhartrihari‟s Three Satakam (Niti-sringar-vairagya) by P.Gopinath, Rashtriya Sanskrit Sansthanam,New Delhi.

COURSE OUTCOMES:

Students will be able to

1. Study of Shrimad-Bhagwad-Gita will help the student in developing his personality and achieve thehighest goal in life
2. The person who has studied Gita will lead the nation and mankind to peace and prosperity
3. Study of Neetishatakam will help in developing versatile personality of students.

Course Code	SI-BT681					
Category	Summer Internship					
Course title	Summer Internship-IV (Seminar/Training /Workshop) (online/offline)					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VI
	0	0	15	1.5	68	
Pre-requisites/ Co-requisites (if any)	-					

Course Objective:

The objectives of the course are:

1. The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice.
2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.
3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. **Demonstrate** the knowledge of Applied Sciences substrate with Allied field of engineering/technology.
2. **Understand** the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. **Communicate** effectively in both verbal and written form through critical thinking processwhich will assist them in the preparation of their proposal and dissertation
4. **Pursue** new and enriched understandings of the texts through sustained inquiry and reevaluate initial hypotheses in light of evidence.
5. **Express, articulate, discuss and defend well** formed arguments within a group or to anaudience or to different engineering communities
6. **Understanding** of lifelong learning processes through critical reflection of internshipexperiences.

Course Code	PC-BT701					
Category	Professional Core					
Course title	Food Biotechnology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester: VII
	3	0	0	3	36	
Pre-requisites/ Co-requisites(if any)	- Microbiology Industrial Microbiology and EnzymeTechnology					

Course Objective:

The objectives of the course are:

To provide knowledge and understanding on techniques, parameters and issues related to the production, processing and consumption of food related to food microbiology along with an appreciation of their impact on society.

COURSE CONTENT:

Module I: Principle of food processing and preservation: 9L

Principles of Food Processing and Preservation, Preservation techniques-High temperature, Low temperature, Irradiation, Dehydration, chemical and natural preservatives, Thermal Death Time Curves, General principles of canning and bottling of foods. Food spoilage. Aseptic Processing & Packaging.

Module II: Technology involved in food production: 10L

Pretreatments to milk for product manufacture, Fermented milk products –Acidophilus milk, Kefir, Koumiss, Yoghurt, cheese, New technologies and product development in dairy industry. Technology involved in bakery industry-Bread, Biscuit, wafer; production of beverages-vinegar, wine, beer, fruit juice, High fructose corn syrup (HFC), Basic preparatory procedures of meat processing, meat tenderization, Application of enzymes in food processing.

Module III: Food additives and food quality assurance: 8L

Introduction to Major Constituents of Food, Functional Classification of Food Additives, Natural additives; Sensory and physical analysis of food, Microbial ecology of food-Intrinsic factors and Extrinsic Factors; Food contaminants and safety measurements; HACCP; Techniques in food analysis-spectroscopic, polarimetric, chromatographic, electrophoretic etc. Quality control of food.

Module IV: Advances in food science and technology: 9L

Development of rapid tests for detection of food borne pathogens and other adulterants, Biosensors: Principles and applications in food analysis; Role of Biotechnology in food processing, Development of Genetically modified food, High fiber food, artificial sweeteners, formulated and fabricated food, nutraceuticals; Application of Nanotechnology in food science.

References:

Textbook:

1. Frazier, Food Microbiology
2. G. Reed, Prescott and Dunn‟s Microbiology, CBS Publishers, 1987
3. Introduction to Food Biotechnology. Author; Perry Johnson-Green. Publisher; CRC Press. Year; 2002.

References books:

1. Jay, Modern Food Microbiology, CBS Publishers, 1987
2. Desrosier, Technology of food preservation, CBS Publisher

Web Reference:

UGC e pathsala: http://epgp.inflibnet.ac.in/ahl.php?csrno=15

Course Outcome:

By the end of this course student will be able to:

1. **Understand and define** various factors affecting life and death of microorganisms in different types of food with special emphasis on spoilage organisms and food borne pathogens.
2. **Identify, select and implement** methods to preserve different types of food and make food consumption safe.
3. **Understand** the principles, practices and recent advancements in food processing techniques.
4. **Understand** different types of biotechnological methods to improve the quality and value of different food and new techniques used in Food Biotechnology.
5. **Critically analyze, assess, control, and communicate** the risks associated with food-borne toxicants along with the development of the strategies used for the evaluation of food safety problems through toxicological criteria.
6. **Explain** the principles, processes and techniques for the assessment and management of food management or food safety hazards and their significances.

Course Code	**PE-BT701A**					
Category	**Professional Core Elective**					
Course title	**Renewable Energy Technology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites(if any)	**- Microbiology** **- Molecular Biology** **- Recombinant DNA Technology**					

Course Objective:

The objectives of the course are:

This course provides an introduction to energy systems and renewable energy resources, with a scientific examination of the energy field and an emphasis on alternate energy sources and their technology and application. The class will explore society‟s present needs and future energy demands, examine conventional energy sources and systems, including fossil fuels and nuclear energy, focusing on

alternate, renewable energy sources such as solar, biomass (conversions), wind power, geothermal, and hydro. Energy conservation methods will be emphasized.Course Content:

Module I (10 L):

An Introduction to Energy Sources: Energy sources (conventional & non-conventional), renewable energy resources, primary & secondary energy sources, energy chain, energy demand, national energy strategy & plan, energy management, energy audit & conservation, Energy storage.
Biological fuel generation: Biomass as a renewable energy source; types of biomass – forest, agricultural and animal residues, industrial and domestic organic wastes; conversion of biomass to clean fuels and petrochemical substitutes by physicochemical and/or fermentation processes.

Module II (8 L):

Sources of biomass; biogas from anaerobic digestion; thermal energy from biomass combustion; ethanol from biomass.

Module III (8 L):

Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation. Magneto Hydro-Dynamic (MHD) Power Generation Principle, MHD system, open cycle system, closed cycle system, design problems & developments, advantages, materials for MHD generators, magnetic field & super conductivity. Microbial fuel cell. Microbial recovery of petroleum by biopolymers (Xantham gum), biosurfactants.

Module IV (10 L):

Solar energy: solar collectors, solar pond, photovoltaic cells, chemical storage. Geothermal energy and wind energy: Use of geothermal energy, operating principles of different types of wind energy mills. Tide and Wave energy. Ocean Thermal Energy Conversion (OTEC). Nuclear energy: nuclear reactions and power generating tidal wave energy.

References/Books:

1. J.E. Smith – Biotechnology, 3rd ed. Cambridge Univ Press.
2. S. Sarkar – Fuels and combustion, 2nd ed., University Press.
3. Abbasi, S.A. and Abbasi, N. (2005), Renewable Energy Sources and Environmental Impact, Prentice Hall of India Pvt. Ltd., Pp.134-136.

Course Outcomes:

At the end of the course, a student will be able to:

1. **Describe** and **identify** the various renewable energy sources and the possible conversion paths toa useful form of energy and develop their own knowledge and understanding using recently published information.
2. **Describe** and **quantify** the major factors affecting the potential contribution to the world's needs of the various sources of energy, such as available resource, status of technical development, and economic aspects.
3. **Describe** and **introspect** the principles behind different non conventional energy sources and finally its future potential both in providing energy and in producing alternative fuels.

4. **Describe, introspect** and **utilize** the renewable energy in problem solving whereconventional energy are not fruitful and require replacement.
5. **Explain** and **understand** the design and applications of power generating devices using renewable energy sources as per industrial requirement.
6. **Review** the latest advancement in the materials developments applied to renewable energy and develop a personal well-argued and quantified view of a possible energy future.

Course Code	**PE-BT701B**					
Category	**Professional Core Elective**					
Course title	**Genomics and Proteomics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:VII**
	3	**0**	**0**	**3**	**36**	
requisites/ Co-requisites(if any)	**- Genetics** **- Recombinant DNA technology** **- Bioinformatics**					

Course Objective:
The objectives of the course are:
1. The course will expose students to the understanding of the principles of genomic analysis of prokaryotes and eukaryotes and application of bioinformatics methods used in this analysis.
2. The aim of this course is to teach students techniques in genomics and proteomics using model organisms representing plants and animals.

