BANASTHALI VIDYAPITH

Bachelor of Technology (Biotechnology)

Curriculum Structure

First Semester Examination, December, 2020
Second Semester Examination, April/May, 2021
Third Semester Examination, December, 2021
Fourth Semester Examination, April/May, 2022
Fifth Semester Examination, December, 2022
Sixth Semester Examination, April/May, 2023
Seventh Semester Examination, December, 2023
Eighth Semester Examination, April/May, 2024

BANASTHALI VIDYAPITH
P.O. BANASTHALI VIDYAPITH
(Rajasthan)-304022

July, 2020

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No. F. 9-6/81-U.3

Government of India
Ministry of Education and Culture
(Department of Education)

New Delhi, the 25th October, 1983

N O T I F I C A T I O N

In exercise of the powers conferred by Section 3 of the University Grants Commission Act, 1956 (3 of 1956) the Central Government, on the advice of the Commission, hereby declare that Banasthali Vidyapith, P. O. Banasthali Vidyapith, (Rajasthan) shall be deemed to be a University for the purpose of the aforesaid Act.

Sd/-
(M. R. Kolhatkar)
Joint Secretary of the Government of India

N O T I C E

Changes in Bye-laws/Syllabi and Books may from time to time be made by amendment or remaking, and a Candidate shall, except in so far as the Vidyapith determines otherwise, comply with any change that applies to years she has not completed at the time of change.

Programme Educational Objectives

The B. Tech. Biotechnology programme aims at holistic development of the students through the unique and innovative five-fold educational ideology of Banasthali Vidyapith.

Biotechnology is an applied discipline of biological science that makes use of living organisms, its components and biological processes to create products and other technology based systems for the welfare of mankind. Past few decades have witnessed a steady growth towards invention and innovation oriented research/startups using biotechnology. Thus, the B. Tech Biotechnology programme has been designed to provide fundamental knowledge of biotechnology and engineering, which can be applied by the students to pursue higher studies or in related industries, to find solutions related to process and product development. It will sensitize the students towards the societal, environmental and ethical issues being faced by a biotechnologist. The key objectives of the programme are to:

- provide fundamental theoretical and practical knowledge of biotechnology to pursue higher education and professional careers
- help graduates to identify and analyze issues, which need biotechnological interventions and find solutions thereof
- sensitize students towards bioethics, IPR and biosafety issues
- inculcate the habit of working in a team with interdisciplinary approach
- develop scientific skills, temperament and communication skills, which will promote a lifelong learning
- nurture overall growth and development of the students.

Programme Outcomes

PO1: **Fundamental Knowledge:** Acquire fundamental knowledge of engineering and biotechnology, which include biochemistry, principles of chemical processes, data structures, biophysics and structural biology, object oriented programming, recombinant DNA technology, basic bioinformatics, animal and plant biotechnology, genetics and foundations courses.

PO2: **Planning ability:** Demonstrate effective planning abilities including conceptual skills, interpersonal skills, decision making and problem solving skills, time and resource management and organizational skills.

PO3: **Problem analysis:** Identify, devise, review research literatures, and analyze biotechnological/engineering problems to find justifiable solutions.

PO4: **Modern tool usage:** Understand, select and apply suitable tools and techniques with proper methodology together with computational tools with an understanding of their limitations.

PO5: **Leadership skills:** Inculcate the habit of working in a team keeping individual identity and gradually develop leadership skills in a multidisciplinary setting.

PO6: **Professional Identity:** Apply logics gained through conceptual knowledge to carry out responsibilities relevant to the professional engineering practice.

PO7: **Bioethics:** Understand the ethical implications of biological research, honour personal values and apply in profession/research/society. Understand what is wrong and right, make decision and take responsibilities associated with the outcome.

PO8: **Communication:** Communicate effectively on intricate engineering/biotechnological issues with the engineering community and with society like, being able to interpret and write effective reports/ document, deliver effective presentations, and correspond through clear instructions.

PO9: **The biotechnologist and society:** Apply proper reasoning through fundamental concepts to assess societal, environmental, health, safety and legal issues and the consequent responsibilities relevant to the professional biotechnological practice.

PO10: **Environment and sustainability:** Understand the significance of ecosystem and its impact on living organisms and search for eco-friendly solutions for sustainable development.

PO11: **Life- long learning:** Recognize the necessity of independent and life-long learning, self assessment, and individual development through introspection and feedback from peers in the broadest context of technological change.

Curriculum Structure
Bachelor of Technology
(Biotechnology)

Semester - I

Course	Code	Course Name	L	T	P	C*
BVF	011/	General English/सामान्य हिन्दी	2	0	0	2
BVF	014					
		Core Foundation Course-I	2	0	0	2
MATH	103/	Calculus/Linear Algebra	3	1	0	4
MATH	107					
PHY	101/	Applied Optics/Modern Physics	3	1	0	4
PHY	106					
CHEM	101/	Chemistry/Biology	3	1	0	4
BIO	101					
CHE	102/	Thermodynamics/Engineering Mechanics	3	1	0	4
PHY	109/					
CS	109/	Computer Fundamentals and Programming	4	0	0	4
EEE	101/	Electrical Engineering				
CS	109L/	Computer Fundamentals and Programming	0	0	4	2
EEE	101L	Lab/Electrical Engineering Lab				
ENGG	101L/	Engineering Drawing and Graphics Lab/	0	0	6	3
ENGG	103L	Measurement Techniques Lab				
		Semester Total:	**20**	**4**	**10**	**29**

Semester - II

Course	Code	Course Name	L	T	P	C*
BVF	014/	सामान्य हिन्दी /General English	2	0	0	2
BVF	011					
		Core Foundation Course-II	2	0	0	2
MATH	107/	Linear Algebra/Calculus	3	1	0	4
MATH	103					
PHY	106/	Modern Physics/Applied Optics	3	1	0	4
PHY	101					
BIO	101/	Biology/Chemistry	3	1	0	4
CHEM	101					
PHY	109/	Engineering Mechanics/Thermodynamics	3	1	0	4
CHE	102					
EEE	101/	Electrical Engineering/	4	0	0	4
CS	109	Computer Fundamentals and Programming				
EEE	101L/	Electrical Engineering Lab/ Computer	0	0	4	2
CS	109L	Fundamentals and Programming Lab				
ENGG	103L/	Measurement Techniques Lab/	0	0	6	3
ENGG	101L	Engineering Drawing and Graphics Lab				
		Semester Total:	**20**	**4**	**10**	**29**

Semester - III

Course	Code	Course Name	L	T	P	C*
		Core Foundation Course-III	2	0	0	2
		Elective Foundation Course-I	2	0	0	2
MATH / MATH	209/ 210	Complex Variables/Differential Equations	3	1	0	4
ENGG / ENGG	201/ 202	Structure and Properties of Materials/ Basic Electronics	4	0	0	4
CS	209	Data Structures	4	0	0	4
CS	209L	Data Structures Lab	0	0	4	2
CHEM	203	Principles of Chemical Processes	3	1	0	4
BT	201	Biochemistry	3	1	0	4
BT	208S	Seminar	0	0	2	1
BT	204L	Biotechnology Lab-I	0	0	4	2
		Semester Total:	**21**	**3**	**10**	**29**

Semester - IV

Course	Code	Course Name	L	T	P	C*
		Core Foundation Course-IV	2	0	0	2
		Elective Foundation Course-II	2	0	0	2
MATH / MATH	210/ 209	Differential Equations/Complex Variables	3	1	0	4
ENGG / ENGG	202/ 201	Basic Electronics/ Structure and Properties of Materials	4	0	0	4
CS	214	Object Oriented Programming	4	0	0	4
CS	214L	Object Oriented Programming Lab	0	0	4	2
BT	203	Biophysics and Structural Biology	3	1	0	4
BT	206	Cell and Molecular Biology-II	3	1	0	4
BT	205L	Biotechnology Lab-II	0	0	4	2
		Semester Total:	**21**	**3**	**8**	**28**

Semester - V

Course Code	Course Name	L	T	P	C*
	Vocational Course-I	2	0	0	2
	Core Foundation Course-V/ Elective Foundation Course-III	2	0	0	2
ECO 307/ MGMT 310	Fundamentals of Economics/ Principles of Management	3	0	0	3
STAT 204	Probability and Statistical Methods	3	1	0	4
BT 310	Microbiology and Immunology	3	1	0	4
BT 309	Metabolic Engineering	3	1	0	4
BT 308	Genetics and Genetic Engineering	3	1	0	4
BT 303L	Biotechnology Lab-III	0	0	8	4
	Semester Total:	**19**	**4**	**8**	**27**

Semester - VI

Course Code	Course Name	L	T	P	C*
	Vocational Course-II	2	0	0	2
	Elective Foundation Course-III/ Core Foundation Course-V	2	0	0	2
MGMT 310/ ECO 307	Principles of Management/ Fundamentals of Economics	3	0	0	3
CHEM 301	Analytical Techniques	3	1	0	4
CHEM 301L	Analytical Techniques Lab	0	0	4	2
BIN 301	Basic Bioinformatics	3	1	0	4
BT 302	Bioprocess Engineering	3	1	0	4
BT 311	Recombinant DNA Technology	3	1	0	4
BT 314L	Biotechnology Lab-IV	0	0	8	4
	Semester Total:	**19**	**4**	**12**	**29**

Semester - VII

Course Code		Course Name	L	T	P	C*
		Reading Elective	0	0	4	2
BT	431P	Project	0	0	48	24
		Semester Total:	**0**	**0**	**52**	**26**

Semester - VIII

Course Code		Course Name	L	T	P	C*
BT	418	Animal Biotechnology	3	1	0	4
BT	405	Environmental Biotechnology	3	1	0	4
BT	429	Plant Biotechnology	3	1	0	4
BT	421L	Biotechnology Lab-V	0	0	8	4
		Discipline Elective	4	0	0	4
		Open Elective	4	0	0	4
		Semester Total:	**17**	**3**	**8**	**24**

List of Discipline Elective

Course Code		Course Name	L	T	P	C*
BT	420	Biomedicial Engineering	4	0	0	4
BT	422	Food and Dairy Biotechnology	4	0	0	4
BT	423	Genomics and Proteomics	4	0	0	4
BT	424	Immunotechnology	4	0	0	4
BT	425	Microbial Technology	4	0	0	4
BT	427	Molecular Modelling and Drug Designing	4	0	0	4
BT	428	Nanotechnology	4	0	0	4
BT	430	Plant Secondary Metabolites	4	0	0	4
RS	401	Geoinformatics	4	0	0	4
BT	433	Bioethics and Biosafety	4	0	0	4
BT	316	Enzyme Engineering and Technology	4	0	0	4

List of Reading Elective

Course Code		Course Name	L	T	P	C*
BT	426R	Molecular Diagnostics	0	0	4	2
BIO	601R	Biodiversity and Conservation	0	0	4	2
BT	432R	Emerging Trends in Biofuel Technology	0	0	4	2

Online Discipline Elective Courses

Course Name
Bioreactor
Principles of Downstream techniques in Bioprocess
Industrial Biotechnology

Online Reading Elective courses

Course Name
Drug Discovery
Proteins and Gel-Based Proteomics
Online course on IPR

List of Core Foundation Courses

Course Code		Course Name	L	T	P	C
BVF	002	Environment Studies	2	0	0	2
BVF	013	Indian Cultural Heritage	2	0	0	2
BVF	017	Selected Writings of Great Authors-I	2	0	0	2
BVF	020	Women in Indian Society	2	0	0	2
BVF	015	Parenthood and Family Relation	2	0	0	2

List of Elective Foundation Courses

Course Code		Course Name	L	T	P	C
BVF	016	Science of Happiness	2	0	0	2
BVF	012	Human Body and Health	2	0	0	2
BVF	010	Design Thinking	2	0	0	2
BVF	019	Universal Human Values	2	0	0	2
BVF	018	Selected Writings of Great Authors-II	2	0	0	2

List of Vocational Courses

Course Code		Course Name	L	T	P	C
VOC	011	Basic Dress Making	0	0	4	2
VOC	005L	Dress Designing	0	0	4	2
VOC	014	Entrepreneurship - I	2	0	0	2
VOC	015	Entrepreneurship - II	2	0	0	2
VOC	020	Radio Production - I	2	0	0	2
VOC	021	Radio Production - II	2	0	0	2
VOC	022	Web Designing and Internet Technology-I	1	0	0	1
VOC	022L	Web Designing and Internet Technology-I Lab	0	0	2	1
VOC	023	Web Designing and Internet Technology-II	1	0	0	1
VOC	023L	Web Designing and Internet Technology-II Lab	0	0	2	1
VOC	009	Library Science - I	1	0	0	1
VOC	009L	Library Science - I Lab	0	0	2	1
VOC	010	Library Science - II	1	0	0	1
VOC	010L	Library Science - II Lab	0	0	2	1
VOC	018	Photography – I	0	0	4	2
VOC	019	Photography - II	0	0	4	2
VOC	016	Introduction to Artificial Intelligence - I	2	0	0	2
VOC	017	Introduction to Artificial Intelligence - II	2	0	0	2
VOC	012	Computer Assisted Learning and Teaching	1	0	0	1
VOC	012L	Computer Assisted Learning and Teaching Lab	0	0	2	1
VOC	013	Emerging Technologies for Learning and Teaching	2	0	0	2

1. Student can opt for at most 2 additional Open (Generic) audit/credit Elective from other disciplines opting at most 1 per semester from Semesters III onwards with prior permission of respective heads and time table permiting.

2. Every Student shall also opt for:
   Five Fold Education: Physical Education I, Physical Education II,
   Five Fold Education: Aesthetic Education I, Aesthetic Education II,
   Five Fold Education: Practical Education I, Practical Education II
   one each semester

*** L - Lecture hrs/week ; T - Tutorial hrs/week;**
P - Project/Practical/Lab/All other non-classroom academic activities, etc. hrs/week; C- Credit Points of the Course

Note: Syllabus of Foundation and Vocational courses are available in separate booklet, "Curriculum Structure and Syllabus Foundation and Vocational Courses"

Project Evaluation Scheme

Duration	Course Code	Course Name	L	T	P	C
1 Semester (5 months) 1 Jul-30 Nov	BT 431P	Project	0	0	48	24

Continuous Assessment (40 Marks)

1. Joining report, brief project outlay	- 10 Marks
2. Synopsis	- 10 Marks
3. Mid-term evaluation by Supervisor	- 10 Marks
4. Further evaluation by Supervisor	- 10 Marks
Total	**- 40 Marks**

End Semester Assessment (60 Marks)

1. Project Report	- 20 marks
2. Presentation	- 20 Marks
3. Viva-voce	- 20 Marks
Total	**- 60 Marks**

Five Fold Activities

Aesthetic Education I/II		Physical Education I/II	
BVFF 101	Classical Dance (Bharatnatyam)	BVFF 201	Aerobics
BVFF 102	Classical Dance (Kathak)	BVFF 202	Archery
BVFF 103	Classical Dance (Manipuri)	BVFF 203	Athletics
BVFF 104	Creative Art	BVFF 204	Badminton
BVFF 105	Folk Dance	BVFF 205	Basketball
BVFF 106	Music-Instrumental (Guitar)	BVFF 206	Cricket
BVFF 107	Music-Instrumental (Orchestra)	BVFF 207	Equestrian
BVFF 108	Music-Instrumental (Sarod)	BVFF 208	Flying - Flight Radio Telephone Operator's Licence (Restricted)
BVFF 109	Music-Instrumental (Sitar)	BVFF 209	Flying - Student Pilot's Licence
BVFF 110	Music-Instrumental (Tabla)	BVFF 229	Aeromodelling
BVFF 111	Music-Instrumental (Violin)	BVFF 210	Football
BVFF 112	Music-Vocal	BVFF 211	Gymnastics
BVFF 113	Theatre	BVFF 212	Handball
Practical Education I/II		BVFF 213	Hockey
BVFF 301	Banasthali Sewa Dal	BVFF 214	Judo
BVFF 302	Extension Programs for Women Empowerment	BVFF 215	Kabaddi
BVFF 303	FM Radio	BVFF 216	Karate - Do
BVFF 304	Informal Education	BVFF 217	Kho-Kho
BVFF 305	National Service Scheme	BVFF 218	Net Ball
BVFF 306	National Cadet Corps	BVFF 219	Rope Mallakhamb
		BVFF 220	Shooting
		BVFF 221	Soft Ball
		BVFF 222	Swimming
		BVFF 223	Table Tennis
		BVFF 224	Tennis
		BVFF 225	Throwball
		BVFF 226	Volleyball
		BVFF 227	Weight Training
		BVFF 228	Yoga

Every Student shall also opt for:
Five Fold Education: Physical Education I, Physical Education II,
Five Fold Education: Aesthetic Education I, Aesthetic Education II,
Five Fold Education: Practical Education I, Practical Education II
one each semester

Evaluation Scheme and Grading System

Continuous Assessment (CA) (Max. Marks)					End-Semester Assessment (ESA) (Max. Marks)	Grand Total (Max. Marks)
Assignment		Periodical Test		Total (CA)		
I	II	I	II			
10	10	10	10	40	60	100

In all theory, laboratory and other non classroom activities (project, dissertation, seminar, etc.), the Continuous and End-semester assessment will be of 40 and 60 marks respectively. However, for Reading Elective, only End semester exam of 100 marks will be held. Wherever desired, the detailed breakup of continuous assessment marks (40), for project, practical, dissertation, seminar, etc shall be announced by respective departments in respective student handouts.

Based on the cumulative performance in the continuous and end-semester assessments, the grade obtained by the student in each course shall be awarded. The classification of grades is as under:

Letter Grade	Grade Point	Narration
O	10	Outstanding
A+	9	Excellent
A	8	Very Good
B+	7	Good
B	6	Above Average
C+	5	Average
C	4	Below Average
D	3	Marginal
E	2	Exposed
NC	0	Not Cleared

Based on the obtained grades, the Semester Grade Point Average shall be computed as under:

$$SGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of courses (with letter grading) registered in the semester, CC_i are the course credits attached to the i^{th} course with letter grading and GP_i is the letter grade point obtained in the i^{th} course. The courses which are given Non-Letter Grades are not considered in the calculation of SGPA.

The Cumulative Grade Point Average (CGPA) at the end of each semester shall be computed as under:

$$CGPA = \frac{CC_1 * GP_1 + CC_2 * GP_2 + CC_3 * GP_3 + ---- + CC_n * GP_n}{CC_1 + CC_2 + CC_3 + ---- + CC_n} = \frac{\sum_{i=1}^{n} CC_i * GP_i}{\sum_{i=1}^{n} CC_i}$$

Where n is the number of all the courses (with letter grading) that a student has taken up to the previous semester.

Student shall be required to maintain a minimum of 4.00 CGPA at the end of each semester. If a student's CGPA remains below 4.00 in two consecutive semesters, then the student will be placed under probation and the case will be referred to Academic Performance Review Committee (APRC) which will decide the course load of the student for successive semester till the student comes out of the probationary clause.

To clear a course of a degree program, a student should obtain letter grade C and above. However, D/E grade in two/one of the courses throughout the UG/PG degree program respectively shall be deemed to have cleared the respective course(s). The excess of two/one D/E course(s) in UG/PG degree program shall become the backlog course(s) and the student will be required to repeat and clear them in successive semester(s) by obtaining grade C or above.

After successfully clearing all the courses of the degree program, the student shall be awarded division as per following table.

Division	CGPA
Distinction	7.50 and above
First Division	6.00 to 7.49
Second Division	5.00 to 5.99
Pass	4.00 to 4.99

CGPA to % Conversion Formula: % of Marks Obtained = CGPA * 10

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First and Second Semester

MATH 103 Calculus

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes:

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

- Uefine limit, infinite series and sequence of partial sums of an infinite series, Convergence and Divergence of an infinite series.
- Relate the limit of a function at a point to the limit of a sequence at that point and tell when a function will fail to have a limit at a point.
- Uefine monotonic functions and find a connection between monotonicity of a function and derivative of a function.
- Umonstrate the concept of Divergence, Curl, Green's theorem, Stokes's theorem.

Section A

Sequences, series, test for convergence, power series, radius of convergence; limit, continuity and differentiability (analytic definitions with simple examples); Rolle's Theorem, mean value theorem and Taylor's theorem; Successive differentiation: Leibnitz' theorem (without proof).

Section B

Review of vectors, Cylinders and quadric surfaces, Vector functions of one variable and their derivatives,Partial derivatives: Chain rule, exact differentials, Gradient, Directional derivative, Tangent planes and normals, Maxima and minima (two variables) including Lagrange's multipliers, Asymptotes and Curve tracing.

Section C

Riemann integral and the fundamental theorem of integral calculus, Reduction Formulae, Multiple integrals, Applications to multiple integrals to find length, area, surface area, volume, surface area of revolution, Improper integral.

Vector fields, Surface integral, Line integral, Independence of path, Conservative fields, Divergence, Curl, Green's theorem, Stokes's theorem.

Suggested Books:

1. Thomas, G.B., Weir, M.D., & Hass, J. (2011). *Thomas' Calculus* (11th ed.).Boston, MA: Pearson Education, Inc.
2. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (9th ed.). Hoboken, NJ : John Wiley & Sons, Inc.
3. Apostol, T.M. (1980). *Calculus* (2nded.). New York, NY: John Wiley & Sons, Inc.
4. Grewal, B.S., & Grewal, J.S. (2012). Higher Engineering Mathematics (42thed.). India, Delhi: Khanna Publishers.

Suggested E-learning material:

1. Differentiation and Integration of Vector Functions

   http://vle.du.ac.in/pluginfile.php/837/mod_resource/content/0/Differentiation%20and%20Integration%20of%20Vector%20Functions.pdf
2. Mean Value Theorems

   http://vle.du.ac.in/pluginfile.php/844/mod_resource/content/0/Mean%20Value%20Theorems.pdf
3. Infinite Series

   http://vle.du.ac.in/pluginfile.php/861/mod_resource/content/0/Infinite%20Series.pdf

MATH 107 Linear Algebra

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

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

- Define basic terms and concepts of matrices, vectors and complex numbers
- Use basic vector space concepts such as linear space, linear dependence, basis, dimension, linear transformation;
- Be familiar with the concepts of eigenvalue, eigenspace and eigenvector and know how to compute these objects;

- Use the characteristic polynomial to compute the eigenvalues and eigenvectors of a square matrix and use them to diagonalise matrices when this is possible; discriminate between 19iagonalizable and non-diagonalisable matrices.
- Use gauss-jordan elimination to solve systems of linear equations and to compute the inverse of an invertible matrix

Section A

Vectors, Algebra of vectors, vector spaces, subspaces, Linear sum and direct sum of subspaces, Linear combination, Linear span, Linear dependence and independence of vectors and its properties. Basis and dimension of vector space and subspace. Linear mappings, Kernel and Range of linear mapping, Singular and non-singular mappings.

Section B

Linear operator, Algebra of linear operators, Invertible operators, Matrix representation of a linear transformation, Change of basis, Range, rank and Kernel, nullity of a matrix, Elementary transformations, Matrix inversion with elementary transformations, Normal form of a matrix, System of linear equations.

Section C

Characteristics polynomial of a matrix, Characteristics values, Characteristics vector, Cayley-Hamilton theorem, Diagonalization of Matrices, Properties of characteristic values and characteristic vectors of Hermitian, skew-Hermitian, Unitary and Normal matrices (including Symmetric, Skew-symmetric and Orthogonal matrices).

Inner product spaces, Orthogonality, Orthogonal sets and bases, Gram-Schmidt orthogonalization process.

Suggested Books:

1. Axler, S. J. (1996*). Linear algebra done right*. New York: Springer.
2. Krishnamurthy, V., Mainra, V. P., & Arora, J. L. (1976). *An introduction to linear algebra*. New Delhi: East-West Press.
3. Friedberg, S. H., Insel, A. J., Spence, L. E., & Thiel, L. (2017). *Linear algebra*. Pearson Education.

4. Halmos, P. R. (2013). *Linear Algebra Problem Book*. Cambridge: Cambridge University Press.
5. Kumaresan, S. (2000). *Linear Algebra: A Geometric Approach*. New Delhi: Prentice-Hall (India).

Suggested E-learning material:

1. Lecture notes on linear Algebra
   https://nptel.ac.in/downloads/111102011/
2. Videos on Linear Algebra topics
   http://web.mit.edu/18.06/www/videos.shtml

PHY 101 Applied Optics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

Upon successful completion, students will have the knowledge and skills to:

- Appreciate the efficacy of Fourier transforms and their application to physical systems.
- Understand linear, time-invariant systems.
- Understand the role of the wave equation and appreciate the universal nature of wave motion in a range of physical systems
- Understand dispersion in waves and model dispersion using Fourier theory.
- Understand diffraction and imaging in terms of Fourier optics and gain physical and intuitive insight in a range of physics.

Syllabus

Section A

Wave Optics- Interference: Superposition of Waves, Theory and method of measurement of wavelength of light and thickness of a thin transparent plate using Fresnel's Bi-prism, Interference in thin films, Newton's rings, Michelson's Interferometer,

Diffraction I: Fraunhofer's diffraction due to single slit, two parallel slits and N slits.

Section B

Diffraction II: Diffraction by plane transmission Grating (PTG), Characteristics of Grating Spectra, Measurement of Wavelength of light using PTG, Concept of resolving power, Rayleigh's criterion of resolving limit, Resolving power of a Grating, Diffraction of X-rays and Bragg's law.

Polarization: Production and detection of plane, Circularly and elliptically polarized light, theory of the polarized light, Optical Activity, Fresnel's Explanation for optical rotation, Measurement of Specific rotation of a cane sugar solution using a Half Shade and a biquartz device polarimeter.

Section C

Modern Optics-Lasers : Spontaneous & Stimulates Emission, Einstein's Coefficient, Criterion of Laser action, Ruby and He-Ne Lasers, Characteristics of Laser light, Application of Laser with special emphasis on Holography.

Optical Fiber: Elementary idea of optical fiber, Light wave communication using optical fibers, Types of optical fibers, Step Index (Single mode and Multi mode) and Graded Index fiber, Light Propagation through optical fiber,

Ray Optics: Critical angle, Total internal reflection, Aceptance angle, Numerical aperture of an optical fiber.

Recommended Books:

1. Prakash S., Verma A. S., Gupta S. K. and Alvi P. A. (2015) A textbook of Optics and Modern Physics, Pragati Prakashan Meerut.
2. Allen S. R. (1997) An introducton to Fiber Optics, PHI
3. Seth S. P. (2007) Elements of Electromagnetic Field, Dhanpat Rai & Company.
4. Ghatak A. (2005) Optics, Tata McGraw hill publication
5. Beynon (1996) Introductory University optics, Prentice Hall of India Pvt. Ltd.
6. Thyagarajan and Ghatak (1981) Lasers Theory and Applications: Macmillan India Ltd
7. Senior John M. (2005) An introduction to Fiber Optics, PHI
8. Sadiku M. N. O (2007) Elements of Electromagnetics, Oxford University Press.

Suggested e-resources:

https://nptel.ac.in/course.php

PHY 106 Modern Physics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

Upon successful completion, students will have the knowledge and skills to:

- Development of an understanding of the interrelationships of science, eengineering and technology.
- Will have skill for problem solving and engineering skills, which then has broad applications.
- Will have a career paths for Engineering physics are usually (broadly) "engineering, applied science or applied physics through research, teaching or entrepreneurial engineering". This interdisciplinary knowledge is designed for the continuous innovation occurring with technology.
- Will have strong ground to provide a more thorough grounding in applied physics of any area chosen by the student (such as nanotechnology, mechanical engineering, electrical engineering, control theory, aerodynamics, or solid-state physics).

Section A

Special Theory of Relativity: Inertial and non-inertial frames of reference, postulates of special theory of relativity, Lorentz Transformations, Relativity of mass, length, time and velocity, Mass energy relation, energy momentum relation;

Wave Mechanics: Compton effect as evidence of quantum nature of radiation, Heisenberg's uncertainty principle, Time dependent & Time independent (Steady State) form of the Schrödinger equation, Solution of Schrodinger equation for free particle in a one dimension box and Potential step.

Section B

Free-electron model of metals, Origin of Bands in solids (Kronig-Penny model), E-k diagram, classification of solids as metal, semiconductors and insulators, Density of energy states and Fermi energy, Crystal structures of Si, Ge and GaAs, Electrical resistivity of semiconductors.

Superconductivity: Introduction, Types of superconductors, Properties of superconductors, Meisner effect, Joshephson effect, BCS theory of superconductivity (no derivation) only qualitative discussion, High Temperature superconductors, Applications of superconductors.

Section C

Dielectric Materials: Dielectric Constant, Type of Dielectrics, Polarization of Dielectrics, Polarization density, Relation between dielectric constant and electric susceptibility, Types of Polarization (Electronic polarization, ionic polarization, orientation polarization), Clausius-Mosotti Equation, **Nuclear Physics**: Nuclear Binding Energy, Fission and Fusion Reactions, Construction, theory and applications of Geiger Muller Counter , Proportional and Scintillation Counter.

Recommended Books:

1. Beiser, A. (2003). Concepts of modern physics. Tata McGraw-Hill Education.
2. Krane, K. S. (1995). Modern physics. Modern Physics, 2nd Edition, by Kenneth S. Krane,. ISBN 0-471-82872-6. Wiley-VCH, August 1995.,
3. Birkhoff, G. D., & Langer, R. E. (1923). Relativity and modern physics. Harvard University Press.
4. Leighton, R. B., & Leighton, R. B. (1959). Principles of modern physics (Vol. 795). New York: McGraw-Hill.
5. Prakash S., Verma A. S., Gupta S. K. and Alvi P. A. (2015) A textbook of Optics and Modern Physics, Pragati Prakashan Meerut
6. Raghuvanshi (2008) Engineering Physics, Tata Mc Hill

Suggested e-resources:

https://nptel.ac.in/course.php

CHEM 101 Chemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

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

- explain the basics of atomic structure and chemical bonding.
- explain the behavior of the system through phase, degree of freedom and component.
- explain the basics of electrochemistry, different type of corrosion and their prevention.

- differentiate nanoscience, nanotechnology, nanochemistry, conventional and non-conventional energy sources and their applications.

Section A

Atomic Structure: Introduction, Schrodinger wave equation, significance of Ψ and Ψ^2, quantum numbers, radial and angular wave function , probability distribution curves, shapes of *s, p, d* orbitals. Aufbau and Pauli principles, Hund's multiplicity rule, fiiling of electron upto 71 elements, exchange energy, pairing energy, symmetrical distribution of charge, extra stability of half-filled and completely-filled orbitals, Slater's rules for evaluation of shielding constant and effective nuclear charge.

Covalent bond: Introduction, Valence bond theory and its limitations, directional characteristics of covalent bond, various types of hybridization and shapes of simple inorganic molecules and ions, valence shell electron pair repulsion (VSEPR) theory with reference to $BeCl_2$, $SnCl_2$, BF_3, BF_4^-, NH_3, H_2O, H_3O^+, PCl_5, SF_4, CIF_3, I_3^-, SF_6, IF_7, ICI_2^-, and $POCl_3$; MO theory, sigma and pi Molecular orbitals theory, homonuclear and heteronuclear (CO, NO) diatomic molecules and their ions.

Section B

Electrochemistry: Electric transport in electrolytic solutions, specific conductance and equivalent conductance, measurement of equivalent conductance, variation of equivalent and specific conductance with dilution, migration of ions and Kohlrausch law, Arrhenius theory of electrolyte dissociation and its uses and limitations, Debye-Huckel-Onsager's equation for strong electrolytes (elementary treatment only), applications of conductivity measurement: determination of degree of dissociation, determination of K_a of acids, determination of solubility product of sparingly soluble salt, conductometric titrations.

Phase Rule: Phase, component, degree of freedom or variance; phase diagram of one-component system: -water system, sulphur system, CO_2 system, phase rule for two-component system: reduced phase rule, eutectic point., Pb-Ag system and its applications.

Corrosion: Definition, types (Dry, Wet, Pitting, Stressed, Galvanic Cell, Water Line and Concentration Cell Corrosion), its significance, Mechanisms of corrosion, Protection from corrosion: Protective coatings, Cathodic protection, sacrificial anode and Modification in designs etc.