Course Content:

Unit I (9 L):

Structure and organization of prokaryotic and eukaryotic genomes - nuclear, mitochondrial and chloroplast genomes; Computational analysis of sequences- finding genes and regulatory regions, gene annotation; Genetic variation-polymorphism; Phylogenetics: ribo-typing; Tools for genome analysis – PCR, RFLP, DNA fingerprinting, RAPD, automated DNA, sequencing; Linkage and pedigree analysis; construction of genetic maps; physical maps, FISH

Unit II (9 L):

Comparative genomics of relevant organisms such as pathogens and non-pathogens; DNA Microarray technology: Basic principles and design; cDNA and oligonucleotide arrays; Applications: Global gene expression analysis comparative transcriptomics; Differential gene expression; Genotyping/SNP detection; Detection technology; Computational analysis of microarray data.

Unit III (9 L):

Overview of protein structure-primary, secondary, tertiary and quaternary structure; Relationship between protein structure and function; Outline of a typical proteomics experiment; Identification and analysis of proteins by 2D analysis; Spot visualization and picking; Tryptic digestion of protein and

peptide fingerprinting; Mass spectrometry; Clinical proteomics and disease biomarkers; Protein-protein interactions: Yeast two hybrid system and Phage display; Pull-down assays (using GST-tagged protein); Protein arrays-definition; Applications- diagnostics, expression profiling.

Unit IV (9 L):

Human disease genes; DNA polymorphism including those involved in diseases; „disease" gene vs. „susceptibility" gene; SNP detection: hybridization based assays (allele specific probes); Polymerization based assays (allele specific nucleotide incorporation, allele-specific PCR); Ligation based assays (allele specific oligonucleotide ligation); Polymorphism detection without sequence information: SSCP; High throughput screening for drug discovery; Identification of drug targets; Pharmacogenomics and pharamacogenetics and drug development; Toxicogenomics.

Texts

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM & Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition.Benjamin Cummings 2007

References

1. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell,2006.
2. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998.
3. Strachan T & Read A, Human Molecular Genetics, 3rd Edition, Garland Science, 1999.

Course Outcome (CO):

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

1. **Identify** and **describe** the structural organization of prokaryotic and eukaryotic genomes.
2. **Explain** the current genomics technologies and demonstrate how these can be used to study gene function.
3. **Perform** various practical techniques including DNA sequencing, PCR and proteomics.
4. **Interpret** data obtained through high throughput expression studies.
5. **Design** a set of experiments to address a particular biological question.

Course Code	**PE-BT701C**					
Category	**Professional Core Elective**					
Course title	**Medical Informatics**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	**-Data Base Management System and ComputerNetworking -Numerical Methods and Biostatistics**					

Course Objective:

The objectives of the course are:

1. The course is designed to develop a better understanding of Medical Informatics, its goals, standards, applications, and uses in healthcare development and clinical research.
2. This course will enable the students to identify and analyze problems related to medical informatics and to build up followed by optimization of complex healthcare processes to improve patient outcome and healthcare delivery.

Course Content:

Module I [12 Lectures]

Introduction: A brief history of Medical Informatics, Taxonomy of Medical Informatics
Systems Design Considerations for the Clinical User, Standards in medical informatics (DICOM and HL7), Basic and advanced medical imaging technology: acquisition, diagnostic display, enhancement and analysis
The Organization of Health Information: The Paper-based Medical Record, The Electronic Medical Record

Module II [9 Lectures]

Health Information System: Big Data in hospitals, Clinical software development, modeling and performance optimization, Laboratory Information Systems, Radiology Information Systems, Pharmacy Information Systems.
Issues with Electronic Medical Record and Paper-based Medical Record.

Module III [7 Lectures]

Ealth: A virtual healthcare delivery system, information provider to the physician and patient, teleradiology, telemedicine, issues in telemedicine.

Module IV [8 Lectures]

Artificial Intelligence in Medicine, Expert Systems in Medicine, Standards and Quality improvement, Ethical and political issues: Accessibility v. Confidentiality, Equity & Equality, Security and confidentiality in medicine, Health as a Human Right.
Future technologies: The Personal Health Record, Smarte Cards, Wireless, RFID.

Textbooks:

1. Shortliffe et al., BIOMEDICAL INFORMATICS, Computer Applications in Health Care and Biomedicine, (Third Edition), Springer-Verlag, 2006.
2. Oleg S.; Pianykh, “Digital Image Quality in Medicine”, Springer(2014).
3. Slack, Cybermedicine: How Computing Empowers Doctors and Patients for Better Health Care, Jossey-Bass.

Reference books:

1. Collen, Morris, A History of Medical Informatics in the United States 1950 to 1990, AMIA (American Medical Informatics Association).
2. Ellis, Technology and the Future of Health Care, Preparing for the Next 30 Years, Jossey-Bass.

Course Outcome (CO):

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

1. **To understand and illustrate** the concept of medical informatics in the development of healthcare and clinical research.
2. **Understand** and analyze advanced imaging technology and its enhancement by MI for developing medical diagnostics.
3. **Design** and **develop** clinical software, electronic medical record for healthcare/clinical/laboratory information.
4. **Understand** and **develop** computerized methods to determine health practice problems including ethical, safety and political issues.
5. **Study** and **develop** new and advanced technologies for healthcare development.

Course Code	**PE-BT701D**					
Category	**Professional Core Elective**					
Course title	**Bioprocess and process Instrumentation**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	3	**0**	**0**	**3**	**36**	
Pre-requisites/ Co-requisites (if any)	▪ **Thermodynamics and Kinetics forBiotechnology** ▪ **Industrial Microbiology and EnzymeTechnology** ▪ **Bioreactor Design And Analysis**					

Course Objective:

The objectives of the course are:

1. To make the students aware of the principles, practices and application of the Bioprocess Engineering and Instrumentation control for different bioprocess operation.
2. How to control bioprocess for desired product

Course Content:

Module I: 8L

Scale up, scale down and its Difficulties: overview of Reactor Types, Some Considerations on Aeration, Agitation, and Heat Transfer, Scale-up, Scale-down.

Bioreactor Instrumentation and Control: Instrumentation for Measurements of Active Fermentation, Using the Information Obtained,

Sterilization of Process Fluids: Introduction and the Kinetics of Death, Sterilization of Liquids, Sterilization of Gases, Problems

Module II: 8L

Traditional Industrial Bioprocess: Anaerobic Bioprocesses: Ethanol Production, Lactic Acid Production, Acetone-Butanol Production, Aerobic Processes: Citric Acid Production, Production of Bakers‟‟Yeast, Production of Penicillins, Production of High-Fructose Corn Syrup (HFCS)

Medical Application of Bioprocess Engineering: Tissue Engineering, Gene Therapy Using Viral Vectors, Stem Cells and Hematopoiesis, Extracorporeal Artificial Liver.

Module III: 13 L

Measurement: Introduction, Principles of measurement, Error Analysis, Static and dynamic characteristics of instruments, Process Instrumentation: Recording, indicating and signaling instruments, Transmission of instrument readings, Instrumentation diagram,
Industrial instruments for measurement

a. Temperature: Filled system Thermometer, Thermocouples, resistance thermometers, radiation and optical pyrometers
b. Pressure: Manometers, elastic deformation and electrical type gauges. Vacuum gauges – mechanical,electrical and ionization types.
c. Flow: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters.
d. Level: Direct and inferential type

Module IV: 7L

Measurement of density and specific gravity, humidity, viscosity and composition.Analytical principles involving emission spectrometry, IR, Spectroscopy, Gas chromatography, Polarography, X-ray and pH.

Textbooks:

1. Bioprocess Engineering Basic Concepts, Second Edition Michael L. Shuler and FikretKargi, Prentice Hall
2. Coughanowr, D. R., LeBlanc, S. "Process Systems Analysis and Control", 3rd edition, McGraw-Hill

Reference books:

1. Seborg, D.E., Edgar, T.F., Mellichamp, D.A. "Process Dynamics and Control", 2nd edition, John Wiley
2. Stephanopoulos, G. "Chemical Process Control: An Introduction to Theory and Practice", PearsonEducation.