Section C

Water: Hardness, types of Hardness, Degree of hardness, determination of hardness by Clark's test and Complex metric (EDTA) method, degree of hardness, numerical based on EDTA and Clark's method, Boiler troubles their causes, disadvantages and prevention, Formation of solids (Scale and Sludge), Carry over (Priming and Foaming), Corrosion and Caustic Embrittlement, Advanced methods of water starelization, Softening of water by Lime-Soda Method, Permutit (Zeolite) Method and Deionization or Demineralization Method, Numerical problems based on Lime-Soda and Zeolite softening methods

Organic Electronic Materials: Introduction**,** classification, factor affecting the conductivity of polymers, Applications.

Optical fires: Introduction, properties, preparation, optical fiber grade glass and uses.

Non-conventional energy: Introduction of solar energy, Application of solar energy, Photovoltaic cell, conversion of solar energy, Biofuel and biomass, Superiority of non-conventional source of energy over conventional energy.

Recommended Books:

1. B.R. Puri and L.R. Sharma & K.C. Kalia (2017), *Principles of Inorganic Chemistry*, 33rd Ed.,Vishal Publications.
2. L.R Sharma, M.S Pathania B.R Puri and Navjot Kaur (2018), A Textbook of Physical Chemistry, Vishal Publications.
3. W. U. Malik, G.D.Tuli & R. D. Madan (2010), *Selected Topics in Inorganic Chemistry*, Revised Ed., S. Chand Publications.
4. Gurdeep Raj(2014), Advanced Physical Chemistry, goel publications.

5. J.D. Lee (1998), *Concise Inorganic Chemistry*, 5th Ed, Oxford Publications.
6. F. A. Cotton and G. Wilkinson (1994), *Basic Inorganic Chemistry*,3rd Ed., John Wiley Publications.
7. P. Bhagchandani (2017), *Inorganic* Chemistry, Sahitya Bhawan Publications.
8. S.S. Dara and S.S.Umare (2004), Textbook of Engineering Chemistry, S. Chand Publications.

Suggested e-Sources:

1. National Programme on Technology Enhanced Learning
   https://nptel.ac.in
2. Online Chemistry Courses
   https://www.edx.org/learn/chemistry
3. Free Online Education SWAYAM
   https://swayam.gov.in

BIO 101 Biology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the basic organization and classification of living organisms.
- gain broad understanding of cellular functions.
- understand the fundamental concepts of molecular biology and recombinant DNA technology.

Section A

- Brief idea of origin of life, Viruses (TMV, HIV, Bacteriophages), overview and brief introduction to five kingdom classification, characteristic features of Protista, Plantae and Animalia.

- Morphology and functions of different parts of flowering plants: Root, stem, leaf, major inflorescence (Spike, Raceme, Corymb and Umbel), flower, fruit and seed.
- Brief about the components and functions of different systems of humans.

Section B

- The cell concept, prokaryotic (Bacteria, cell structure) and eukaryotic cell (plant and animal cell). Cell organelles and their functions.
- Brief introduction and significance of carbohydrates, lipids, proteins and enzymes.
- Mendelian inheritance, chromosome theory of inheritance, deviations from mendelian ratio (Incomplete dominance, co-dominance, complementary genes, multiple alleles). Linkage and crossing over, sex determination, sex linked inheritance, genetic counseling.

Section C

- Structure and replication of DNA, structure of RNA and brief concept of transcription and translation in prokaryotes and comparison with eukaryotes, Genetic code, Basic concept of recombinant DNA Technology and its applications. Overview of Human Genome Project, Biosafety issues.

Suggested Books:

- Green, N. P. O., Stout, G. W., Taylor, D. J. & Soper, R. (2005). *Biological Sciences*. Cambridge University Press.
- Reece, J. B., Urry, L. A., Cain, M. L., Wasserman, S. A., Minorsky, P. V., & Jackson, R.B. (2013). *Campbell Biology*. Pearson Publisher, India.

Suggested e-Resources:

- **Structural organization of plants and animals** https://www.emedicalprep.com/study-material/biology/structural-organization-in-plants-and-animals/

- **Morphology, anatomy and functions of different systems of humans:**

  https://www.khanacademy.org/science/high-school-biology/hs-human-body-systems/hs-body-structure-and-homeostasis/a/tissues-organs-organ-systems

- **Basic concept of cell**

  https://biologydictionary.net/cell/

- **Gene-gene interaction** http://www.biologydiscussion.com/genetics/gene-interactions/gene-interactions-allelic-and-non-allelic-cell-biology/38795

- **Human genome project**

  https://www.genome.gov/12011238/an-overview-of-the-human-genome-project/

- **Application of recombinant DNA technology:**

  https://medcraveonline.com/JABB/JABB-01-00013

CHE 102 Thermodynamics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning outcomes:

The students will be able to:

- Carryout thermodynamic analysis of real systems.
- Carryout thermodynamic analysis multiphase systems with chemical changes.
- Understand thermodynamic functions and their relationships

Section A

Definition, significance and limitations, Classical versus statistical thermodynamics, definition of thermodynamic terms: system, surroundings etc., types of systems, intensive and extensive properties, state and path functions and their differentials, Euler reciprocity relation and cyclic rule, thermodynamic process, concept of heat and work.

First law of thermodynamics: statement, definition of internal energy and enthalpy, heat capacity-heat capacities at constant volume and pressure and their relationship, Bomb calorimeter, Joule's Law, Joule-Thomson coefficient and inversion temperature, calculation of w, q, ΔU & ΔH for the expansion of ideal gases under isothermal and adiabatic conditions for reversible process, application of first law of thermodynamics in closed systems, zeroth law of thermodynamics and the absolute temperature scale.

Section B

Thermochemistry: Heat of reaction at constant pressure and at constant volume, Hess's law of heat summation and its application, temperature dependence of enthalpy (Kirchhoff's equation), bond dissociation energy and its calculation from thermo-chemical data,

Second law of Thermodynamics: need for the law, different statements of the law, Carnot cycle and its efficiency, Carnot theorem, Heat Engine, Efficiencies, thermodynamic scale of temperature.

Concept of Entropy: Entropy as a state function, entropy as a function of V & T, entropy as a function of P & T, entropy change in physical change, Clausius inequality, entropy as a criteria of spontaneity and equilibrium, entropy change in ideal gases and mixing of gases.

Section C

Thermodynamic Relations: Maxwell's equations, TdS equations, difference in heat capacities, ratio of heat capacities, energy equations, Joule-Kelvin effect, Clausius-Clapeyron equation.

Third law of Thermodynamics: Nernst heat theorem, statement and concept of residual entropy, evaluation of absolute entropy from heat capacity data, Gibb's and Helmholtz functions: Gibbs-Helmholtz equation, Gibbs function (G) and Helmholtz function (A) as thermodynamic quantities, A & G as criteria for thermodynamic equilibrium and spontaneity, their advantage over entropy change, variation of G and A with P, V and T.

Recommended Books:

1. Atkins, P. W., & De, P. J. (2006). Atkins' physical chemistry. Oxford: Oxford University Press.
2. Puri, S., Sharma, R. L., & Pathania M. S. (2004). Principles of physical chemistry. Vishal Publishing Co.
3. Sharma, K. K., & Sharma, L. K. (1977). A textbook of physical chemistry. Vikas Publishing House.
4. P. K. Nag (2009). Basic & applied thermodynamics. Tata McGraw Hill.
5. Van Ness, H. C. (1983). Understanding thermodynamics. Courier Corporation.
6. Van Wylen, G. J., & Sonntag, R. E. (1985). Fundamentals of classical thermodynamics. New York: Wiley.

E-resource(s): https://nptel.ac.in

PHY 109 Engineering Mechanics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

Upon successful completion, students will have the knowledge and skills to:

- Students will demonstrate proficiency in mathematics and the mathematical concepts needed for a proper understanding of physics.
- Students will show that they have learned concept of Newtonian mechanics and kinematics.
- Students will be capable of oral and written scientific communication, and will prove that they can think critically and work independently

Section A

System of forces, Fundamental laws of mechanics, Composition of forces, Free body diagram, Lami's theorem, Moments and couple, Varignon's theorem, Condition of equilibrium, Types of support and loading, Reaction, Analysis of simple trusses by methods of joints and methods of sections.

The laws of Coulomb friction, Ladder, wedges, Belt friction and rolling, Principle of virtual work and its applications.

Section B

Location of centroid and center of gravity, area moment of inertia, mass moment of inertia law of mechanics, Variation of mechanical advantages, efficiency, reversibility of machine Pulleys, wheel and axle, wheel and differential axle, Transmission of power through a belt and rope, Moment of inertia of masses- Transfer formula for mass moments of inertia- Mass moment of inertia of composite bodies.

Section C

Kinematics of a Particle: Rectilinear motion, plane curvilinear motion, Projectile motion, Constrained motion of connected particles.

Dynamics of Particles and Rigid Body: Newton's Law of motion, D'Alembert's principle.

Work & energy: Work, Energy (Potential, kinetic and spring), Work-Energy relation, Law of conservation of energy,

Impulse & momentum: Impulse, momentum, Impulse-momentum relation, Impact

Vibration: Definitions, Concepts- simple harmonic motion-free vibrations-simple and compound pendulums-torsional vibrations.

Recommended Books:

1. Kumar D. S. (2009) Engineering Mechanics, Laxmi Publication
2. Dubey N. H (2015) Engineering Mechanics, McGraw Hill Edu
3. Sharma M. (2009) Engineering Mechanics, CBH
4. Sharma (2009) Mechanics, Pearson

Suggested e-resources:

https://nptel.ac.in/course.php

CS 109 Computer Fundamentals and Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- Describe the concepts of computer basics and programming.

- Explain the organization and operations of a computer system.
- Design the combinational and sequential circuits.
- Employ the logical thinking for analyzing problems, designing and implementing algorithmic solutions.
- Employ the skills for the use of the C programming language to implement the real world applications.

Section A

Brief introduction to computer organization, Block diagram, Hardware and software. Introduction to operating System, Concept of Data and Information, Representation of data, bits and bytes, Number System (binary, octal, decimal, hexadecimal), Representation of integers, real numbers, positive and negative numbers, Binary arithmetic, simple concepts and theorems of Boolean algebra. Representation of characters: BCD, ASCII, EBCDIC codes. Programming fundamentals: Program, Steps in program development, programming language, compilers, interpreters. Algorithms, flowcharts, Control statements sequencing, conditional and unconditional branching and looping.

Section B

Overview of C language- History, structure of a program data types, variables, constants, operators (arithmetic, logical, relational), expressions (arithmetic and logical), assignments, conditional statements, control statements, simple I/O. Single and multi-dimensional arrays, Searching (linear, binary), sorting (bubble, selection) and merging, matrix arithmetic.

Section C

Concept of pointers, pointer expression, pointer v/s arrays, functions, parameter passing (call by value, call by reference), recursion, structure, union and enumerated data types, concept of structured programming.

Suggested Books:

1. Sinha, P. K. (2003). *Computer fundamentals: concepts, systems & applications*. BPB publications.

2. Balagurusamy, E. (2012). *Programming in ANSI C*. Tata McGraw-Hill Education.
3. Kanetkar, Y. P. (2016). *Let us C*. BPB publications.
4. Rajaraman, V., & ADABALA, N. (2014). *Fundamentals of computers*. PHI Learning Pvt. Ltd.

Suggested E-learning material:

1. Introduction to Programming in C
   https://nptel.ac.in/courses/106104128/
2. Introduction to Programming in C Specialization
   https://www.coursera.org/specializations/c-programming
3. Sinha, P. K. (2003). Computer fundamentals: concepts, systems & applications. BPB publications.
   https://www.edutechlearners.com/computer-fundamentals-p-k-sinha-free-pdf/

CS 109L Computer Fundamentals and Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

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

- Perform internal and external DOS commands.
- Implement problems based on expressions containing constants, variables and operators.
- Implement problems based on conditional statements, switch and loops.
- Implement problems based on array, pointers, functions, files and command line arguments.

Lab Exercise

1. Explore DOS & WINDOWS Operating System

2. Implement Following programs in 'C'
   I. Simple Programs
      i. Arithmetic Calculation
      ii. Formula Based Calculation
   II. Conditional Statements
      i. Check odd-even, positive-negative
      ii. Calculation of Division, Rank of student
      iii. Solution of Quadratic Equations
      iv. Menu Driven Programs
      v. Programs using if and switch statement
   III. Looping
      i. Sum of digits of number, reverse of number, palindrome checking
      ii. Table Generation
      iii. Prime number checking, generation
      iv. Calculation of GCD, LCM
      v. Sum of various series, Fibonacci series,sin, cos, exp etc.
      vi. Pattern Drawing
   IV. Programming with Arrays
      i. Max, min & Average calculation
      ii. Linear Search
      iii. Binary Search
      iv. Bubble Sort
      v. Selection Sort
      vi. Merging
      vii. Number System Conversion
      viii. Matrix Manipulation- sum of row, column & diagonal element
      ix. Display and sum of upper triangular, lower triangular matrix elements

x. Matrix Arithmetic (Addition, Subtraction, Multiplication)

xi. String Manipulation

V. Pointers and Functions

i. Use of Functions the previous programs

ii. Use of pointers and function in array and string processing

iii. Recursion-factorial, GCD, Fibonacci, Power, Tower of Hanoi etc.

VI. Structures

i. Operations on Complex number

ii. Record storage, searching, sorting, generating reports

iii. Use of Union

EEE 101 Electrical Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes

The Students will be able to:

- Understand the importance of electrical engineering
- Solve complex DC circuits
- Solve& predict the behavior of AC circuit
- Understand different machines along with measurement techniques
- Select appropriate element, device or machines with respect to application

SECTION A

DC Networks: Node Voltage and Mesh Current Analysis; Source Conversion. Superposition Theorem, Thevenin's Theorem, Norton's Theorem, Maximum power Transform, Laplace transforms and inverse Laplace transforms: Basic Theorem and Circuit analysis using Laplace transformations, Initial and final value theorem.

SECTION B

Single Phase AC Circuits: EMF Equation, Average, RMS and Effective Values. RLC Series, Parallel and Series, Parallel Circuits, Complex Representation of Impedances. Phasor Diagram, Power and Power Factor.

Three Phase A.C. Circuits: Delta-Star and Star-Delta Transformation, Line & Phase Quantities, 3-Phase Balanced Circuits, Phasor diagram, Measurement of Power in Three Phase Balanced Circuits.

SECTION C

Transformer: Magnetic coupled circuits, Dot convention for coupled circuits, coefficient of coupling, mutual inductance, EMF Equation, Voltage & Current, Relationship and Phasor Diagram of Ideal Transformer.

Introduction to principle of DC Machines, synchronous machines and induction motors.

Text Books

1. Toro, V. D. (1989). *Electrical Engineering Fundamentals* (2nd ed.). PHI Publication.
2. Bobrow, L. S. (1996). *Fundamental of Electrical Engineering*(2nd ed.). Oxford Publication.
3. Nagrath,J. &Kothari,D.P. (2017).*Basic Electrical Engineering*(3rd ed.).India: TMH.
4. Sahdev,S. K. (2015). *Basic Electrical Engineering*. India: PearsonEducation India.

Reference Books

1. Chakrabarti,A.K. (2018). *Circuit Theory* (7th ed.). Dhanpat Rai and Co.
2. Alaxender, C. &Sadiku, M. N. O. (2003). *Fundamentals of Electrical circuits.* Oxford University Press.
3. Choudhary, D. R. (2013). *Networks and Systems.* Wiley Eastern Ltd.
4. Hayt, W. H., Kemmerly, J.&Durbin,S. M. (2013). *Engineering Circuit analysis*(8th ed.).Tata Mc Graw Hill.
5. Valkenburg, M.E.V.(2006). *Network Analysis*. New Delhi: Prentice Hall.