Course Outcome:

Students will be able to

1. **Understand** the importance of process dynamics (unsteady state operation)
2. **Tune** a controller to reject disturbances or manage operating point transitions
3. **Understand** how to control biological process for effective production.
4. **Ability to use** modern engineering and computational tools for different engineering activities.

Course Code	**PE-BT702A**					
Category	**Professional Core Elective**					
Course title	**Biomaterials**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester:VII**
	2	**0**	**0**	**2**	**24**	
Pre-requisites/ Co-requisites(if any)	- **Structure of Biomolecules** - **Biochemistry** - **Microbiology** - **Immunology** - **Recombinant DNA Technology**					

Course Objective:

The objectives of the course are:

1. To understand the principles and biology underlying the design of implants and artificial organs.
2. This course deals with applications resulting from the combination of Biotechnology and Biomedical engineering in the fields of medicine and environment.
3. To focus on principles of biomaterials and its applications.

Course Content:

Module I: [6 Lectures]

Introduction to Biomaterial and Some Common Biopolymers

Introduction to biomaterial, biologically derived materials or materials compatible with biology. Common biomaterials: some proteins, many carbohydrates and some specialized polymers; Collagen (protein in bone and connective tissues): Structure, production and its use. Fibroin (protein in silk): Production and its use.

Module II [6 Lectures]Classes of Biomaterials

Major classes of materials used in medicine: Polymers of natural and synthetic origin, Biodegradable Polymers (PHB, PCL, PHV, and PHA, Biopol); Carbohydrates and Modified carbohydrates,polyphenols - Hydrogels – Elastomer – Dendrimers; Ceramics, Bioceramics, Bioglasses, Composites.

Module III [6 Lectures]Biomaterial Properties

Polymers: synthesis, polymerization processes, molecular weights determination and distributions (e.g., chain vs. step, thermoplastics vs. thermosets, Elastomer, Dendrimers), Mechanical (Elastic and Viscoelastic) and Thermal properties (glassy and rubbery states), structural features (crystalline vs. noncrystalline materials), general mechanical properties and relationship to processing.

Module IV [6 Lectures] Biomaterial Applications

Biomaterial requirements for certain medical applications (joint vs. blood vessel, soft and hard tissue replacements, cardiovascular, drug delivery); General overview of components in the human body used

to construct implantable materials: temporary or permanent, biodegradable and bioactive materials, drug delivery systems; legal and ethical issues related to biomaterials used in medical applications.

Texts Books:

1. Biomaterials Science: An introduction to Materials in Medicine, Edited by Ratner, Hoffman, Schoet and Lemons, Second Edition: Elsevier Academic Press, 2004.
2. Biomaterials: SUJATA V. BHATT, Second Edition, Narosa Publishing House,2005.
3. BIOMATERIALS-Principles and Applications– Joon B.Park Joseph D. Bronzino, CRC Press, 2003
4. Comprehensive structural integrity, Vol.9: Bioengineering Editors: Mithe, Ritchie and Karihalo, Elsevier Academic Press, 2003.

Reference Books:

1. Biomaterials Science and Biocompatability, Fredrick H. Silver and David L. Christiansen, Piscataway, Springer, New Jersey.
2. Biological Performance of Materials: Fundamentals of Biocompatibility, Janathan Black, Marcel Dekker, Inc., New York and Basel, 1981.
3. "Biomaterials Science and Engineering", PARK J.B., Plenum Press, 1984.
4. Standard Handbook of Biomedical Engineering & Design – Myer Kutz, McGraw-Hill, 2003
5. Introduction to Biomedical Engineering – John Enderle, Joseph D. Bronzino, Susan M. Blanchard, Elsevier, 2005.
6. Biomedical Materials, R.Narayan(ed.), Springer Science

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102106057/
2. NPTEL: http://nptel.ac.in/courses/102107058/#
3. NPTEL: http://nptel.ac.in/courses/102106036/

Course Outcome (CO):

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

1. **Describe and compare** the various classes of mainstream biomaterials on the basis of structure and function currently used for medical applications.
2. **Understand the fundamental principles** of biomaterials and their properties and the working principles and applications of various types of biomedical materials
3. **Apply modern and appropriate** analytical techniques for characterization of biomaterials.
4. **Explain the basic principles** governing biocompatibility and biofunctionality materials,including interactions between materials and living organisms.
5. **Apply the basic concepts** used in designing biomaterials, medical devices and artificial organs with the regulation of ethics.
6. **Analyze biocompatibility** and tissue-material interaction for different kinds of biomaterials.

Course Code	PE-BT702B					
Category	Professional Core Elective					
Course title	Biosensor and Diagnostics					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester:VII
	2	0	0	2	24	
requisites/ Co-requisites (ifany)	-					

Course Objective:

The objectives of the course are:

1. The module gives an introduction and elementary idea about biosensors, transducers and also imparts knowledge of electrical or optical signal that can be quantified and recorded.
2. The course also illustrates the development of lab on chip technology based diagnostic tools in the field of medical science.

Course Content:

Module I: [6Lectures]

Fundamentals of Biosensors: Principles; Characteristics of Ideal Biosensors; Basic measuring procedure; Medically significant measurands, functional specifications of medical sensors; Sensor characteristics: linearity, repeatability, hysteresis, Components of biosensor; Advantages & Limitations

Types of biosensors, bio-chemical sensors, chemical potential and equilibrium; electrochemical cell at equilibrium; Nernst equation; pH electrode; Ion-sensitive electrodes.

Module II: [5 Lectures]

Bioelectric potentials/Physiological signals: Action potentials and impulse propagation, origin of bioelectric signals, electrode theory, types of electrodes, selection criteria for electrodes recording electrodes and skin-contact imped.

Lab on chip: Microfluidic interfaces for biosensors, DNA and protein microarrays, Microfabricated PCR technology, Nanobiosensor.

Module III [8 Lectures]

Basics of Transducers: Transducers in general, active and passive transducers, Principles and applications –Potentiometric, Amperometric, Conductrometric, resistormetric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene based biosensors.

Physiological Transducers: Calorimetric, Optical, Pressure transducers, catheter tip pressure transducers, temperature transducers, pulse sensors, respiration sensors, digital transducers, selection criteria for transducers.

Module IV [5 Lectures]

Diagnostic uses: Ultrasonic, Optical & Laser biosensors: Basics of ultrasound, theory, characteristics, design, applications in medical science for diagnostic and therapeutic, Optical fiber sensor, Polarization, Refractive index, Light scattering, micro-opto- electromechanical system [MOEMS], Laser in industry.

Textbooks:

1. Biosensors: Tran Minh Canh, Chapman & Hall
2. Biosensors: Oxford University Press, USA;

Reference books:

1. Turner, A.P.F, Karube. I.,and Wilson, G.S, Biosensors Fundamentals and applications, Oxford Univ.Press.
2. Handbook of Biosensors and Electronic Noses: Medicine, Food and the Environment: CRC-Press; 1edition; 1996
3.

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/

Course Outcome (CO):

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

1. **Understand** and **illustrate** the concept of biosensors and transducers specific to diagnosticsystems.
2. **Understand** and **design** of biosensors and **evaluate** the physiological signal generation fordeveloping diagnostic tools.
3. **Understand** and **analyze** the role of lab on chip devises to develop new integrated sensorsproviding practical solution in the field of biomedical engineering.
4. **Design** and **develop** implantable sensors and **evaluate** the challenges based on biocompatibilityand other aspects.
5. **Summarize** the advantages, limitations and application of biosensors in the field of diagnostic and therapeutic.

Course Code	**PE-BT702C**					
Category	**Professional Core Elective**					
Course title	**Medical and Pharmaceutical Biotechnology**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	2	**0**	**0**	**2**	**24**	
Pre-requisites/ Co-requisites (if any)	**-** **Microbiology** **-** **Genetics**					

Course Objective:

The objectives of the course are:

1. The course aims exposing students to various topics in Biotechnology, including the pharmacist‟s role in Biotechnology, genetic engineering and its application to pharmacy.
2. The course will also cover methods in producing commercial products and modern diagnostic system.

Course Content:

Module 1: 6L: Drug Development in Pharmaceutical Process:

Introduction to production, formulation and packaging of large and small molecule pharmaceuticals; Generation of large molecule pharmaceuticals by natural extraction (Blood products, Haemophilia A and B, Anticoagulants, Thrombolytic agents) and recombinant methods (hormones, interferon‟s and Erythropoietin as biopharmaceutical); New techniques for production of the above large molecule pharmaceuticals and their advantages/ therapeutic applications; Techniques for development of new generation antibiotics.

Module II: 6L: Disease Diagnosis Techniques:

Biosensor assays for assessing ligand –receptor interaction; Antibody engineering; Antibodies as in vitro and in vivo probes; DNA and RNA based diagnostics and therapy: PCR, PCR/OLA procedures, RFLP, SSCP, Microarrays, In-situ hybridization.

Module III: 6L: Disease Therapy

Gene Therapy, Antisense RNA therapy Ribozyme therapy, status, problems and prospects of further development. Toxicogenomics: Use of toxicological profiles and information in genomics; need and development

Module Iv: 6L: Proteomics in Drug Development:

Development and applications of proteomics in drug development process; Use of proteomics in protein based biomarkers in disease diagnosis (e.g. cancer); development and future prospects; drug development pipeline; applications of enzyme immunoassays for diagnosis.

Textbooks

1. Biopharmaceuticals- Biochemistry and Biotechnology: Gary Walsh; John Wiley & Sons
2. S. P. Vyas, V. Dixit, Pharmaceutical Biotechnology, CBS Publishers
3. Pharmaceutical Biotechnology; Sambhamurthy&Kar, NewAge Publishers

Reference Books

1. EpenetosA.A. (ed), Monoclonal antibodies: applications in clinical oncology, Chapman and HallMedical, London
2. V.Venkatesharalu -Biopharmaceutics and Pharmacokinetics-Pharma Books Syndicate
3. F.C. Hay, O.M.R. Westwood, Practical Immunology, 4th Edition-, Blackwell Publishing, 2002
4. S. Hockfield, S. Carlson, C. Evans, P. Levitt, J. Pintar, L. Silberstein, Selected Methods for Antibodyand Nucleic Acid probes, Volume1, Cold Spring Harbor Laboratory Press, 1993.

Course Outcome (CO):

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

1. **Provide** an historical outlook in the field of medical biotechnology and the innovative processes.
2. **Understand**, **define** and **differentiate** traditional and recombinant therapeutic molecules and their production.
3. Ability to make **understand** disease diagnosis and their therapeutic approach.

4. **Understand** the process and methodology of instruments used for clinical diagnosis.
5. **Applying** interdisciplinary subjects to **analyze** and **evaluate** different therapeutic approaches.
6. **Understanding** the role of Proteomics in **analyzing** diseases progression and development of drug.

Course Code	**OE-BT701A**					
Category	**Open Elective Courses**					
Course title	**Biosafety**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	2	**0**	**0**	**2**	**24**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

The recent advances in the field of Biotechnology have brought into focus several safety issues. The inventions in the field of genetic engineering and related fields of molecular biology not only affect us but also the plants, microflora, animals and the entire environment and the way we practice agriculture, medicine and food processing. The present course focuses on the biosafety the modern society confronts. Topics such as biosafety levels, GM food debate, and impact of biotechnology on biosafety, governance of biosafety, environmentally responsible use of biotechnology, will be discussed in the course.

Course Content:

Module I: Introduction (4 Lectures)

Historical background, introduction to biological safety cabinets, primary containment for biohazards, biosafety levels of specific microorganisms, recommended biosafety levels for infectious agents and infected animals.

Module II: Biosafety guidelines (8 Lectures)

Government of India definition of genetic modified organism (GMOs) and living modified organisms (LMOs), roles of institutional biosafety committee, review committee on genetic manipulation (RCGM), genetic engineering approval committee (GEAC) for GMO applications in food and agriculture, environmental release of GMOs. The GM-food debate and biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance. Biosafety assessment of pharmaceutical products such as drugs/vaccines etc.

Module III: Handling and transportation of GM, infectious and radioactive materials (6 Lectures)
Risk analysis, risk assessment, risk management and communication, overview of national regulations and relevant international agreements including Cartagena Protocol.

Module IV: Biosafety management & Concept of social science (6 Lectures)

Key to the environmentally responsible use of biotechnology, ethical implications of biotechnological products and techniques, social and ethical implications of biological weapons.
Reason to apply its principles to study cause of health problems and suggest appropriate intervention/ solution to problem.

Text Books/ Reference Books:

1. Regulatory Framework for GMOs in India (2006) Ministry of Environment and Forest, Governmentof India, ND.
2. Cartagena Protocol on Biosafety (2006) Ministry of Environment and Forest, Government of India,New Delhi.
3. P.K. Gupta, Biotechnology and Genomics, Rastogi Publications
4. Biotechnology & Safety Assessment, Thomas, Ane/Rout Publishers.

Web References:

1. http://www.cbd.int/biosafety/background.shtml
2. http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html MAJOR

Course Outcome:

1. **Understanding and identification** of biohazards and functioning of Biosafety committees.
2. **An ability to apply** the GMO regulations and assessment of the personal care products.
3. **An awareness** of the principles of containment for transgenic, infected or exotic animals and plants.
4. **Ability to evaluate** risk assessments for work involving biological agents including with radioactive materials.
5. **Analyze** the appropriate measure to study cause of health problems in society.

Course Code	**OE-BT701B**					
Category	**Open Elective Courses**					
Course title	**Soft Skill**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lec. Hrs.**	**Semester: VII**
	2	**0**	**0**	**2**	**24**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:
1. To cause a basic awareness about the significance of soft skills in professional and inter-personal communications and facilitate an all-round development of personality.
2. To comprise pleasant and appealing personality traits as self-confidence, positive attitude, emotional intelligence, social grace, flexibility and friendliness.

Course Content:

Module I: [4 Lectures]Introduction:

A new approach to learning, planning and goal-setting, human perceptions: understanding people, types of soft skills: self-management skills, aiming for excellence: developing potential and self-actualisation need achievement and spiritual intelligence

Module II: [5 Lectures]Conflict and Stress:

Conflict resolution skills: seeking win-win solution; types of conflicts: becoming a conflict resolution expert; types of stress: self-awareness about stress; regulating stress: making the best out of stress

Module III: [5 Lectures]Habits:

Habits: guiding principles; habits: identifying good and bad habits; habits: habit cycle; breaking bad habits; using the zeigarnik effect for productivity and personal growth; forming habits of success

Module IV: [10 Lectures]

Communication, Communication barrier and body language:

Communication: significance of listening; active listening; ; barriers to active listening; telephone communication; technology and communication: technological personality?; mobile personality?; e-mail principles; netiquette; e-mail etiquette; communication skills: effective communication; barriers to communication; interpersonal transactions; miscommunication; non-verbal communication: pre-thinking; pre-thinking ; interpreting non-verbal cues; body language: for interviews; body language: for group discussions; human relations: developing trust and integrity

Textbooks:

1. Dorch, Patricia. What Are Soft Skills? New York: Execu Dress Publisher, 2013.
2. Petes S. J., Francis. Soft Skills and Professional Communication. New Delhi: Tata McGraw-Hill Education, 2011.

Web Reference:

1. NPTEL: http://nptel.ac.in/syllabus/109104107/

Course Outcome (CO):

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

1. **Understand** the **use** and the **significance** of soft skills in the working environment.
2. **Apply** conflict resolution skills to **solve** their problems and able to **minimize** their stress.
3. **Identify** their good and bad habits which help them to **forming** habits of success
4. **Understand** the significance of listening to **influence** the people.
5. **Interpret** non-verbal cues as well as body language.
6. **Developed** trust and integrity in their professional as well as personal life.

Course Code	OE-BT701C					
Category	Open Elective Courses					
Course title	Research Methodology					
Scheme and Credits	L	T	P	Cr. Points	Lec. Hrs.	Semester:VII
	2	0	0	2	24	
Pre-requisites	Computer Basic, Microsoft-Office (MS Word,MS Power Point, MS Excel), Networking					

Course Objective:

The objectives of the course are:

1. To learn the basic research terminology.
2. To study the various research designs and techniques.
3. To identify various sources of information for literature review and data analysis.
4. To study the content of research report and thesis.