E-Resources:

1. https://nptel.ac.in/courses/108108076/
2. https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/
3. https://swayam.gov.in/electrical/c/4/engineering
4. https://swayam.gov.in/courses/4746-july-2018-fundamentals-of-electrical-engineering
5. https://nptel.ac.in/courses/108105053/pdf/L-03(GDR)(ET)%20((EE)NPTEL).pdf
6. https://nptel.ac.in/courses/108105053/pdf/L-04(GDR)(ET)%20((EE)NPTEL).pdf
7. https://nptel.ac.in/courses/108105053/pdf/L-06(GDR)(ET)%20((EE)NPTEL).pdf
8. https://nptel.ac.in/courses/108105053/pdf/L-07(GDR)(ET)%20((EE)NPTEL).pdf
9. https://nptel.ac.in/courses/108105053/pdf/L-08(GDR)(ET)%20((EE)NPTEL).pdf
10. https://nptel.ac.in/courses/108105053/pdf/L-14(NKD)(ET)%20((EE)NPTEL).pdf
11. https://nptel.ac.in/courses/108105053/pdf/L-15(NKD)(ET)%20((EE)NPTEL).pdf
12. https://nptel.ac.in/courses/108105053/pdf/L-17(NKD)(ET)%20((EE)NPTEL).pdf
13. https://nptel.ac.in/courses/108105053/pdf/L23(TB)(ET)%20((EE)NPTEL).pdf
14. https://www.scribd.com/doc/123459017/basic-electrical engineering?campaign=SkimbitLtd&ad_group=725X1342X724adc86fb3fde3cdc1f294ab4f382ea&keyword=660149026&source=hp_affiliate&medium=affiliate

EEE 101L Electrical Engineering Lab

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes

The Students will be able to:

- Handle measuring instruments and apparatus
- Identify the various electrical and electronic components as per the ratings
- Verify circuit laws and solve electrical networks
- Analyze the characteristics of semiconductor devices
- Design basic AC & DC circuits

LIST OF EXPERIMENTS

1. Study of electronic components and apparatus.
2. Study ofdigital& analog Multimeter.
3. Study of Cathode Ray Oscilloscope (CRO)
4. Verification of principle of Superposition Theorem with DC.
5. Verification of principle of Thevenin's theorem with DC.
6. Verification of principle of Norton's theorem with DC.
7. Verification of principle of Maximum Power Transfer with DC.
8. Determine the frequency response of current in RL & RC circuit.
9. Determine the frequency response of current in RLC circuit.
10. Study of VI characteristics of PN junction diode.
11. Study ofVI characteristics of Zener diode.
12. Study ofVI characteristics of LED, LDR and Photodiode.
13. Study of VI characteristics of BJT in CE configuration.

ENGG 101L Engineering Drawing and Graphics Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcomes

The Students will be able to:

- Apply the concepts of engineering drawing in their respective field of interest.
- Implement various BIS and ISO concepts of drawing.
- Draw the sectional views of various engineering objects.
- Use engineering curves in tracing the paths of simple machine components.
- Draw various views related to real objects.
- Draw and read plan of industrial standards.
- Visualize the design ideas using software.

Indian Standard –Drawing Instruments, Lines & Lines symbols; Sheet Layout of rules of printing; Line sections & Conventions, Lettering, Scales, Curved used in Engineering Practice, Projection of Points, Projection of Lines, Projection of Planes, Projection of Solids, Orthographic Projections, Sectional Views, Rivets & Riveting Joints, Threads, Foundation Bolts & Nuts.

Computer Aided Drawing using Auto CAD /MICRO STATION.

Text Books:

1. Gill,P. S. (2010).*Engineering Drawing*. Kataria Publication,.
2. Bhatt,N. D. & Panchal, V.M. (2011). *Geometrical and Machine Drawing* (19th ed.). Charotar Publication.

e-Resources:-

1. https://nptel.ac.in/courses/112103019/
2. http://www.me.umn.edu/courses/me2011/handouts/drawing/blanco-tutorial.html

3. https://ocw.mit.edu/courses/mechanical-engineering/2-007-design-and-manufacturing-i-spring-2009/related-resources/drawing_and_ sketching/
4. https://nptel.ac.in/courses/112104172/

LIST OF EXPERIMENTS

1. Drawing sheet related to lettering.
2. Drawing sheet related to scale.
3. Drawing sheets related to conic sections.
4. Drawing sheets related to Engineering Curves.
5. Drawing sheet related to Projection of points.
6. Drawing sheet related to Projection of lines.
7. Drawing sheet related to orthographic projection by 1st angle.
8. Drawing sheet related to orthographic projection by 3rd angle.

ENGG 103L Measurement Techniques Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**6**	**3**

Learning Outcomes:

After successful completion of the course, students should be able to:

- perform adulteration test and qualitative analysis of biomolecules.
- familiarize with the working principle of microscope.
- understand the fundamental concepts of plant identification and vegetational analysis.
- gain hand on training to check purity of biomolecules.

Biology

1. To test for adulteration in turmeric, wheat flour, ghee and milk.
2. Qualitative analysis of nitrate, carbonate and replaceable base deficiency in soil samples.
3. Determination of soil pH.

4. Biochemical test for sugar, albumin and ketone bodies in urine samples.
5. Biochemical tests for lipids and cholesterol.
6. Detection of Vitamin A in the given sample.
7. Study of typical prokaryotic and eukaryotic cells with the help of a microscope.
8. Gram staining to identify gram positive and gram negative bacteria
9. Description of plant identification (Neem, Babool, Peeli Kaner, Tulsi, Chandani and Aak/ Madar).
10. Vegetational analysis by Quadrat method.
11. Determination of concentration and purity of DNA.
12. Determination of concentration and purity of RNA.
13. Preparation of stained temporary mount of onion peel.

Suggested Books:

- Biradar, V.K., & Samshe, A. (2016). *Practical Biochemistry*. New Delhi: APH Publishing Corporation.
- Sharma, S., & Sharma, R. (2016). *Practical Manual of Biochemistry* (2nd ed.). New Delhi: Medtech.
- Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.
- Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher.

Third and Fourth Semester

MATH 209 Complex Variables

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

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

- Demonstrate an understanding of the basic concepts of underlying complex analysis.
- Explain the essential concepts of complex functions and their role in applied contexts.
- Investigate limit, continuity and differentiability of complex functions.
- Demonstrate capacity for mathematical reasoning through analyzing analytic functions.
- Use complex analysis techniques to solve problems in diverse situation in physics, engineering and other mathematical contexts.
- Demonstrate an understanding to determine the singularity of the complex functions
- Demonstrate an understanding of Fourier series, Fourier integrals and Fourier transforms.

Section A

Complex functions; Exponential function, Trigomometric and hyperbolic function, Polar form, branch cuts.Continuity, Differentiability, Analytic function, Cauchy-Riemann equations, Harmonic functions.

Section B

Conformal map, Bilinear Transformation, Line integral in complex plane, Cauchy's Integral theorem, Cauchy's integral formula, Derivative of analytic functions, Power series, Taylor's series, Laurent series,

Section C

Singularities, Residue, Residue theorem and Evaluation of real integrals.

Fourier series, half-range expansions, Fourier integrals, Fourier transforms: Fourier sine and cosine transform, Inverse Fourier transforms.

Suggested Books:

1. Kasana, H. S. (2005).*Complex Variables: Theory and Applications* (2nd ed.). India, Delhi:PHI Learning Pvt. Ltd.
2. Ramana, B.V. (2015), *Higher Engineering Mathematics* (25th ed.).India, Delhi: Tata McGraw Hill Co. Ltd.
3. Kreyszig, E. (2011). *Advanced Engineering Mathematics* (9^{th}ed.). Hoboken, NJ : John Wiley & Sons, Inc.

Suggested E-Learning Material:

1. Complex Analysis

   https://nptel.ac.in/courses/111103070/

MATH 210 Differential Equations

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

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

- Solve nth order homogeneous differential equations with constant coefficient and Euler Cauchy differential equations.
- Understand some methods such as Variation of parameters, Methods of undetermined coefficient and Frobenius method for solving a differential equation.
- Solve Laplace transformation, Inverse Laplace transformation.
- Solve Ordinary differential equation by using Laplace transformation.
- Solve homogeneous and non-homogeneous linear Partial differential equations with constant coefficients.
- Understand the use of Partial differential equations in solving Heat, Wave and Laplace equations.

Section A

Ordinary differential equation of the 1st order and 1st degree; Ordinary linear differential equation of nth order- homogeneous and non-homogeneous with constant coefficient; Euler Cauchy differential

equations, Variation of parameters, Methods of undetermined coefficients, System of linear differential equations.

Section B

Power series solutions of ordinary differential equations,Frobenius Method, Legendre equation and Legendre polynomials, Bessel equations and Bessel functions of first and second kind.

Laplace transform and its properties; Convolutions, Inverse Laplace transform, application of Laplace transform for solving ordinary differential equations.

Section C

Partial differential equations of first order, homogeneous and non-homogeneous linear partial differential equations with constant coefficients, Classification of second order Partial differential equations; Solution of one dimensional wave and heat equation, solution of Laplace equation

Suggested Books:

1. Ramana, B.V. (2017). *Higher engineering mathematics*. Mc Graw Hill.
2. Kreyszig, E. (2005). *Advance engineering mathematics.* Wiley Eastern.
3. Zill, D.G. (2013). A first course in differential equation with modeling application. Cengage Learning.

Suggested E-Learning Material:

1. Differential Equations for Engineers
   https://nptel.ac.in/courses/111106100/
2. Differential Equations
   https://ocw.mit.edu/courses/mathematics/18-03-differential-equations-spring-2010/
3. Differential Equations
   https://freevideolectures.com/course/3302/differential-equations-i
4. Differential Equations
   https://www.khanacademy.org/math/differential-equations

ENGG 201 Structure and Properties of Materials

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

The students will be able to:

- Relate fundamentals of material properties with its utilization
- Design and develop better products and equipment
- Identify needs and applications of materials economically.

Section A

Atomic bonding in solids: Bonding forces and energies; primary and secondary bonding; Metallic structures: unit cells, crystal systems, crystallographic directions and Miller-Bravais indices, linear and planar densities, close-packed crystal structures; Polymer structure: molecular weight, molecular configurations of polymer; Defects and dislocations: vacancies and interstitials dislocations, grain boundaries; Mechanical test behaviour of metals: elastic and plastic deformation.

Section B

Deformation mechanisms: slip system, plastic deformation, strengthening mechanisms; Diffusion; Phase diagram: phases, micro structure, phase equilibrium, Iron-carbon system: Fe-Fe3C phase diagram, development of microstructure in Fe-C alloys, mechanical behaviour of Fe-C alloy, Tempered Martensite; Kinetics of phase transformations: Avrami rate equation, correlation of properties to microstructure, isothermal transformation diagram, continuous cooling transformation.

Section C

Magnetic materials: dia, para, ferroand ferrimagnetism; soft and hard magnetic materials and their applications; Conductive materials: electrical properties of conductive and resistive materials, important characteristics and electronic applications of specific conductive & resistive materials; Semiconductor materials: crystal growth, zone refining, degenerated and non-degenerated semiconductors, direct and indirect band-gap semiconductors.

Recommended Books:

1. Callister, W. D., & Rethwisch, D. G. (2018). Materials science and engineering: An introduction.
2. Shackelford, J. F. (2014). Introduction to materials science for engineers. Pearson.
3. Viswanathan B. (2006). Structure and properties of solid state materials. Alpha Science Intl. Ltd .
4. Budinski, K. G., & Budinski, M. K. (2016). Engineering materials: Properties and selection. New Delhi: Pearson India Education.

E-resource(s): https://nptel.ac.in

ENGG 202 Basic Electronics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

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

- Understand the fundamental of semiconductors and design semiconductor circuits.
- Understand the different type of diode/ transistors with their responses.
- Analyze various types of oscillators available with their utilization.

Section A

Electronics component- Active & Passive components, Types of resistors, inductors & capacitors, Recapitulation of semiconductor, Intrinsic and Extrinsic Semiconductor, Charge density of semiconductors generation and recombination of charges, diffusion, the continuity equation, Injected minority carrier charges, potential variation with in a graded semiconductor, Potential variation in step graded junction, PN Junction diode, current components, volt Ampere characteristic-temperature dependency, space charge & diffusion capacitance, switching time

Section B

Breakdown diode, Tunnel diode, LED, Photo diode, load line, clipping, clamping. The junction Transistor, current, components, configuration - CB, CE, CC, Typical junction values, Ebers-Moll model, photo transistor,

analysis of transistor amplifier using h parameter Transistor Hybrid Model, Emitter follower, Darlington pair, Miller theorem & its Dual, cascading amplifier

Section C

Biasing and stabilization - Static & Dynamic, Bias stability, load line, Need of stabilization, self-bias, fixed bias, emitter bias, feedback bias, Transistor as an Inverter, brief introduction of different coupling techniques

FET- Pinch off, V-I characteristics, MOSFET- Depletion & Enhancement type, Oscillators- Barkhausen criterion, phase shift oscillator, General form of oscillator circuit - Colpitts, Hartley, Wein bridge, crystal oscillator

Recommended Books:

1. Millman. J, Halkias. C, Parikh. C. (2017). *Integrated Electronics*. *(2/e).* New Delhi: TMH Publications.
2. Boylestad.R. (2012). *Electronic Devices& Circuits Theory.(6/e).* New Delhi: Pearson Publications.
3. Somanathan B. Nair. (2006). *Electronics Devices and Applications.* New Delhi: Prentice Hall India Learning Private Limited
4. Smith. S.(2008). *Microelectronics Circuits. (5/e).* New Delhi: Oxford press, India.
5. Streetman Ben. G. (2006). *Solid State Electronic Devices (6/e)*. New Delhi: PHI Publications.

Suggested E-resources:

1. **Basic Electronics** by Prof. Pramod Agarwal, Department of Electrical Engineering, Indian Institute of Technology, Roorkee. https://nptel.ac.in/courses/117107095/4
2. **Circuits and Electronics** by Anant Agarwal, Massachusetts Institute of Technology: MIT OpenCourseWare.

   https://ocw.mit.edu/courses/electrical-engineering-and-computer-science/6-002-circuits-and-electronics-spring-2007/video-lectures/6002_l16.pdf

CS 209 Data Structures

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

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

- Develop knowledge of basic data structures for storage and retrieval of ordered or unordered data. Data structures include: arrays, linked lists, stacks, queues, binary trees, heaps.
- Develop knowledge of applications of data structures including the ability to implement algorithms for the creation, insertion, deletion, searching, and sorting of each data structure.
- Analyze and compare algorithms for efficiency using Big-O notation.
- Describe the concept of dynamic memory management, data types, algorithms, Big O notation.
- Apply Algorithm for solving problems like sorting, searching, insertion and deletion of data.

Section A

Concept of data types, Abstract data type, Data structures, running time of a program, asymptotic notations: Big-Oh, Theta, Little-oh, Omega. Linear data structures: Static implementation of stack, queue, and their applications Searching and Sorting: Linear search and Binary Search, Bubble sort, Selection sort, Insertion sort, Quick sort, Radix sort.

Section B

Linked List: Linear, doubly or two way, circular, header and various operations; Representation of polynomial using linked list, addition and subtraction of polynomials. Dynamic implementation of stacks and queues. Dynamic memory management: fixed and variable block storage, storage techniques: first-fit, best-fit, worst-fit, next-fit; data compaction, and garbage collection.

Section C

Non linear data structures: Tree concepts, General Tree, binary tree and types, binary search tree, implementation of various operations on Binary Search Tree (tree traversal, searching, insertion and deletion, counting leaf

and non-leaf nodes, height), Heap and heap sort, Balanced tree: concepts, rotations, insertion and deletion.

Suggested Books:

1. Langsam, Y., Augenstein, M., & Tenenbaum, A. M. (1996). *Data Structures using C and C++*. New Jersey: Prentice Hall.
2. Tremblay, J. P., & Sorenson, P. G. (1976). *An introduction to data structures with applications.* New York: McGraw-Hill.
3. Horowitz, E., Sahni, S., & Anderson-Freed, S. (2008). *Fundamentals of data structures in C.*Universities Press: Computer Science.
4. Aho, A. V., Hopcroft, J. E., & Ullman, J. D. (1983). *Data Structures and algorithms.* Addison Wesley Publishing Company.

Suggested E-Learning Material:

1. Programming and Data Structures
   https://swayam.gov.in/course/1407-programming-and-data-structures
2. Data Structures and Program Methodology
   https://nptel.ac.in/courses/106103069/

CS 209L Data Structures Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course students will be able to

- Implement problems based on basic data structures like stack and queues.
- Implement problems on linked lists.
- Implement problems for performing different operations like insertion, deletion and searching on binary tree and binary search tree.

Lab Number	**Problems**
L1-L4	Implementation of stack, Applications of stacks (parenthesis checker, postfix evaluation, infix to postfix), recursion

L5-L7	Implementation of linear, circular, circular queue, priority queue
L8-L12	Implementation of linear link list (creation, traversal, insertion, deletion, searching, sorting, merging, reverse)
L13-L14	Implementation of circular link list (creation, traversal, insertion, deletion, searching, sorting)
L15-L16	Implementation of doubly link list (creation, traversal, insertion, deletion, searching, sorting)
L17	Linked representation of stack and queue
L18	Polynomial arithmetic (Addition, Subtraction)
L19-L28	Implementation of binary search tree (creation, traversal, insertion, deletion,searching), Non recursive traversal (inorder, preorder, postorder)
L29-30	Heap creation, insertion, deletion, heap sort

CHEM 203 Principles of Chemical Processes

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand basic concept of biochemical equation and material balance.
- develop concept of energy balance, thermodynamic approaches, unit operations.
- apply the gained knowledge in bioprocess industries.

Section A

- Basic Concepts, Units and Dimensions, Basic chemical calculations, Steady state and dynamic processes, Single and multiphase systems.
- Types of Variables, Intensive and extensive variables, Specific properties, State Variables. Types of Equation: Mass and energy conservation, equilibrium relations.

Section B

- Process Classification, material balances for steady state processes, properties of gases, liquids and solids, equations of state, phase equilibria for ideal mixtures.
- Reactions and stoichiometry, Non-Reacting single phase systems; Single and multiple units without recycle, with recycle, bypass and purge, Non-Reacting multiphase systems.

Section C

- Processes involving vaporization and condensation, reacting systems.
- Energy Balances for Steady State Processes: Specific heat capacity, Enthalpy, Heat of reaction, thermo chemistry, Isothermal systems, Adiabatic Systems, Simultaneous material and energy balances.
- Unsteady State Material Balances, Reaction rate laws, Introduction to Modeling simulation for chemical processes: Basic idea about Model representation, types of modeling equations, types of mathematical models: Linear model vs nonlinear model, Static model vs dynamic model, Lumped parameter model vs Distributed model and Fundamental model vs empirical model, role of computer simulation in chemical processes.

Suggested Books:

- Bailey, J.E., & Ollis, D.F. (1944). *Biochemical Engineering Fundamentals* (2nd ed.). New York: McGraw-Hill Book Company.
- Bhatt, B.I., & Vora, S.M. (2008). *Stoichiometry* (4th ed.). New Delhi: Tata McGraw-Hill Publishing Company Limited.
- Dutta, R. (2007). *Fundamentals of Biochemical Engineering*. Ane Books India.
- Felder, R.M., & Rousseau, R.W. (2000). *Elementary Principles of Chemical Processes* (3rd ed.). Wiley India.
- Jana, A.K. (2008). *Chemical process Modelling and computer Simulation*. New Delhi: Prentice Hall of India private Limited.

Suggested e-Resources:

- **Energy Balance**
  http://www.learncheme.com/screencasts/mass-energy-balances/textbook-felder-3rd

- **Lumped and Distributed model**
  https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0162774

BT 201 Biochemistry

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental knowledge in biochemistry.
- understand molecular basis of various biochemical pathways and their regulations.
- apply the gained principles to solve the research problem in the field of biochemistry.

Section A

- Carbohydrates: Classification, structure and properties, glycolysis and fermentation and their regulations, gluconeogenesis and glycogenolysis, metabolism of galactose and galactosemia, pentosephosphate pathway.
- Citric Acid Cycle: Significance, reactions and energetics of the cycle, amphibolic role of the cycle. Glyoxylic acid cycle
- Enzymes: Nomenclature, classification, characteristics, enzyme kinetics and its mechanism of action, mechanism of inhibition, enzymes and iso-enzymes in clinical diagnosis. Co-enzymes and Cofactors: Role of Vitamins, metals ions, significance.

Section B

- Lipids: Classification, structure and properties of lipids. Oxidation of fatty acids, beta oxidation and its energetics, alpha oxidation of fatty acids, omega oxidation. Biosynthesis of ketone bodies and their utilization, biosynthesis of saturated and unsaturated fatty acids, control

of lipid metabolism, essential fatty acids and eicosanoids, phospholipids and sphingolipids.

- Proteins and Metabolism of Amino acids: Classification, structure and properties, nitrogen balance, biosynthesis of amino acids, catabolism of amino acids, conversion of amino acids to specialized products.
- Biological Oxidation: Redox-potential, the respiratory chain, its role in energy capture and its control. Energetics of oxidative phosphorylation, inhibitors of respiratory chain and oxidative phosphorylation, Chemiosmotic coupling theory and mechanism of ATP production in oxidative phosphorylation.

Section C

- Metabolism of Ammonia and Nitrogen containing Monomers: Assimilation of ammonia, urea cycle, metabolic disorders of urea cycle, porphyrin biosynthesis, formation of bile pigments, hyperbilirubinemia, purine biosynthesis, purine nucleotides interconversion, pyrimidine biosynthesis, formation of deoxyribonucleotides.
- Nucleic acids: Structure of DNA and RNA, Brief introduction of genetic organization of the mammalian genome, alteration and rearrangements of genetic material, mutation, physical and chemical mutagenesis / carcinogenesis, DNA repair mechanism, biosynthesis of tRNA and rRNA.

Suggested Books:

- Berg, J.M., Tymoczko, J.L., Gatto Jr., G.J & Stryer, L. (2015). *Biochemistry* (8th ed.). W.H. Freeman and Company.
- Garrett, R.H. & Grisham, C.M. (2012). *Biochemistry* (5th ed.).Wadsworth Publishing Co Inc.
- Nelson, D.L. & Cox, M.M. (2012). *Lehninger Principles of Biochemistry* (6th ed.). W.H. Freeman.
- Palmer, T (2004). Enzymes: *Biochemistry, Biotechnology and Clinical Chemistry* (Horwood Chemical Science) Reprint Edition. Albion.
- Rodwell, V.W., Bender, D., Botham, K.M., Kenelly, P.J., & Weil, P.A. (2018). *Harper's illustrated Biochemistry* (31st ed.). McGraw-Hill Education / Medical.

➢ Voet, D. & Voet, J.G. (2010). *Biochemistry* (4th ed). Wiley.

Suggested e-Resources

- **Metabolic pathways, Biomolecules**
  https://epgp.inflibnet.ac.in/ahl.php?csrno=2
- **Glycolysis**
  https://www.khanacademy.org/science/biology/cellular-respiration-and-fermentation/glycolysis/a/glycolysis
- **Mechanism of enzyme action**
  http://www.biologydiscussion.com/enzymes/enzymes-properties-and-mechanism-of-enzyme-action/6145
- **Enzyme action**
  http://chemistry.elmhurst.edu/vchembook/571lockkey.html

BT 208S Seminar

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**2**	**1**

Learning Outcomes:

After successful completion of the course, students should be able to:

- show competence in identifying, defining and explaining relevant topics.
- deal with nerves and develop the ability to speak in public.
- use body language and voice modulations to grab the listener's attention and hold their interest, which is important for effective presentation.
- use slides and visual aids effectively.

BT 204L Biotechnology Lab-I

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain hands on training to quantitatively analyze biomolecules.
- perform measurement techniques and solve mass and energy balance problems.
- apply the acquired knowledge to develop enterpreunership skills in industries.

Biochemistry

1. Estimation of proteins by Lowry's and TCA methods.
2. Estimation of carbohydrates: Total sugars by Anthrone method.
3. Reducing sugars by Nelson Somogyi method.
4. Estimation of serum cholesterol.
5. Preparation and purification of casein from buffalo milk.
6. Determination of titrable acidity of milk
7. To find λ_{max} for proteins.
8. To find λ_{max} for nucleic acids.

Principles of Chemical Processes Lab

Experiments based on measuring techniques

9. Measurement of temperature by Thermocouple.
10. Measurement of pressure by Manometer.
11. Measurement of RPM.
12. Determination of mass flow rate.
13. Calculation of TOC and ThOD of organic compounds present in the solution.
14. Mass balance problems.
15. Energy balance problems.
16. Newton Raphson (NR) optimization.

Suggested Books:

- Biradar, V.K., & Samshe, A. (2016). *Practical Biochemistry*. New Delhi: APH Publishing Corporation.
- Kumar, A., Garg, S., & Garg, N. (2017). *Biochemical Tests: Principles & Protocols*. New Delhi: Viva Books.-all
- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, S., & Sharma, R. (2016). *Practical Manual of Biochemistry* (II Ed.). New Delhi: Medtech.
- Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed,). Prentice Hall PTR Upper Saddle River, NJ, USA.
- Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.
- Yadav, V.K., & Yadav, N. (2018). *Biochemistry & Biotechnology: A Laboratory Manual*. Jaipur: Pointer Publisher.

CS 214 Object Oriented Programming

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Describe the features of C++ supporting object oriented programming.
- Explain the relative merits of C++ as an object oriented programming language.
- Describe how to apply the major object-oriented concepts to implement object oriented programs in C++, encapsulation, inheritance and polymorphism.
- Apply advanced features of C++ specifically stream I/O, templates and operator overloading

- Apply other features of the C++ language including templates, forms of casting, conversions, and file handling.

Section A

Basic Concept of Object Oriented Programming: Need of OOP, advantage over other programming paradigms, Tokens, Keywords, Identifiers and Constants, Basic Data Types, Control Structures.

Functions: Call by Value, Call by Reference, Function Overloading.

Class & Objects: Concepts of Objects & Classes, declaring multiple objects, array of objects, Friend Functions.

Section B

Constructors and Destructors: Introduction, Default, Parameterized and Copy Constructor, Concept and use of destructors.

Operator Overloading: Overloading Unary Operators, Overloading Binary Operators.

Inheritance: Derived and Base Class, Public, Private, Protected, Multiple and Multilevel Inheritance, Function Overriding.

Pointers: Pointers to Objects, this Pointer, Virtual Functions, Polymorphism.

Section C

Console I/O: Concept of Streams, Hierarchy of Console stream Classes, Unformatted and formatted I/O Operations, Managing Output with Manipulators

Templates: Class and function templates, overloading of function templates

File Handling: Classes for file stream operations, open and close a file, EOF, file modes, file pointers and their manipulators, sequential I/O operations, updating a file-Random access, Error Handling During File Operation.

Suggested Books:

1. Balagurusamy, E. (2001). *Object Oriented Programming with C++, 6e*. Tata McGraw-Hill Education.
2. Schildt, H. (2003). *C++: The complete reference*. McGraw-Hill.

3. Lafore, R. (1997). *Object-oriented programming in C++*. Pearson Education.
4. Stroustrup, B. (2000). *The C++ programming language*. Pearson Education India.
5. Venugopal, K. R. (2013). *Mastering C++*. Tata McGraw-Hill Education.

Suggested E-Learning Material:

1. Stroustrup, B. (2000). *The C++ programming language*. Pearson Education India.

   http://www.stroustrup.com/C++.html
2. Programming in C++

   https://nptel.ac.in/courses/106105151/

CS 214L Object Oriented Programming Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course students will be able to

- Implement problems based on expressions, arrays and strings.
- Carry out problems using functions, class, constructor and destructor.
- Implement problems using pointers, operator overloading, inheritance, file handling and exception handling.

Lab Number	**Problems**
1-8	Implementation of simple problems with the Objects and class. Understanding of private, public and protected access using problem, Implementation of static variable & static member function.Constructors & destructors. Problems using friend function.
9	Implementation of polymorphism.
10	Implementation of inheritance

11-16	Implementation of operator overloading to overload various operators: unary operators (+, -, *, % etc) and binary operators: +, *, [ ], >> and << operators on vectors
17-18	Problem related with dynamic binding. Problems using this pointer
19-20	Problems related with the templates function and template classes.

BT 203 Biophysics and Structural Biology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain basic understanding of molecular and quantum mechanics in studying biomolecules.
- acquire problem solving skills related to macromolecular folding and interactions.
- understand the molecular processes behind locomotion, neuronal signaling and vision.

Section A

- Elements of Quantum Mechanics: Quantization of energy, Atomic structure wave equation, Quantum Mechanical Tunnelling.
- Energies, forces and Bonds: inter-atomic potentials for strong and weak bonds, non central forces, bond energies, spring constant.
- Basic principle of protein structure: Ramachandran plot, motifs, folds, fibrous proteins, membrane proteins.

Section B

- Configuration of DNA, RNA, Glycosidic bond rotation and base stacking.

- Zwitterionic properties of amino acids, peptide bonds, and disulfide cross links.
- Basic principles of X-ray diffraction studies, calculation and interpretation of electron density map.
- Protein secondary structure prediction methods: Chou and Fasman, Garnier-Osguthorpe-Robson.
- Classification of three-dimensional structure of protein: HSSP, SCOP.

Section C

- Muscular movement: molecular structure of skeletal muscle, mechanical events of muscle contraction, force velocity, power velocity and tension- length relationship curves.
- Neuronal physiology: Ion channels, structure of Neurons, Synapse, Action potential and its propagation through nerve fiber. Post synaptic potential and Neural networking.
- Photoreception: Structure of photoreceptors and photo chemical events of vision.
- Molecular interaction: Protein-Protein interactions, Protein-DNA interactions, Techniques for the studies of these interactions.

Suggested Books:

- Atkins, P., & Paula, J.D. (2009). *Atkins Physical Chemistry* (9th ed.). OUP Oxford.
- Ber, J.M., Tymoczko, J.L., Gatto, G.J. & Stryer, L. (2015). *Biochemistry* (8th ed.) WH Freeman & Co.
- Brenden, C., & Tooze, J. (1998). *Introduction to Protein Structure* (2nd ed.) Garland Science.
- Cotterill, R. (2002). *Biophysics: An Introduction*. Wiley Press.
- Creighton, T.E. (1992). *Proteins: Structures and Molecular Properties*. WH Freeman &Co.
- Hall, J.E. (2015). *Guyton and Hall Textbook of Medical Physiology* (13th ed.). Saunders Press.

- Nelson, D. L., & Cox, M.M. (2017). *Lehninger Principles of Biochemistry* (7th ed.) WH Freeman &Co.
- Voet, D., Voet, J.D., & Pratt, C.W. (2016). *Fundamentals of Biochemistry* (5th ed.). John Wiley.
- Wilson, K., & Walker, J. (2010). *Principles and Techniques of Biochemistry and Molecular Biology*. Cambridge University Press.

Suggested e-Resources:

- **Muscular and Neuronal Physiology**
  https://www.khanacademy.org/science/biology/human-biology
- **Proteins**
  https://study.com/academy/lesson/proteins-structure-function-types.html
- **Nucleic Acids**
  https://chemistry.tutorvista.com/biochemistry/nucleic-acid-function.html

BT 206 Cell and Molecular Biology – II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand functions of cell organelles and regulation of cellular processes.
- explain the role and mechanism of cell signaling.
- develop detailed understanding of fundamental processes viz., replication, transcription and translation.

Section A

- Cell: Prokaryotic and eukaryotic cell, cell compartmentalization, cytoskeleton.

- Molecular structure and functional aspects of plasma membrane, carrier proteins and active membrane transport.
- Endocytosis and exocytosis.
- Autocrine, paracrine and endocrine stimulation.
- Cell Signaling: G-protein linked receptors, enzyme linked cell surface receptors (tyrosine kinases), structural features of trans membrane receptors, secondary messengers, role of Ca^{2+} ions, MAP kinase cascade.
- Cell cycle and division.

Section B

- The Nucleus, nucleolus, structure of chromosomes, nucleosomes, chromosomal DNA and its packaging.
- Mitochondria and chloroplast organization transport of proteins, genome of mitochondria and chloroplast.
- Endoplasmic reticulum, golgi apparatus, role in protein processing and transport.
- Lysosomes, intracellular digestion, sorting of lysosomal enzymes in golgi, lysosomal storage diseases.

Section C

- Central dogma and genetic code.
- DNA replication.
- Transcription: The transfer of DNA sequence information to RNA, exon, intron, tRNA and rRNA, mRNA processing.
- Translation: mRNA translation in prokaryotes and eukaryotes, notable features of the translation process.
- Inhibitors of transcription and translation.
- The fate of newly synthesized protein.