Course Content:

Module I: [5 Lectures]

Introduction to Research Methodology: Meaning of Research, Objectives of Research, Purpose of Research, Types of Research, Significance of Research, Criteria of Good Research

Selection and formulation of a Research Problem: Meaning of research problem, Review of Literature, Formulating the problem, Techniques involved in formulating problem **Literature Review:** Purpose of Review of Literature, Literature Search Procedure, Importance of Review of Literature

Module II: [5 Lectures]

Hypothesis: Meaning of Hypothesis, Types of Hypothesis, Hypothesis Testing

Research Design: Meaning for Research Design, Components of Research Design, Classifications of Research Design, Principles of experimental design

Module III: [8 Lectures]

Methods of Data Collection: Meaning of Data, Primary sources of Data, Secondary sources of Data, Methods of collecting Data

Processing and Analysis of Data: Recapitulation (Measures of Central Tendency, Dispersion, correlation and Regression, Chi- square test: Applications, Steps, characteristics, limitations, Analysis of Variance and Co-variance)

Observation: Meaning of Observation, Process of Observations, Types of Observation

Module IV: [6 Lectures]

Presentation tool: Introduction to Presentation Tool, Features & Functions, Creating Presentations, Customizing Presentation. [Tools used: Microsoft PowerPoint, Open Office or any other tool]

Research Report Writing: Meaning of Research Report, Types of Research Report, and Contents of the Research Report

Ethical issues in research: Code of Ethics in Research, Ethics and Research Process, Importance of Ethics in Research

Textbooks:

1. Kothari, C.R. (2004). Research methodology: Methods and techniques. New Age International (P)Ltd., New Delhi.
2. Kumar, R. (2011). Research methodology: A step-by-step guide for beginners. Los Angeles: SAGE.

Web Reference:

1. http://nptel.ac.in/courses/121106007/
2. http://nptel.ac.in/courses/107108011/

Course Outcome (CO):

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

1. Understand the basic concepts of research and its methodologies.
2. Select and define appropriate research problem and parameters.
3. Understand, Identify and develop various research designs and techniques.
4. Examine and Analyze quantitative, qualitative methods for data collection, observation and result.
5. Understand and implement the presentation tools and its features.
6. Formulate a research report and thesis.

Course Code	**HM-BT791**					
Category	**Humanities and Social Science and ManagementCourse**					
Course title	**Group Discussion**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: VII**
	0	**0**	**1**	**0.5**	**12**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:

The objectives of the course are:

A ***group discussion*** among students is being organized to see and evaluate their thinking skills, listening abilities and how they are communicating their thoughts. One should learn to control the conversation through listening attentively and then having the perseverance to mould it towards his/her own direction.

Course Content:

Module I:

Practice GD-sessions and help them learn the application of various soft skills related to it. (2P)

Module II:

Enhancing Reading Comprehension ability through practicing various types of passages on Subjective (/non-technical), Objective (/scientific) writing, though Case Studies etc. (2P)

Module III:

Developing good writing style through assignments on various Creative writing topics, writing reviews, proposals, analytical essays etc. (2P)

Module IV:

Developing Interview Skills through Lessons on different types of interviews, how to strategically handle various unexpected situations in an interview board, Conducting Mock Interview Sessions, Solving Questions on Verbal Reasoning to crack the Aptitude test etc. (4P)

Recommended books:

1. Ashraf Rizvi (2005): *Effective Tech Communication*. Tata McGraw-Hill Education
2. Meenakshi Raman &Sangeeta Sharma (2015): Technical Communication Principles and Practice (3rd edition). Oxford University Press.
3. Dr. Nira Konar (2011): *English Language Laboratories: A Comprehensive Manual*. Prentice Hall IndiaLearning Private Limited.

Course Outcome (CO):

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

1. **Understanding** the mechanism of interpretation through language learning by practising reading, writing and comprehension skills.
2. **Understanding** complex engineering problems by a sound grammatically correct knowledge base of English & honing LSRW skills for software research, solutions, marketing etc.
3. **Honing** „Reading Skills" and its sub skills using Visual / Graphics/Diagrams /Chart Display/Technical/Non Technical Passages; Learning Global / Contextual / Inferential Comprehension for technical competence.
4. **Equipping** learners to solve various problems related to aptitude tests and interviews through the practice of various Verbal reasoning, analytical essays & business correspondence.
5. **Learning** field survey along with leadership qualities and statistical analysis through Technical Report Writing & learning team-work through language activities.
6. **Awareness** about the society, public health and safety, growth and changes in society, culture and environment through comprehension, technical report writing practice, group discussions & presentations.

Course Code	PC-BT791					
Category	Professional Core					
Course title	Food Biotechnology Lab					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VII
	0	0	2	1	24	
Pre-requisites/ Co-requisites (if any)	- Chemistry - Microbiology					

Course Objective:

The objectives of the course are:

1. To study the properties of water and testing of various parameters.
2. To learn and understand the principles behind the qualitative and quantitative estimation of biomolecules.
3. To understand the methods of isolating and characterizing various microbes associated withfood.
4. Analysis of foods and food products for chemical components, detection of adulterants.

Course Content:

1. Quality of water (pH, TDS, TSS, Hardness etc.)
2. Determination of Moisture, Acidity and pH in food sample/beverages
3. Determination of Protein in food sample
4. Determination of total Fat of a food sample
5. Determination of total Carbohydrate of a food sample
6. Determination of Reducing sugar in the food sample
7. Quantification of Microbes: Sampling and Serial Dilution; Bacterial count in food Products(TVC)
8. Chromatographic separation of Food colors and estimation by spectrophotometer
9. Detection of Adulterants in spices, spices powder, milk and milk products
10. Estimation of vitamin C content from a food sample
11. Quality testing of milk by MBRT method

Reference books:

1. S. Sadasivam, A. Manickam (2007) Biochemical Methods. New Age International (P) Limited.
2. W.F. Harrigan (2011) Laboratory Methods in Food Microbiology. Academic Press.
3. D.T. Plummer (1987) Introduction of Practical Biochemistry. Tata McGraw-Hill.

Course Outcome (CO):

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

1. **Understand and analyze** the various properties of water.
2. **Construct** a comprehensive understanding of the nutritional properties of food constituents.
3. **Estimate** qualitatively and quantitatively proteins, lipids, carbohydrates and metabolites offoods.
4. **Understand and apply** the microbiological techniques for the study of foods.
5. **Examine, Analyze** foods and food products for detection of chemical components and

adulterants.

Course Code	**PW-BT781**					
Category	**Project**					
Course title	**Project Work-I (In-house/Industry/Research Institute)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester : VII**
	0	**0**	**4**	**2**	**90**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:
The objectives of the course are:
Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Projects offer the opportunity to apply and extend material learned throughout the program.

Course Outcome (CO):
After successful completion of this course, the student will be able to:
1. **Demonstrate** a sound technical knowledge of their selected project topic.
2. **Undertake** problem identification, formulation and solution.
3. **Design** engineering solutions to complex problems utilizing a systems approach.
4. **Conduct** an engineering project
5. **Communicate** with engineers and the community at large in written an oral forms.
6. **Demonstrate** the knowledge, skills and attitudes of a professional engineer.

Course Code	**SI-BT781**					
Category	**Summer Internship**					
Course title	**Summer Internship-V (Seminar/Training /Workshop) (Online/Offline)**					
Scheme and Credits	**L**	**T**	**P**	**Cr. Points**	**Lab. Hrs.**	**Semester: VII**
	0	**0**	**15**	**1.5**	**68**	
Pre-requisites/ Co-requisites (if any)	**-**					

Course Objective:
The objectives of the course are:
1. The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice.
2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.

3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. **Demonstrate** the knowledge of Applied Sciences substrate with Allied field of engineering/technology.
2. **Understand** the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. **Communicate** effectively in both verbal and written form through critical thinking process which will assist them in the preparation of their proposal and dissertation
4. **Pursue** new and enriched understandings of the texts through sustained inquiry and reevaluate initial hypotheses in light of evidence.
5. **Express, articulate, discuss and defend well** formed arguments within a group or to an audience or to different engineering communities
6. **Understanding** of lifelong learning processes through critical reflection of internship experiences.