Suggested Books:

- Alberts, B., Johnson, A., Lewis, J., Raff, M., Roberts, K., & Walter, P. (2008). *Molecular Biology of the Cell* (5th ed.). New York: Garland Science.
- Cooper, G. M., & Hausman, R. E. (2013). *The Cell: a Molecular Approach* (6th ed.). Washington: ASM; Sunderland.
- Hardin, J., Bertoni, G., Kleinsmith, L. J., & Becker, W. M. (2012). *Becker's World of the Cell. Boston* (8th ed.). Benjamin Cummings.
- Karp, G. (2008). *Cell and molecular biology: Concepts and experiments*. John New Jersey: Wiley and Sons.
- Krebs, J. E., Lewin, B., Kilpatrick, S. T., & Goldstein, E. S. (2014). *Lewin's Genes XI. Burlington*, MA: Jones & Bartlett Learning.
- Lodish, H. F. (2016). *Molecular Cell Biology* (8th ed.). New York: W.H. Freeman.
- Watson, J. D. (2008). *Molecular Biology of the Gene* (5th ed.). Menlo Park, CA: Benjamin/Cummings.

Suggested e-Resources:

- **Macromolecular assembly**

  https://www.sciencedirect.com/science/article/pii/B9780323341264000050

- **Cell division**

  https://www2.le.ac.uk/projects/vgec/highereducation/topics/cellcycle-mitosis-meiosis

- **Lysosomal storage disorders**

  https://onlinelibrary.wiley.com/doi/pdf/10.1111/j.1365-2141.2004.05293.x

BT 205L Biotechnology Lab-II

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- perform techniques related to histochemical localization of biomolecules.
- gain hands-on training to analyze stages of cell division.
- predict structure of biomolecules using bioinformatics tools.

Cell and Molecular Biology

1. Estimation of DNA by DPA method.
2. Determination of Logic properties (pH value of glycine by titration).
3. Study of the stages of mitotic and meiotic cell division.
4. Separation of different organelles/molecules by sucrose density gradient/differential gradient.
5. Histochemical localization of biomolecules (protein, carbohydrate or any other).

Biophysics

6. Download PDB files for protein complexes with proteins (haemoglobin, myoglobin, insulin), nucleic acid and do various exercises using:

   - Rasmol

   - SPDBV

Suggested Books:

- Saxena, J., Baunthiyal, M. & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, R.K., Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.
- Swamy, P.M. *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication.

Fifth and Sixth Semester

ECO 307 Fundamentals of Economics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning Outcomes:

Upon Completion of the course student will be able to :

- Understand various aspects of economics that affects the day today functioning of business.
- Understand the oncept of demand, supply and productin and how the same is related to market.
- Understand the basic financial concepts that affects the functioning of the business.

Section A

What Economics is all about? Micro and Macro Economics.Origin and meaning of Engineering Economics, Role of Economics in Engineering, Scope of Engineering Economics.

Theory of Demand: Law of Demand, Demand Function and Determinants of Demand, Types of Demand.

Elasticity of Demand: Concept, Types and Measurement.

Section B

Production function and Laws of Production.Optimal Input combination. Cost concepts and cost output relationship.

Types of market structures; Determination of equilibrium price and output under perfect competition.

Section C

Timevalue of Money and Project Evaluation: Interest Formulas; Cash Flow Diagram; Principles of Economic Equivalance, Evaluation of Engineering Projects using methods of Present Value and Internal Rate of Return.

Capital Budgeting: Concept and significance of capital budgeting.

Depreciation Analysis: Meaning and causes of depreciation; methods of calculating depreciation – straightline and declining balance methods.

Books Recommended:

1. Thuesen. G.J., and Fabrycky, N.Engineering Economy, (9 ed) PHI Learining Private Limited, New Delhi.
2. S. ParkChan: Contemporary Engineering Economics: 3rd Edition, Prentice Hall.
3. M. Parkin: Economics: 5th Edition, Addison Wesley.
4. Mahendra P. Agasty: Engineering Economics and Costing, Second Edition: Scitech Publications (India) Pvt. Ltd.
5. R. Panneerselvam: Engineering Economics, Tenth Printing: PHI Learning Private Limited, New Delhi.

Suggested E-Learning Material:

1. Agrawal, D. (2017, Mar 8). Indifference Curve. Retrieved from Youtube:

   https://www.youtube.com/watch?v=31_rYca4eio.
2. econ (2012). Cost. Retrieved from:

   https://www2.econ.iastate.edu/classes/eon301/jintanakul/Notes/Ch7.pdf
3. Khan, Y. (2014, Dec 18). Production Function. Retrieved from Youtube:

   https://www.youtube.com/watch?v=MwuTt3L2hEQ.
4. Bhogal, S. (2018, June 04). Income and Cross Elasticity. Retrieved from Youtube:

   https://www.youtube.com/watch?v=i704CriwwrY.

MGMT 310 Principles of Management

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**0**	**0**	**3**

Learning Outcome:

Upon completion of the course the student will be able to:

- Evaluate the global context for taking managerial actions.
- Understand conflict resolution, motivation and leadership.
- Understand application of theories and management principles.

Section-A

What is management? Scientific approach-Taylor's contribution, administrative approach-Henry Fayol's contribution, human relation approach-Elton Mayo's contribution, system approach.

Planning: Need and process, types of plans-goals, objectives, policies and strategies; decision making-situations and process.

Section-B

Organizing: Organization structure, departmentation, centralization v/s decentralization, span of management, delegation and power of authority. Motivation-importance, theories of motivation-Maslow, McClleland Herzberg, theories.

Section-C

Theories and styles of leadership-Trait, behavioral.

Communication: Process and principles, types of communication, barriers to communication.

Control: Process of evaluation & control, method of control.

Suggested Reading:

1. Tripathi, P. C., & Reddy, P. N. (2017) Principles of Business Management, (22ed.) Tata McGraw Hill, New Delhi
2. Robbins & D. Cenzo. *Fundamentals of Management (10ed)*, New Delhi, Pearson Education Asia
3. Prasad,L.M.*Principles and practice of Management (9ed)* .Sultan Chand & sons, New Delhi

4. Weihrich&Koonts. *Management-A Global Perspective (13ed)*, Tata McGraw Hill, New Delhi

Suggested E-Learning Material:

1. Prachi, J. (2016). *Planning Function of Management*. Retrieved from Management Study Guide: https://www.managementstudyguide.com/planning_function.htm
2. Amit,L. (2018, December). *Controlling: Features,process and types*. Retrieved from: https://www.youtube.com/watch?v=JRVXfaFrMEM
3. Brian, T. (2017, May 11). *Different Types of Leadership Styles*. Retrieved from: https://www.youtube.com/watch?v=vilZazhIjoc
4. Chandan,P (2017, September 26). *Organising:Meaning,Process and Types*. Retrieved from https://www.youtube.com/watch?v=XrmJG_8d9Cg

STAT 204 Probability and Statistical Methods

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- Understand the concepts of random variables, probability distributions and independence of random variables.
- Understand the meaning of probability and probabilistic experiment
- Familiarize with the all approaches to probability theory and particularly, the axiomatic approach.
- Understanding the meaning of conditional probability.
- Distinguish between independent and uncorrelated random variables.
- Distinguish between discrete and continuous random variables and be able to represent them using probability mass, probability density, and cumulative distribution function.
- Identify important types of distributions such as exponential, Binomial, Poisson, Normal, and use them as suitable models in basic science and engineering problems.

- Understand the concept of statistical hypothesis and able to solve such type of real life problems.

Section A

Basic concepts of Probability, Classical, Empirical and Axiomatic approach to Probability. Addition and Multiplication theorems of Probability. Baye's theorem and its simple applications. Marginal, Joint and Conditional probability. Mathematical Expectation: Expectation of sum & products of random variables, Variance & Covariance.

Section B

Correlation & Regression Karl Pearson coefficient of Correlation. Partial and Multiple Correlation (upto three variables only).

Probability Distributions: Binomial, Poisson, Normal, Rectangular & Exponential distributions with simple applications. Fitting of Binomial, Poisson, and, Normal distributions.

Section C

Sampling distribution, Standard Error, Simple random sampling and stratified random sampling with their role. Test of significance for mean, variance, Proportion and correlation coefficient. Test of goodness of fit and independence of attributes. Analysis of variance with one observation per cell.

Suggested Books:

1. Johnson, R. A., Miller, I., & Freund, J. E. (2011). *Probability and Statistics for Engineers*, Prentice Hall.
2. Goon, A. M., Gupta, B. D. & M. K. Gupta.(1980). *Fundamental of Statistics*. (Vol. I & II).The World Press Pvt. Ltd. Kolkata.
3. Mood, A. M., Graybill, F. A., &Boes, D. C. (2001). *Introduction to Theory of Statistics* (3rd ed.). McGraw- Hill International.

Suggested E-Learning Material:

1. Probability and Random variables

   https://ocw.mit.edu/courses/mathematics/18-440-probability-and-random-variables-spring-2014/lecture-notes/

2. Probability and Statistics
   https://nptel.ac.in/courses/111105041/27
3. Statistical Inference
   https://nptel.ac.in/courses/111105043/

BT 310 Microbiology and Immunology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- explain bacterial and fungal classification and ultra structure.
- fundamental knowledge of techniques related to isolation, staining and maintenance of microbes.
- understand fundamental concept of immunology.

Section – A

- Discovery of microorganisms and their significance.
- Bacteria: Classification, structural organization, composition of cell wall, cell membrane, capsule, nutrition, respiration, methods of recombination and asexual reproduction.
- Fungi- classification, ultra structure and characteristics, nutrition and reproduction.
- Nature, organization, classification and replication of Plant and animal viruses and bacteriophages.
- Coronavirus: SARS-CoV-2; An overview of its structure, transmission, life cycle, pathogenesis, diagnosis, COVID-19 pandemic and treatment.

Section – B

- Sterilization techniques: Physical and Chemical methods.
- Techniques in Microbiology: Media preparation, isolation and pure culture techniques, staining techniques, preservation and maintenance of culture.

- Industrial applications of microorganisms in food and medicines.
- Introduction to Immunology: Innate and acquired immunity, active and passive immunity, organs and cells of immune system.
- Antigen and antigenicity: Concept of immunogens, antigens, haptens, characteristic properties of antigens.

Section-C

- Immunoglobulins: Molecular structure, properties, classification and significance of immunoglobulin. Immunoglobulin as antigens– isotypes, allotypes and idiotypes.
- Cell mediated and humoral immune response.
- General idea of Major Histocompatibility Complex, complement system.
- Hypersensitive reactions: (Type I, II, III and delayed type IV).
- Monoclonal antibody (production and their applications).

Suggested Books:

- Goldsby, R. A., Kindt, T.J., & Osborne, B. A. (2006). *Kuby Immunology* (6th ed.). New York: W.H. Freeman & Co. Ltd.
- Madigan, M., Martinko, J., Stahl, D., & Clark, D. (2010). *Brock Biology of Microorganisms* (13th ed.). Pearson
- Paul, W.E. (1999). *Fundamental Immunology* (14th ed.). Lippincott-Raven.
- Pelczar, M.J., Sun, C.E., & Krieg, N.R. (2002). *Microbiology* (5th ed.). New Delhi: Tata Mc Graw Hill.
- Willey, J. M., Sherwood, L.M. & Woolverton, C.J. (2014). *Prescott's Microbiology* (9th ed.). McGraw-Hill Education.

Suggested e-Resources:

- **Bacteria structure** http://www.biologydiscussion.com/bacteria/cell-structure-of-bacteria-with-diagram/47058
- **Bacterial growth & nutrition** http://www.biologydiscussion.com/bacteria/nutrition-and-growth-in-bacteria/47001

- **Introduction to Immunology**
  http://www.biology.arizona.edu/immunology/tutorials/immunology/page2.html
- **Coronaviruses: Replication, structure, pathogenesis**

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7074995/

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4369385/

BT 309 Metabolic Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the basic concept about cellular metabolism, pathway design and bioenergetics.
- understand regulatory mechanisms and metabolic modeling.
- develop analytical skills to address metabolic engineering problems.

Section – A

- Basic concepts of metabolic engineering, overview of cellular metabolism. Introduction to various pathways.
- Primary and secondary metabolites.
- Medical and agricultural importance of secondary metabolites.
- Different models for cellular reactions, flexible and rigid metabolic pathways.
- Metabolic regulation at enzyme level and whole cell level, examples of metabolic pathway manipulations.

Section – B

- Metabolic pathway synthesis algorithms.
- Metabolic flux analysis and its applications.
- Mathematical calculation for the flow of carbon.

- Methods for experimental determination of metabolic fluxes by isotope labeling.
- Stereochemistry of regulatory molecules.
- Concepts of regulatory analogs.

Section – C

- Genetic regulation of metabolic fluxes.
- Gene expression in response to environmental stimuli.
- Analysis of metabolic control and the structure of metabolic networks.
- Thermodynamics of cellular processes – New concepts for quantitative bioprocess research and development.

Suggested Books:

- Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering fundamentals* (2nd ed). McGraw-Hill.
- Bower, J.M., & Bolouri, H., (2001). *Computational Modeling of Genetic and Biochemical Networks* (1st ed.). MIT Press.
- Stephanopoulos, G.N., Aristidou, A.A., & Nilsen, J., (1998). *Metabolic Engineering-Principles and Methodologies*. Academic Press.

Suggested e-Resources:

- **Metabolites**

  http://lifeofplant.blogspot.com/2011/03/metabolites-primary-vs-secondary.html

  http://www.bio21.bas.bg/ipp/gapbfiles/v-34_pisa-08/08_pisa_1-2_67-78.pdf

- **Metabolic engineering file**

  https://biotechnologyforbiofuels.biomedcentral.com/track/pdf/10.1186/s13068-017-0791-3

BT 308 Genetics and Genetic Engineering

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	3	1	0	4

Learning Outcomes:

After successful completion of the course, students should be able to:

- explain the theoretical and experimental concepts of classical and molecular genetics.
- develop comprehensive concept of genetic engineering including vectors and techniques.
- identify various applications of genetics and genetic engineering.

Section-A

- Mendel's laws of inheritance.
- Gene-Gene interaction, multiple alleles, lethal alleles.
- Linkage and crossing over, linkage maps, three point testcross, Interference, calculating recombinant frequencies.
- Sex-determination: Chromosomes theory, Genic balance theory and hormone theory, other factors affecting sex determination, Lyon's hypothesis, dosage compensation, sex-linked inheritance.
- Chromosomal aberrations: Structural and numerical mutation, spontaneous and induced mutation, chemical and physical mutagens, induced mutations in plants, animals and microbes for economic benefit of man.

Section-B

- Vector systems: *E. coli*-the host cell plasmids structural and functional organization, replication, classification, incompatibility groups, construction of an ideal plasmid vector pBR322.
- Phage biology, construction of vector, other phages and cosmids.
- Direct gene delivery methods- Biolistics, electroporation, liposome mediated, microinjection.
- Construction, cloning and selection of inserts ligation, infection, transfection and cloning.

- Synthesis and cloning of cDNA, cDNA library.
- Enzymes used in molecular cloning: Nucleases, restriction Endonucleases, phosphodiesterase, polynucleotide kinase, DNA ligase, DNA polymerase, reverse transcriptase, terminal deoxynucleotidyl transferase.
- Isolation of DNA, RNA: bacteriophage, prokaryotic and eukaryotic.

Section-C

- Inborn errors of metabolism, autosomal and sex linked diseases.
- One gene-one enzyme, one gene-one protein, one gene-one polypeptide hypothesis.
- Heredity and environment with special reference to the study of twins.
- Human Genome Project: Genetic diseases in humans, genetics and society.
- Current techniques of genetic analysis.
- Important discoveries of genetic engineering.
- Identification and analysis of recombinant clones.

Suggested Books:

- Brown, T. A. (1990). *Genetics: A molecular approach* (3rd ed.). UK: Chapman and Hall.
- Gupta, P. K. (2005). *Biotechnology and Genomics*. India: Rastogi Publications.
- Primrose, S. B., Twyman, R., & Old, B. (2001). *Principles of Gene Manipulation* (6th ed.). USA: Wiley-Blackwell.
- Russel, P. J. (1996). *Genetics*. USA: Addison-Wesley.
- Sambrook, J. F., & Russell, D. W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.). USA: Cold Spring Harbor Laboratory Press.
- Singh, B. D. (2015). *Biotechnology*. Kolkata, India: Kalyani Publishers.