Course Code	PW-BT881					
Category	Project					
Course title	Project Work-II (In-house/Industry/Research Institute)					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester : VIII
	0	0	18	9	405	
Pre-requisites/ Co-requisites (if any)	-					

Course Objective:
The objectives of the course are:
Final Year Projects represent the culmination of study towards the Bachelor of Engineering degree. Projects offer the opportunity to apply and extend material learned throughout the program.

Course Outcome (CO):
After successful completion of this course, the student will be able to:
1. **Demonstrate** a sound technical knowledge of their selected project topic.
2. **Undertake** problem identification, formulation and solution.
3. **Design** engineering solutions to complex problems utilizing a systems approach.
4. **Conduct** an engineering project
5. **Communicate** with engineers and the community at large in written an oral forms.
6. **Demonstrate** the knowledge, skills and attitudes of a professional engineer.

Course Code	SI-BT881					
Category	Summer Internship					
Course title	Summer Internship-VI (Seminar/Training /Workshop) (Online/Offline)					
Scheme and Credits	L	T	P	Cr. Points	Lab. Hrs.	Semester: VIII
	0	0	15	1.5	68	
Pre-requisites/ Co-requisites (if any)	-					

Course Objective:
The objectives of the course are:
1. The aim of this course is to use the internship experience to enable students to develop their engineering skills and practice.
2. The internships will be aligned with the aims of the engineering program and its areas of specialization. Students will experience a real-life engineering workplace and understand how their engineering and professional skills and knowledge can be utilized in industry and research.
3. They will also be able to demonstrate functioning engineering knowledge, both new and existing, and identify areas of further development for their future careers.

Course Outcome (CO):

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

1. **Demonstrate** the knowledge of Applied Sciences substrate with Allied field of engineering/technology.
2. **Understand** the impact of engineering solutions on the society and also will be aware of contemporary issues.
3. **Communicate** effectively in both verbal and written form through critical thinking process which will assist them in the preparation of their proposal and dissertation
4. **Pursue** new and enriched understandings of the texts through sustained inquiry and reevaluate initial hypotheses in light of evidence.
5. **Express, articulate, discuss and defend well** formed arguments within a group or to an audience or to different engineering communities
6. **Understanding** of lifelong learning processes through critical reflection of internship experiences.

Detail Syllabus for Value Added Course (Non-credit)

Category : Value Added Course
Course Title : Instrumentation and Techniques in Nanobiotechnology
Course Code : VAC (BT) 001
Contacts Hours : 30

Course Objective:

1. Course will deliver a comprehensive knowledge base for evaluation of the potential risks and benefits of nanotechnology to the environment and to human health and safety.
2. Course will cover inter- and multi-disciplinary science and engineering.

Course Content:

Module I: [10 Lectures]: Introduction to Nanotechnology: Nanoscale Properties (Electrical, Optical, Chemical); Cellular Nanostructures; Nanopores; Biomolecular motors; Criteria for suitability of nanostructures for biological applications.

Characterization techniques by FTIR, DSC, DTA, TGA, Low Energy Electron Diffraction (LEED), Scanning Probe Microscopy-principle of operation, instrumentation and probes, Low temperature Scanning Probe Microscopy, Auger, SEM, TEM, XRD (Powder/Single crystal), (AFM), Scanning Tunneling Microscopy (STM), EDX, ESCA etc, recent advancements.

Module II: [10 Lectures]: Engineered Nanomaterials: Engineered Nanomaterials: Carbon nanomaterials (fullerenes, graphene, nanotubes, nanofibers); Metal nanoparticles (synthesis, properties and applications); Magnetic nanoparticles (synthesis, properties and applications); Quanatum dots, liquid crystals; Nanoporous materials (metalic, zeolite,MOFs)

Module III: [10 Lectures]: Nanotechnology In Health Care: Nanobiotechnology for Drug Discovery; Cells Targeting by Nanoparticles with conjugated with small Molecules; Nanoscale Delivery of Therapeutics; Nanoparticle Combinations for Drug Delivery: Liposome–Nanoparticle Hybrids.

Texts:

1. Multilayer Thin Films, Editor(s): GeroDecher, Joseph B. Schlenoff Publisher: Wiley- VCH Verlag GmbH & Co. KGaA.
2. Bionanotechnology: Lessons from Nature Author: David S. Goodsell Publisher: Wiley- Liss.
3. David S Goodsell, “Bionanotechnology”, John Wiley & Sons, 2004.
4. Biomedical Nanotechnology Editor: Neelina H. Malsch Publisher: CRC Press

References:

1. Kewal K. Jain, The Handbook of NanomedicineHumana Press, (2008).
2. Zhang, Nanomedicine: A Systems Engineering Approach” 1st Ed., Pan Stanford Publishing, (2005).
3. Robert A. Freitas Jr., ―Nanomedicine Volume IIA: Biocompatibility, Landes Bioscience

Publishers, (2003).

Course Outcome (CO):

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

1. To **interpret** the **analyze** different instrumentation techniques of nanotechnology.
2. **Describe** and **interpret** the basics of synthesis and characterization of nanomaterials.
3. **Learn** and **analyze** the use of engineered nanomaterials in biomedical and environment.
4. **Solve** and **understand** scientific problems related to nanotechnological materials.
5. **Create** awareness on the toxicity of nanomaterials.

Category : Value Added Course
Course Title : Advanced Tissue EngineeringCourse
Code : VAC (BT) 002
Contacts Hours : 30

Course Objective:

1. The course focuses on functional biomaterials for manufacturing tissue engineeredconstruct, drug delivery, therapeutics.
2. To make the students learn about how the biomaterials mimic natural cell behaviour,showing effective cell growth and repair.

Course Content:

Module I: [10 Lectures] Introduction (Structural and Organization of tissues): Basic definition, Introduction to tissue engineering, Cells as therapeutic agents with examples. Tissue organization, Tissue Components, Tissue types, Functional subunits. Homeostasis in highly prolific tissues and Tissue repair. Angiogenesis and basic wound healing, currentscope of development and use in therapeutic and in-vitro testing. Cell differentiation, Cell migration - underlying biochemical process.

Module II: [10 Lectures] Molecular & Cellular aspects: Cell-extracellular matrix (ECM) interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Cell signalling molecules like growth factors, hormone; Cell attachment: differential cell adhesion, receptor-ligand binding, and Cell surface markers.

Module III: [10 Lectures] Biomaterials: Engineering biomaterials for tissue engineering(collagen, silk and polylactic acid), Characterization techniques (porosity, mechanicalstrength, 3-D architecture and cell incorporation). Engineered tissues for replacing bone, cartilage, tendons, ligaments, skin and liver; Tissue Engineering Case Studies.

Textbooks:

1. Principles of tissue engineering, Robert. P.Lanza, Robert Langer & William L. Chick,Academic press.

2. The Biomedical Engineering –Handbook, Joseph D. Bronzino, CRC press.
3. Introduction to Biomedical Engg., Endarle, Blanchard & Bronzino, Academic press.

Reference books:

1. Tissue Engineering, B. Palsson, J.A. Hubbell, R.Plonsey & J.D. Bronzino, CRC- Taylor& Francis
2. Nanotechnology and Tissue engineering - The Scaffold", Cato T. Laurencin, Lakshmi S. Nair, CRC Press.

Web Reference:

1. NPTEL: http://nptel.ac.in/courses/102103016/

Course Outcome (CO):

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

1. **Understand** and **analyze** the cellular fate to design tissue engineering system.
2. **Design**, fabricate scaffolds and **interpret** cellular interaction for growing biologicalmaterial.
3. **Construct** multicomponent biomaterials by advanced manufacturing technologies.
4. **Design** a biomaterial system considering the main issues of biocompatibility includingtoxicity.
5. **Analyze** simple models to quantify aspects of bioreactor design.
6. **Fabricate** biomaterial based tissue engineered construct and **development** of artificialorgans.

Category : Value Added Course
Course Title : Synthetic Seed Production
Course Code : VAC (BT) 003
Contacts Hours : 30

Course Objective:

1. The course is aimed at understanding concepts of seed biotechnology.
2. To make the students learn methods of developing synthetic seeds.
3. To impart theoretical knowledge and practical knowledge used in agriculturalbiotechnology.

Course Content:

Module I: [10 Lectures] Introduction:

Scope of biotechnology in conservation of seeds and their improvement; Tools and techniques of Tissue culture; Plant Growth medium; Design of laboratory and commercial tissue culture facility. Fumigation, wet and dry sterilization, ultraviolet sterilization, ultra filtration and surface sterilization. Laminar flow hood. Culture techniques and regeneration protocols for plants growth; Plant hormones and their role in development.

Module II: [10 Lectures]

Basic steps in Plant tissue culture; Growth and maintenance of axenic cultures. Selection of explants for Tissue Culture (Shoot tip, leaf discs, axillary buds, cotyledons, inflorescence and floral organs). Callus

culture - initiation and maintenance of callus. Organogenesis and embryogenesis, Somatic embryogenesis, acclimatization. Somaclonal variation and its role in plant growth and improvement. Encapsulation of somatic embryos, shoot buds, or any other tissue; Protoplast culture and utility, development of hybrid plants; Cybrids development technique; Production and maintenance of disease free clones. Characteristics of Synthetic Seeds; Types of synthetic seeds

Module III: [10 Lectures]

Large scale propagation methods; Genetic uniformity of plants; Field sowing of artificaila seeds; Rapid multiplication of plants. Cryopreservation of seed, plant material and callus- principles and techniques. Preservation of nonviable seeds. Storage of artificial or synthetic seeds. Genetic purity analysis of seeds. Advantages of Synthetic Seeds

Textbooks:

1. Plants from Test Tubes by L. Kyte and J. Kleyn, 1996.
2. Micropropagation by P. Debergh and R. H. Zimmerman, 1994

Reference books:

1. An introduction to Plant Tissue Culture. New central Book Agency,(P) Ltd, Calcutta.Kumar, A. and Kumar, V.A. 1996.
2. Plant Biotechnology and Tissue Culture. Principles and perspectives. International Book distributing Comp. Lucknow.
3. Biotechnology: Fundamentals and Applications. Agrobios (India) Publ. Agro House, behind Nasrani Cinema, Chopasani Road, Jodhpur-342 002. Purohit, S.S. (2003)

Course Outcome (CO):

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

1. To **learn** the basic principle of establishment of tissue culture work station.
2. To **understand** and **analyze** different techniques of plant tissue culture.
3. **Express** and **interpret** the basics of different techniques in synthetic seeds production.
4. **Solve** and **understand** scientific problems related to tissue culture techniques.
5. To **learn** application of synthetic seed for crop production and preservation.

Category : Value Added Course
Course Title : Protein Purification Techniques
Course Code : VAC (BT) 004
Contacts Hours : 30

Course Objective:

To enable the students to

1. Understand the methods to obtain pure proteins, enzymes and in general about product development R and D

2. Have depth knowledge and hands on experience with on purification processes requiredin multi-factorial manufacturing environment in a structured and logical fashion

Course Content:

Module I: [6 Lectures] Downstream Processing of Proteins: Introduction to protein purification, principles characteristics of proteins in bioprocesses. Cell disruption forprotein as the product release – mechanical, enzymatic and chemical methods.Pretreatment and stabilisation of proteins.

Module II: [4 Lectures] Physical Methods of Separation: Unit operations for solid- liquid separation - filtration and centrifugation.

Module III: [4 Lectures] Isolation of Protein Products: Adsorption, liquid-liquid extraction, aqueous two-phase extraction, membrane separation– ultrafiltration and reverse osmosis, dialysis, precipitation of proteins by different methods.

Module IV: [12 Lectures] Protein Product Purification: Chromatography – principles, instruments and practice, adsorption, reverse phase, ion-exchange, size exclusion, hydrophobic interaction, bioaffinity and pseudo affinity chromatographic techniques.

Module V: [4 Lectures] Final Protein Product Formulation and Finishing Operations: Crystallization, drying and lyophilization in final protein product formulation.

Textbooks:

1. Belter, P.A. E.L. Cussler And Wei-Houhu – "Bioseparations – Downstream Processing For Biotechnology, Wiley Interscience Pun. (1988).
2. Sivasankar, B. "Bioseparations : Principles and Techniques". PHI, 2005.

Reference books:

1. R.O. Jenkins, (Ed.) – Product Recovery In Bioprocess Technology – Biotechnology By Open Learning Series, Butterworth-Heinemann (1992).
2. J.C. Janson And L. Ryden, (Ed.) – Protein Purification – Principles, High ResolutionMethods And Applications, VCH Pub. 1989.
3. R.K. Scopes – Protein Purification – Principles And Practice, Narosa Pub. (1994).

Course Outcome (CO):

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

1. **Plan and carry out** the separation of proteins independently
2. **Analyze critically and evaluate** the results, which are obtained from experimental protein separation
3. **Know how to choose and use** the different methods of protein analysis
4. **Optimize** purification strategies and purification hygiene in the choice of protein purification strategy
5. **Perform** laboratory analyzes according to Good Laboratory Practice (GLP)

6. **Demonstrate an understanding** of the various purity requirements and analyzes that exist in different parts of the industry

LIST OF MOOCS COURSES FOR SECOND TO FOURTH YEAR STUDENTS FOR B.TECH (BIOTECHNOLOGY) HONOURS DEGREE					
Sl. No.	**PLATFORM**	**DISCIPLINE**	**COURSE NAME**	**DURATION**	**CREDIT**
1	NPTEL	Biotechnology & Bioengineering	Introduction to Proteogenomics	12 Weeks	3
2	NPTEL	Biotechnology & Bioengineering	Biomicrofluidics	4 Weeks	1
3	NPTEL	Biotechnology & Bioengineering	Computer Aided Drug Design	8 Weeks	2
4	NPTEL	Biotechnology & Bioengineering	Drug Delivery: Principles and Engineering	12 Weeks	3
5	NPTEL	Biotechnology & Bioengineering	Introduction to Mechanobiology	8 Weeks	2
6	NPTEL	Biotechnology & Bioengineering	Introduction to Biostatistics	8 Weeks	2
7	NPTEL	Biotechnology & Bioengineering	Biomedical Nanotechnology	4 Weeks	1
8	NPTEL	Biotechnology & Bioengineering	Experimental Biotechnology	12 Weeks	3
9	NPTEL	Biotechnology & Bioengineering	Tissue Engineering	8 Weeks	2
10	NPTEL	Biotechnology & Bioengineering	Introduction to Developmental Biology	12 Weeks	3
11	NPTEL	Biotechnology & Bioengineering	Plant Developmental Biology	4 Weeks	1
12	NPTEL	Biotechnology & Bioengineering	Wildlife Ecology	12 Weeks	3
13	NPTEL	Biotechnology & Bioengineering	Wildlife Conservation	8 Weeks	2
14	NPTEL	Biotechnology & Bioengineering	Nanotechnology in Agriculture	8 Weeks	2
15	NPTEL	Biotechnology & Bioengineering	Medical Biomaterials	8 Weeks	2
16	NPTEL	Biotechnology & Bioengineering	Introduction to Professional Scientific Communication	4 Weeks	1
17	NPTEL	Biotechnology & Bioengineering	Bioengineering: An Interface with Biology and Medicine	8 Weeks	2
18	NPTEL	Biotechnology & Bioengineering	Introductory Mathematical Methods for Biologists	8 Weeks	2
19	NPTEL	Biotechnology & Bioengineering	Biostatistics and Design of experiments	8 Weeks	2
20	NPTEL	Biotechnology & Bioengineering	Structural Biology	12 Weeks	3
21	NPTEL	Biotechnology &	Computational Systems Biology	12 Weeks	3