- Snustad, D. P., & Simmons, M. J. (2008). *Principles of Genetics* (5th ed.). USA: John Wiley & Sons.

Suggested e-Resources:

- **Linkage and crossing over**

  http://classpages.warnerpacific.edu/bdupriest/BIO%20250/Lecture%207%20Linkage%20&%20Mapping.pdf

- **Sex determination theory**

  http://www.biologydiscussion.com/genetics/modern-theories-of-sex-determination-with-diagrams/5257

- **Plasmid vector**

  https://nptel.ac.in/courses/102103045/module3/lec17/3.html

- **Direct gene delivery methods**

  https://www.slideshare.net/saugatbhatt/methods-27443684

- **cDNA library**

  https://nptel.ac.in/courses/102103013/19

- **Enzymes used in molecular cloning**

  http://www.biologydiscussion.com/enzymes/types-of-enzymes-involved-in-dna-synthesis-and-cloning-7-types/12075

- **One gene one enzyme hypothesis**

  http://www.biologydiscussion.com/genetics/one-gene-one-enzyme-hypothesis-genetics/59768

- **Techniques of genetic analysis**

  http://psych.colorado.edu/~carey/hgss/hgsschapters/HGSS_Chapter07.pdf

- **Important discoveries of genetic engineering**

  https://www.genome.gov/pages/education/genetictimeline.pdf

BT 303L Biotechnology Lab-III

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	0	0	8	4

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain hands-on experience in microbial and immunological techniques.
- understand chromosome structure and solve genetic problems.
- apply gained hands-on skills in enzymology and genetic engineering in related industries.

Microbiology

1. Preparation of media for fungal and bacterial culture and their sterilization, slant preparation.
2. Streaking technique, spread plate technique.
3. Isolation and enumeration of microbes from air/soil by serial dilution/agar plating method.
4. Antibiotic sensitivity test.

Immunology

5. Blood film preparation and identification of leucocytes.
6. Ouchterlony double diffusion and immuno-electrophoresis.
7. ELISA: Determination of antibody titre.

Genetics

8. Microscopic examination of Giant chromosomes.
9. Genetic problems and Genetic traits.

Genetic Engineering

10. Isolation of genomic DNA and its electrophoretic separation.
11. Extraction of RNA and its estimation by orcinol method.
12. Amplification of a gene fragment using PCR.

Enzymology

13. To obtain standard curve of p-nitrophenol solution.

14. To determine activity of acid phosphatase from mung bean seeds.
15. Purification of an enzymatic protein by salt precipitation.
16. Determination of kinetic properties (K_m and V_{max} values) of an enzyme.
17. To check time and protein linearity of an enzymatic reaction.
18. Immobilization of an enzyme.

Suggested Books:

- Cappuccino, J. G., & Welsh, C. (2016). *Microbiology: a Laboratory Manual*. Benjamin-Cummings Publishing Company.
- Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India.
- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Vats, S. (2015). *A laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.

CHEM 301 Analytical Techniques

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcome:

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

- understand the principle and various types of chromatography.
- understand and apply the concept and application of electrophoresis.
- understand the principles of NMR, UV-visible and IR spectroscopy.
- perform theoretical calculations related to the techniques discussed.

Note: The paper will contain three questions from every section aggregating nine questions. Candidates are required to attempt total of six questions, taking two questions from each section.

Section-A

Measurement of pH: Determination of pH, ion selective electrode, nstrumentation, applications.

Conductometric Measurements: Definitions, relations & laws, effect of dilution, conductance measurements, and applications; Conductometric titrations: types, advantages and disadvantages.

Fluorimetry and Phosphorimetry: Introduction, comparison of absorption and fluorescence methods, theory, instrumentation, applications of fluorimetry and phosphorimetry, comparison of fluorimetry and phosphorimetry, comparison of fluorimetry and phosphorimetry with absorption methods.

Section-B

Principles and Applications of Chromatographic Techniques: Thin Layer Chromatography, Paper Chromatography, Column Chromatography

Gas Chromatography: Introduction, principles, instrumentation, apparatus and materials, retention volume, resolution, applications.

High Performance (Pressure) Liquid Chromatography: Introduction, principle, instrumentation, apparatus and materials, column efficiency and selectivity, comparison with gas-liquid chromatography, applications.

Electrophoresis: Introduction, principle, types, applications.

Section-C

UV spectroscopy: The nature of electronic excitation, the origin of UV band structure; chromophores, Auxochromes, effects of conjugation and geometry; Calculation of lamda maxima, effect of solvents, qualitative and quantitative applications.

1R Spectroscopy: The IR absorption process; the modes of vibrations, coupled interactions, hydrogen bonding. The Hook's law, radiation source, sample handling, qualitative and quantitative applications.

Nuclear Magnetic Resonance Spectroscopy: Principles, Instrumentation techniques; Shielding and deshielding of magnetic nuclei, chemical shift and its measurements, factors influencing chemical shifts, spin-spin interaction, factors influencing coupling constant 'J', Applications.

Recommended Books:

1. Christian ,G. D., *Analytical Chemistry*, John Wiley; 6th Edition.
2. Skoog, D.A., West, D.M., Hollar, F.J.& Crouch S.R.; *Fundamentals of Analytical Chemistry,* Cengage learning; 9 Ed.
3. .Willard, H. L., Merritt, L. , Dean, J.A. & Settle, F.A.(2004) *Instrumental methods of Analysis*; HCBS Publishing New Delhi: 7th Ed.
4. Ewing, G. W. Ewing, *Instrumental Methods of Chemical Analysis*, McGraw-Hill Int 5th Ed.
5. .Holler, F. J., Skoog, D. A. & Crouch, S. R. *Priniciples of Instrumental Analysis*, Thomson Books/Cole , 6thEd.
6. Mendham, J., Denney, R.C. , Barnes ,J.D. & Thomas, M. *Text Book of Quantitative Inorganic Analysis*, Pearson Education Asia,6th Ed.
7. Willard, H.H., Merritt, J.A. Dean, L.L. & Settle, F.A. *Instrumental Methods of Analysis*, CBS Publishing New Delhi, 7th Ed.

Suggested e-Sources:

1. National Programme on Technology Enhanced Learning
   https://nptel.ac.in
2. Online Chemistry Courses
   https://www.edx.org/learn/chemistry
3. Free Online Education SWAYAM
   https://swayam.gov.in

CHEM 301L Analytical Techniques Lab

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**4**	**2**

1. Conductometric Technique:

1.1 To determine the strength of the given acid conductometrically using standard alkali solution.

1.2 To determine the solubility and solubility product of a sparingly soluble electrolyte conductometrically.

1.3 To study the saponification of ethyl acetate conductometrically.

1.4 To determine the ionization constant of a weak acid conductometrically.

2. Colorimetric Technique: To verify Beer-Lambert law for KMnO4/K2Cr2O7 and determine the concentration of the given solution of the substance.
3. Potentiometric Technique: To titrate potentiometrically the given ferrous ammonium sulphate solution using KMnO4/K2Cr2O7 as titrant and calculate the redox potential of Fe2+/Fe3+ on system on the hydrogen scale.
4. pH metric Technique: Determine the pH values of various mixtures of CH3COONa and CH3COOH in aqueous solution and hence find out the dissociation constant of the acid.
5. Chromatographic techniques:

5.1 Separation of binary organic mixture by column chromatography.

5.2 Separation of metals by paper chromatography.

5.3 Separation of fluorescent materials by thin layer chromatography.

BIN 301 Basic Bioinformatics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental concepts in information retrieval, programming languages and operating systems.
- identify various biological databases and develop data mining methods.
- predict 3D structure of proteins and their regular structural elements for the integrity of the structure.

Section-A

- Bioinformatics: Introduction and historical background.
- Information retrieval: LAN, WAN, introduction to internet, WWW, NICNET, ERNET, VSNL, ISDN, introduction to FTP, login and other network services, publication on worldwide web, on-line publishing ventures e.g. biomed, online international database access.
- Conceptual understanding of assemblers, operating systems (DOS, Windows, UNIX, LINUX).

Section-B

- Concept of CD-ROM, e-mail, websites, internet, networking, databases.
- Biological databases: Primary sequence databases (Protein and DNA databases), secondary databases, composite databases.
- Sequence format i.e. genbank and FASTA format.
- Sequence alignment and databases searching: Evolutionary basis of sequence alignment, optimal alignment methods, substitution scores and gap penalties.

Section-C

- Statistical significance of alignment, similarity searching tools: FASTA, BLAST.
- Pair wise database searching: EMBOSS, multiple Sequence alignment: CLUSTAL W.
- Protein structure prediction method- Homology modeling, ab-initio method and threading method.
- Scope of bioinformatics, BTIS Network in India, centers for bioinformatics (DICs and sub DICs) in India.

Suggested Books:

- Baxevanis, A.D. & Ouellette, B.F.F. (2004). *Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins* (3rd ed.). Wiley.

- Bosu, O. & Thukral, S.K. (2007). *Bioinformatics: database, tools and algorithms* (1st ed.). Oxford University Press.
- Sharma, V., Munjal, A., & Shanker, A. (2017). *A Text Book of Bioinformatics* (2nd ed.). Meerut: Rastogi Publications.
- Sinha, P.K & Sinha, P. (2016). *Computer Fundamentals* (6th ed.). New Delhi: BPB publication.

Suggested e-Resources:

- **Chou-Fasman Method for protein secondary structure prediction** https://pdfs.semanticscholar.org/fd8c/c95aec2d7af19ed28eea3688b3c231d0e745.pdf
- **Homology modeling**

  https://proteinstructures.com/Modeling/homology-modeling.html
- **ExPASy**

  https://www.expasy.org/

BT 302 Bioprocess Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the concept of microbial growth and sterilization, and carry out stoichiometric calculations and specify models of their growth.
- understand design of bioreactor and bioprocess controlling parameters.
- understand the applications of microbes and enzymes in food, pharmaceutical and fuel industry.

Section – A

- Growth kinetics and death kinetics.
- Microbial growth: structured and unstructured.
- Kinetics of batch, fed-batch and continuous processes.
- Mass balance, energy balance.
- Maintenance coefficient and yield concept.
- Mass transfer, volumetric mass transfer coefficient, aeration and agitation.
- Media sterilization and medium rheology.

Section – B

- Bioreactors: components and control of process parameters.
- Types of bioreactors: CSTR, airlift, fluidized bed, plug flow reactor, photobioreactor, bubble column, advances in bioreactor designing.
- Down stream processing: recovery and purification of fermentation products.
- Upscaling of bioprocess.

Section – C

Fermentative production of:

- Organic solvents: acetone, ethanol, butanol.
- Organic acids: lactic acid, citric acid and acetic acid.
- Enzymes: Proteases, lipases and alpha-amylase.
- Antibiotics: Penicillin, streptomycin and tetracycline.
- Amino acids: L-glutamic acid, phenylalamine and L-lysine.

Suggested Books:

- Bailey, J.E., & Ollis, D.F. (1986). *Biochemical Engineering fundamentals* (2nd ed). McGraw-Hill College.
- Clark, D.S., & Blanch, H.W. (1997). *Biochemical Engineering*. CRC Press.
- Crueger, W., & Crueger, A. (1990). *Biotechnology, A Text Book of Industrial Microbiology* (2nd ed.). USA: Sinauer Associates Inc.,
- Shuler, M.L., & Kargi, F. (2002). *Bioprocess Engineering Basic Concepts* (2nd ed,). USA: Prentice Hall PTR Upper Saddle River.
- Stanbury, P.F., Whitaker, A., & Hall S.J. (1995). *Principles of Fermentation Technology* (2nd & 3rd ed.). Elsevier Science Ltd.

Suggested e-Resources:

- **Application of microbial enzymes**

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5387804/pdf/BMRI2017-2195808.pdf

- **Acetone-Butanol-Ethanol fermentation**

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4894279/pdf/fnw134.pdf

- **Microbial culture fermentation**

  https://pdfs.semanticscholar.org/b4d3/7ed66ef2e37ce22ff7a3be09e3df7568fe49.pdf

BT 311 Recombinant DNA Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the concept of DNA synthesis, amplification and sequencing.
- gain fundamental concepts of cloning in both prokaryotes and eukaryotes.
- explain use of molecular probes and DNA finger printing for relevant applications.

Section A

- Chemical synthesis of DNA: Phosphodiester, triester approaches, phosphoramidite method, solid phase automated synthesis of DNA.
- Sequencing of DNA: Chemical and dideoxy method, random and directed approaches, automated DNA sequencing, improved gel based sequencers, mass spectrometry based sequencing, pyrosequencing.
- Polymerase chain reaction (PCR)- Basic principle, modifications: multiplex, nested, hot start, reverse transcriptase, real time, inverse, anchored, touch down and applications.
- Site directed mutagenesis: Oligonucleotide directed mutagenesis using M13 DNA, oligonucleotide directed mutagenesis using plasmid DNA, PCR based oligonucleotide directed mutagenesis, deletion mutagenesis.

Section – B

- Gene expression analysis: Northern blot, primer extension, SI mapping, RNase protection assays, reporter assays.
- Cloning in *Bacillus subtilis.*
- Cloning in yeast: YEPs, YIPs, YRP, YAC.
- Cloning in plants-*Agrobacterium tumefaciens* mediated gene transfer: Binary vector, cointegrate vector; viral vector mediated gene transfer, direct gene transfer methods.
- Cloning in mammalian cell using SV-40 vector- Early replacement and late replacement vector.

Section – C

- Molecular probes- DNA, RNA probes, application, radioactive and non-radioactive labeling of probes.
- Eukaryotic selectable markers.
- Various molecular markers: RAPD, AFLP, SNPs, SSR, ARDRA.
- DNA fingerprinting- Principle of technique, Basic DNA fingerprinting procedure.
- Antisense RNA technology, RNAi, siRNA.
- Gene therapy.
- Methods of detection of genetic disorders: Cytogenetic testing, biochemical testing, molecular testing.

Suggested Books:

- Glick, B.R., Pasternak, J.J. & Patten, C.L. (2010). *Molecular Biotechnology: Principles and Applications of Recombinant DNA* (4th ed.). American Society for Microbiology.
- Kumar, H.D. (1990). *Nucleic acid and biotechnology*. Vikas Publication.
- Primrose, S. B., & Old, R.W. (2001). *Principles of Gene Manipulation* (6th ed.).Wiley-Blackwell.
- Sambrook, J.F. & Russell, D.W. (2001). *Molecular Cloning: A Laboratory Manual* (3rd ed.) Vol. 1, 2 and 3. Cold Spring Harbor laboratory.
- Winnacker, E.L. (1987). *From genes to clones: Introduction to gene technology*. Wiley VCH.

Suggested e-Resources:

- **Solid phase oligonucleotide synthesis**
  https://www.atdbio.com/content/17/Solid-phase-oligonucleotide-synthesis
- **Antisense Technology**
  https://www.ukessays.com/essays/sciences/antisense-technology-applications-7151.php
- **SV40 vector**
  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC322153/pdf/nar00317-0279.pdf

BT 314L Biotechnology Lab-IV

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain basic skills in production and estimation of commercially important molecules.
- gain hands on training related to genetic manipulation techniques.
- perform sequence alignment of biomolecules using bioinformatic tools.

Bioprocess Engineering

1. Determination of growth kinetics of *E. coli*
2. Demonstration of Bioreactor.
3. Estimation of growth and product yield in a Bioconversion process.
4. Comparison between aerobic and anaerobic process.
5. Lactic acid production and estimation by titration.

Recombinant DNA Technology

6. Isolation of plasmid DNA from *E. coli.*
7. Restriction digestion of plasmid DNA and its electrophoretic separation.
8. To transfer plasmid pJB3JI from J53 strain of *E. coli* to HB101 strain of *E. coli.*

Bioinformatics

9. To check similarity between DNA and Protein sequence using DOT PLOT method.
10. To check sequence alignment of DNA and Protein sequence using dynamic programming.
11. Various exercises of *in silico* functional and comparative genomics in downloaded DNA and Protein sequences using:
    a. BLAST
    b. FASTA
    c. ClustalX

Suggested Books:

- Green, M. R., & Sambrook, J. (2012). *Molecular Cloning: a Laboratory Manual.*Cold Spring Harbor, NY: Cold Spring Harbor Laboratory Press.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (I Ed.). New Delhi: Vayu Education of India.
- Swamy, P.M. *Laboratory Manual on Biotechnology* (I Ed.). Meerut: Rastogi Publication.
- Vats, S. (2015). *A Laboratory Text book of Biochemistry, Molecular Biology and Microbiology*. Germany: GRIN Verlag.