		Bioengineering			
22	NPTEL	Biotechnology & Bioengineering	Aspects Of Biochemical Engineering	12 Weeks	3
23	NPTEL	Biotechnology & Bioengineering	Metabolic Engineering	8 Weeks	2
24	NPTEL	Biotechnology & Bioengineering	Environmental Chemistry and Microbiology	12 Weeks	3
25	NPTEL	Biotechnology & Bioengineering	Bioenergetics of Life Processes	4 Weeks	1
26	NPTEL	Biotechnology & Bioengineering	Bioenergy	4 Weeks	1
27	NPTEL	Biotechnology & Bioengineering	Animal Physiology	12 Weeks	3
28	NPTEL	Biotechnology & Bioengineering	Human Molecular Genetics	4 Weeks	1
29	NPTEL	Biotechnology & Bioengineering	Basics of Biology	12 Weeks	3
30	NPTEL	Biotechnology & Bioengineering	Cell Biology: Cellular organization, division and processes	8 Weeks	2
31	NPTEL	Biotechnology & Bioengineering	Data Analysis for Biologists	8 Weeks	2
32	NPTEL	Biotechnology & Bioengineering	Interactomics : Basics & Applications	12 Weeks	3
33	NPTEL	Biotechnology & Bioengineering	Demystifying The Brain	4 Weeks	1
34	NPTEL	Biotechnology & Bioengineering	Plant Cell Bioprocessing	12 Weeks	3
35	NPTEL	Biotechnology and Bioengineering	Fundamentals of micro and nanofabrication	12 Weeks	3
36	NPTEL	Biotechnology and Bioengineering	Organ Printing	8 Weeks	2
37	NPTEL	Biotechnology and Bioengineering	Introduction to Biomolecular Modeling	12 Weeks	3
38	NPTEL	Biotechnology and Bioengineering	Genome Editing and Engineering	12 Weeks	3
39	NPTEL	Biotechnology and Bioengineering	Biomechanics	12 Weeks	3
40	NPTEL	Biotechnology and Bioengineering	Cellular biophysics: a framework for quantitative biology	8 Weeks	2
41	NPTEL	Biotechnology and Bioengineering	Introduction to Biomedical Imaging Systems	12 Weeks	3
42	NPTEL	Biomedical Engineering/Design	Medical Image Analysis	12 Weeks	3
43	NPTEL	Chemical Engineering	Waste to Energy Conversion	8 Weeks	2
44	NPTEL	Chemistry	Medicinal Chemistry	12 Weeks	3
45	NPTEL	Chemistry	Bioinorganic Chemistry	4 Weeks	1

46	NPTEL	Chemistry	Biophysical chemistry	12 Weeks	3
47	NPTEL	Chemistry and Biochemistry	NMR spectroscopy for Structural Biology	12 Weeks	3
48	NPTEL	Civil Engineering	Water and waste water treatment	12 Weeks	3
49	NPTEL	Civil Engineering	Applied Environmental Microbiology	12 Weeks	3
50	NPTEL	Computer Science and Engineering	Fundamental Algorithms: Design and Analysis	4 Weeks	1
51	NPTEL	Computer Science and Engineering	Data Analytics with Python	12 Weeks	3
52	NPTEL	Computer Science and Engineering	Design and analysis of algorithms	8 Weeks	2
53	NPTEL	Computer Science and Engineering	The Joy of Computing using Python	12 Weeks	3
54	NPTEL	Computer Science and Engineering	Introduction To Programming In C	8 Weeks	2
55	NPTEL	Computer Science and Engineering	An Introduction to Programming Through C++	12 Weeks	3
56	NPTEL	Computer Science and Engineering	Problem Solving Through Programming In C	12 Weeks	3
57	NPTEL	Computer Science and Engineering	An Introduction to Artificial Intelligence	12 Weeks	3
58	NPTEL	Humanities and Social Sciences	Developing Soft Skills and Personality	8 Weeks	2
59	NPTEL	Humanities and Social Sciences	Patent Law for Engineers and Scientists	12 Weeks	3
60	NPTEL	Humanities and Social Sciences	Technical English for Engineers	8 Weeks	2
61	NPTEL	Humanities and Social Sciences	Speaking Effectively	8 Weeks	2
62	NPTEL	Humanities and Social Sciences	Patent Drafting for Beginners	4 Weeks	1
63	NPTEL	Humanities and Social Sciences	Ecology and Society	12 Weeks	3
64	NPTEL	Humanities and Social Sciences	Health Research Fundamentals	8 Weeks	2
65	NPTEL	Humanities and Social Sciences	Effective Writing	4 Weeks	1
66	NPTEL	Humanities and Social Sciences	Soft Skill Development	8 Weeks	2
67	NPTEL	Humanities and Social Sciences	Enhancing Soft Skills and Personality	8 Weeks	2
68	NPTEL	Humanities and Social Sciences	Human Behaviour	8 Weeks	2
69	NPTEL	Humanities and Social Sciences	Education for Sustainable Development	12 Weeks	3
70	NPTEL	Humanities and Social Sciences	Training and Development	12 Weeks	3
71	NPTEL	Management	Industrial Safety Engineering	12 Weeks	3

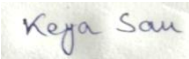
72	NPTEL	Management	Leadership and Team Effectiveness	12 Weeks	3
73	NPTEL	Multidisciplinary	Introduction to Research	8 Weeks	2
74	NPTEL	Multidisciplinary	Current regulatory requirements for conducting clinical trials in India for investigational new drugs/new drug	8 Weeks	2
75	NPTEL	Multidisciplinary	Regulatory requirements for medical devices including in vitro diagnostics in India	4 Weeks	1
76	NPTEL	Multidisciplinary	Entrepreneurship Essentials	12 Weeks	3
77	NPTEL	Multidisciplinary	Introduction to Environmental Engineering and Science - Fundamental and Sustainability Concepts	12 Weeks	3
78	NPTEL	Multidisciplinary	Biology for Engineers and other non-biologist	4 Weeks	1
79	NPTEL	Multidisciplinary	Ecology and Environment	8 Weeks	2
80	NPTEL	Multidisciplinary	Oral Biology	8 Weeks	2
81	NPTEL	Design Engineering	Innovation by Design	4 Weeks	1
82	COURSERA	Software Development	Programming for Everybody (Getting Started with Python)	7 Weeks	1
83	COURSERA	Basic Science	Introduction to the Biology of Cancer	6 Weeks	1
84	COURSERA	Basic Science	Ecology: Ecosystem Dynamics and Conservation	5 Weeks	1
85	COURSERA	Basic Science	The Science of Stem Cells	5 Weeks	1

Those relevant courses were ratified and approved by the Board of Studies (BOS, Biotechnology), HIT-Haldia.

CONFIRMATION / APPROVAL

The proposed syllabus has been approved by the following Board of Study's Members:

BOS Members-Department of Biotechnology, Haldia Institute of Technology

No	Name	Designation	Affiliation	Email ID	Signature	Date
1	Prof. Suvroma Gupta	Professor and HOD	Dept. of Biotechnology,HIT, Haldia	suvroma.gupta@gmail.com		26/09/2022
2	Dr. Keya Sau	AssociateProf	Dept. of Biotechnology,HIT, Haldia	keyasau07@gmail.com		26/09/2022
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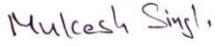
4	Dr. Mukesh Singh	Associate Prof	Dept. of Biotechnology,HIT, Haldia	msingh006@gmail.com		26/09/2022
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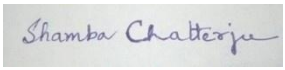
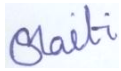
6	Dr. Shamba Chatterjee	Assistant Prof	Dept. of Biotechnology,HIT, Haldia	shamba.c@gmail.com		26/09/2022

7	Dr. Swati Maiti	Assistant Prof	Dept. of Biotechnology, HIT, Haldia	swatimaiti.bt@gmail.com		26/09/2022
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9	Mrs.Ahana Bhaduri	Assistant Prof	Dept. of Biotechnology, HIT, Haldia	ahana.bhaduri@gmail.com		26/09/2022
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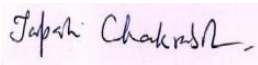
1	Prof. Tapati Chakraborti	Professor	Department of Biochemistry & Biophysics University of Kalyani, Kalyani	t_chakraborti@yahoo.com tcbiochem@gmail.com		26/09/2022
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