Seventh and Eighth Semester

BT 431P Project

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**0**	**0**	**48**	**24**

Learning Outcomes:

After successful completion of the course, students should be able to:

- critically and systematically integrate knowledge to identify problems that needs to be addressed within framework of specific thesis.
- develop research hypothesis, think analytically, design the experiments, carry out experimental work and present the results in a scientific manner.
- ability to conduct research independently.
- develop project management, report writing, problem solving and communication skills.

BT 418 Animal Biotechnology

	L	T	P	C
Max. Marks : 100				
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand fundamental concepts of cell and tissue culture techniques and methodology.
- understand the basics of *in vitro* fertilization and animal cloning.
- gain knowledge about various applications of animal biotechnology in pharmaceutical industry.

Section - A

- Animal cell culture: brief history of animal cell culture, cell culture media and reagents, animal cell growth characteristics.

- Disaggregation techniques, primary cell cultures, secondary culture, continuous cell lines, suspension cultures, establishment and maintenance of cell cultures.
- Cell viability assays, cytotoxicity assays, survival assay and transformation assay.

Section - B

- Animal reproductive biotechnology: structure of sperms and ovum; cryopreservation of sperms and ova of livestock; artificial insemination; super ovulation, embryo recovery and *in vitro* fertilization.
- Culture of embryos; cryopreservation of embryos; embryo transfer technology; transgenic manipulation of animal embryos.
- Animal cloning: Basic concept; cloning for conservation of endangered species.

Section - C

- Vaccinology: History of development of vaccines, introduction to the concept of vaccines, conventional methods of animal vaccine production, recombinant approaches to vaccine production, modern vaccines.
- Somatic hybridization: Fusogens, basis of somatic hybridization technology, storage of hybridoma cells, productions of monoclonal antibodies.
- General overview of applications of transgenic animal technology and animal cell culture products.

Suggested Books:

- Bernard, R., Glick, Jack, J., Pasternak, Cheryl, L, &. Patten. (2009). Molecular Biotechnology Principles and Applications of Recombinant DNA (4th ed.). ASM press.
- Butler, M. (2004). *Animal Cell Culture & Technology* (2nd ed.). UK: Taylor & Francis.
- Davis, J. M. (2011). *Animal Cell Culture: Essential Methods*. USA: John Wiley & Sons Ltd.

- Freshney, R. I. (2011). *Culture of Animal Cells: A Manual of Basic Technique and Specialized Applications* (6th ed.). USA: Wiley-Blackwell.
- Gordon, I. (2005). *Reproductive Techniques in Farm Animals.* Oxford: CAB International.
- John, R. W. (2000). *Animal Cell Culture: a Practical Approach* (3rd ed.). UK: Oxford Unievrsity Press.
- Levine, M. M. (2004). *New Generation Vaccines*. New York: M. Dekker.
- Pörtner, R. (2007). *Animal Cell Biotechnology: Methods and Protocols*. Totowa, NJ: Humana Press.

Suggested e-Resources:

- **Animal cell culture products**

  http://www.biologydiscussion.com/biotechnology/animal-biotechnology/applications-of-animal-cell-cultures/10457

- **Artificial Insemination**

  https://fertilityfirst.com.au/wp-content/uploads/2017/02/intrauterine-insemination-iui.pdf

- **Intracytoplasmic Sperm Injection (ICSI)**

  https://www.intechopen.com/books/advances-in-embryo-transfer/new-advances-in-intracytoplasmic-sperm-injection-icsi-

BT 405 Environmental Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the biological process for sewage and wastewater management.
- explain the role of biology in sustainable technology development.

- gain knowledge about the role of microbes in environmental remediation.

Section – A

- Biological processing of sewage and wastewater treatment: Anaerobic and aerobic, conventional, advanced and new emerging technology, methanogensis, methanogenic, acetogenic and fermentative bacteria – technical process and conditions.
- Solid waste management: Waste monitoring, treatment and disposal of non-hazardous solid waste, general remedial measures for medical waste management and hazardous waste.

Section – B

- Bioenergy and biofuel**:** Advantages of biofuels, plant derived fuels, energy crops, biogas, bioethanol and biohydrogen.
- Biopolymers and bioplastics: Types of Bio-polymers, preparation of Bio polymers and bioplastics, properties and practical applications of PHB, advantages and disadvantages of bioplastics.
- Biosensors: Principle and application, BOD, ammonium, nitrate and sulphate.

Section – C

- Biodegradation of xenobiotics**:** Organisms involved in degradation of chlorinated hydrocarbons, polyaromatic hydrocarbons, pesticides.
- Surfactants and microbial treatment of oil pollution.
- Biofertilizers and biopesticides.
- Bioremediation and biorestoration: General approaches, reforestation through micropropagation, use of microbes for improving soil fertility, germplasm conservation (gene banks), conservation of Biodiversity (*in situ* and *ex situ*).

Suggested Books:

- Jogdand, S. N. (2010). *Environmental Biotechnology (Industrial pollution management)* (3rd ed.). Mumbai, India: Himalaya Publishing House.
- Milton, W. (Ed.). (1999). *An Introduction to Environmental Biotechnology*. USA: Springer.
- Modi, P.N. (2015). *Sewage treatment & disposal and waste water engineering*. New Delhi, India: Rajsons Publications Pvt. Ltd.
- Srinivasan, D. (2009). *Environmental Engineering*. New Delhi, India: PHI Learning Pvt. Ltd.
- Thakur, I.S. (2012). *Enviromental Biotechnology: Basic concepts and Application* (2nd ed.). New Delhi: I K International Publishing House.
- Tripathi, B.N., Shekhawat, G.S., & Sharma, V. (Ed.). (2009). *Applications of Biotechnology*. Jaipur, India: Aavishkar Publishers.

Suggested e-Resources:

- **Biological treatment of wastewater**

  https://www.fluencecorp.com/what-is-biological-wastewater-treatment/

- **Biogas**

  http://www.biologydiscussion.com/biomass/production-of-biogas-from-biomass/10436

- **Biofuel**

  http://uru.ac.in/uruonlinelibrary/BioFuels/Biomass%20and%20biofuels.pdf

- **Biosensor**

  https://www.frontiersin.org/articles/10.3389/fbioe.2016.00011/full

- **Xenobiotic compound biodegradation**

  http://www.biologydiscussion.com/microbiology-2/bioremediation/xenobiotic-compounds-meaning-hazards-and-biodegradation/55625

BT 429 Plant Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**3**	**1**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the fundamental concepts of cell and tissue culture techniques and methodology.
- understand the basic concepts of transgenic plants and molecular pharming.
- gain the basic knowledge of chloroplast engineering and edible vaccines.

Section – A

- Plant tissue culture: historical perspective, totipotency, media preparation – nutrients and plant hormones.
- Sterilization techniques, establishment of cultures – callus culture, cell suspension culture, organogenesis, somatic embryogenesis, artificial seeds.
- Micropropagation, somaclonal variation, somatic hybridization, cybrids.
- Protoplast isolation and culture, viability test, techniques of protoplast fusion, haploid production and applications.

Section – B

- Transgenic plants - basic concept and use of suitable promoters.
- Development of plants resistant to environmental stress and herbicides.
- Development of pathogen resistant plants (Virus and insect resistance).
- Overview of plant secondary metabolites, metabolic engineering, strategies for enhancement of their production in cell and tissue culture.
- Concept of plants as biofactories, molecular pharming.

Section – C

- Chloroplast engineering: techniques, advantages and application of chloroplast transgenics in production of biopharmaceuticals and introduction of agronomic traits.
- Edible Vaccines.
- Plant gene banks, germplasm collection, cryobanks.
- Biotechnology of biological nitrogen fixation: *nif* genes.

Suggested Books:

- Bhojwani, S.S., & Razdan, M K. (1996). *Plant Tissue Culture: Theory and Practice*. Nederland: Elsevier Science.
- Chawla, H.S. (2000). *Introduction to Plant Biotechnology*. USA: Science Publishers.
- Gupta, P.K. (2005). *Elements of Biotechnology*. India: Rastogi Publications.
- Singh, B.D. (2015). *Biotechnology*. Kolkata, India: Kalyani Publishers.
- Slater, A., Scott, N., & Fowler, M. (2008). *Plant Biotechnology: The Genetic Manipulation of Plants* (2nd ed.). UK: Oxford University Press.

Suggested e-Resources:

- **Background of Tissue Culture Technology**

  https://www.isaaa.org/resources/publications/pocketk/14/default.asp
- **Embryogenesis and organogenesis**

  https://nptel.ac.in/courses/102103016/module1/lec8/3.html
- **Single Cell Cultures and Cloning**:

  http://www.biologydiscussion.com/botany/tissue-culture/methods-for-obtaining-single-cell-clones-from-callus-culture-plant-tissue-culture/43004
- **Protoplasm isolation and regeneration**

  https://nptel.ac.in/courses/102103016/12

- **Haploid plant production**

http://www.biologydiscussion.com/plants/haploid-plants/production-of-haploid-plants-with-diagram/10700

- **Preservation of cell lines**

  https://www.ukessays.com/essays/biology/techniques-for-cell-preservation-biology-essay.php

- **Somatic hybridization**

  http://www.biologydiscussion.com/somatic-hybridization/somatic-hybridization-aspects-applications-and-limitations/10686

BT 421L Biotechnology Lab – V

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**0**	**0**	**8**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- acquire basic skills in plant and animal biotechnology techniques relevant for biological research and biotech industry.
- determine toxicity of hazardous component.
- gain hands-on skills to assess water pollution.

Plant Biotechnology

1. Preparation of MS medium.
2. Sterilization techniques.
3. Embryo culture.
4. Shoot tip culture.
5. Encapsulation of embryo using sodium alginate.
6. Isolation of protoplasts.
7. Estimation of total phenolic content from plant leaves.

Environmental Biotechnology

8. Determination of total hardness of water.
9. Determination of fluoride in water/soil/biosamples.

10. Determination of LD_{50} of common pesticides/weedicides.
11. Bacteriological Analysis of wastewater.
12. Estimation of BOD from water samples.

Animal Biotechnology

13. Cell counting and determination of cell viability.
14. Preparation of metaphase chromosomes.

Suggested Books:

- Kumar, V. (2011). *Laboratory Manual of Microbiology*. New Delhi: Scientific Publishers.
- Mahajan, R., Sharma, J., & Mahajan, R.K. (2010). *Practical Manual of Biotechnology* (1st ed.). New Delhi: Vayu Education of India.
- Saxena, J., Baunthiyal., & Ravi, I. (2015). *Laboratory Manual of Microbiology, Biochemistry and Molecular Biology*. Jodhpur: Scientific Publishers.
- Sharma, R.K., Sangha, S.P.S. (2009). *Basic Techniques in Biochemistry & Molecular Biology*. New Delhi: I.K. International Publisher.
- Swamy, P.M. *Laboratory Manual on Biotechnology* (1st ed.). Meerut: Rastogi Publication.
- Trivedi, R. (2016). *Practical Manual in Microbial Physiology and Industrial Microbiology* (1st ed.). New Delhi: S. K. Book Agency.

Discipline Elective

BT 420 Biomedicial Engineering

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand different human systems and associated physiological disorders.
- gain fundamental knowledge of the role of recent medical advances in diagnostics and ethical issues related to it.
- apply the gained knowledge in clinical research and diagnostic sector.

Section – A

- An introduction to biomedical engineering.
- Applications and scope of engineering in medical science.
- Respiratory system: Anatomy and physiology, disorders and diagnostics.
- Digestive system: Anatomy and physiology, disorders and diagnostics.
- Excretory System: renal anatomy and physiology, disorders and diagnostics.

Section – B

- Electrical potentials in the human body.
- Cardio vascular system: Anatomy of heart, cardiac cycle and ECG or EKG, pacemaker, heart disorders, diagnostics.
- Haemodynamics: Blood flow, velocity, circulation time, blood pressure, resistance, blood and vascular modeling.
- Muscular system: Anatomy, physiology and electrical properties of muscles. Clinical consideration and diagnostics.
- Nervous system: Synapse, electrical properties of neurons, neuromuscular functions, disorders and diagnostics.

Section - C

- Biomaterials and implantable sensors.
- Testing of biomaterials *in vitro* and *in vivo.*
- Artificial heart.
- Dialysis machine.
- Medical imaging: X- ray, design of X-ray tube.
- Medical imaging processes and projections, 3D, 2D slice identification, CAT, MMR, MRI, PET / SPECT.

Suggested Books:

- Bushberg, J. T. (2012). *The Essential Physics of Medical Imaging*. Philadelphia, PA: Wolters Kluwer / Lippincott Williams & Wilkins.
- Chatterjee, C.C. (1992). *Human Physiology* (11th ed.). Kolkata: Medical Allied Agency.
- Enderle, J.D., Bronzino, J.D., & Blanchard, S. M. (2005). *Introduction to Biomedical Engineering*. Amsterdam: Elsevier Academic Press.
- Fung, Y.C. (1993). *Biomechanics: Mechanical Properties of Living Tissues*. New York: Springer-Verlag.
- Tortora, G. J., & Derrickson, B. (2017). *Principles of Anatomy & Physiology* John Wiley & Sons.
- Webster, J.G., & Clark, J.W. (1998). *Medical instrumentation: Application and Design*. New York: Wiley.

Suggested e-Resources:

- **Cardiovascular and hemodynamics**

  https://pdfs.semanticscholar.org/a102/b25a8c6b74b97b4bfc8e6d5391aa95308925.pdf

- **Medical image processing**

  https://www.intechopen.com/books/medical-imaging-principles-and-applications/research-in-medical-imaging-using-image-processing-techniques

- **Artificial heart**

https://www.heartfoundation.org.au/images/uploads/publications/Artificial-hearts-information-sheet.pdf

BT 422 Food and Dairy Biotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand parameters affecting microbial growth and its effect on food.
- gain fundamental knowledge of various food processing and preservation methods.
- understand contemporary food related policies and their implications.

Section – A

- Introduction and history of microorganisms in food.
- Intrinsic and extrinsic parameters that affect microbial growth.
- Microbiological examination of food. Enumeration and detection of food borne microorganisms (conventional, immunological, molecular, biosensor).
- Bioassay and related methods.
- Food preservation by controlling growth of microorganisms (asepsis, low temperature, high temperature, non-thermal processes, hurdle concept).

Section – B

- Alcoholic beverages: Beer, wine and distilled spirits.
- Fermented meat products: sausages, salami.
- Fermented vegetables products: Sauerkraut, miso, tempeh, kimchi, gundruk, khalpi.
- Protein foods: Single cell proteins (SCP), mushroom, algal proteins.
- Overview of the International and National guidelines for safety assessment of genetically modified (GM) foods.

Section – C

- Emerging processing and preservation technologies for milk and dairy products.

- Fermented dairy products: Cheese, yogurt, kefir, butter.
- Lactose metabolism and production of aroma compounds.
- Food safety acts (Indian act-Food Safety and Standards Act, 2006, Various food acts-PFA, FPO, AGMARK, MMPO, MFPO, edible oil acts, standard weight acts) and regulatory agencies monitoring safety of foods .

Suggested Books:

- Adams, M.R., & Moss, M.O. (2007). *Food Microbiology*. Royal Society of Chemistry.
- Banwart, G.J. (1989*). Basic Food Microbiology*. CBS Publishers and Distributors, Delhi
- Frazier, W.C., & Westhoff, D.C. (2003). *Food Microbiology*. Tata McGraw Hill, Inc., New York.
- Joshi, V.K., & Pandey, A. (1999). *Biotechnology: Food Fermentation*. Asiatech Publishers Inc.
- Robinson, R.K. (1990). *Dairy Microbiology*. Elsevier Applied Sciences, London.
- Stanbury, P.F., Hall, S.J., & Whitaker, A. (1999). *Principles of Fermentation Technology*. Butterworth-Heinemann, Elsevier Science Ltd.

Suggested e-Resources:

- **History of microorganisms in food**

  https://link.springer.com/chapter/10.1007%2F0-387-23413-6_1

- **Quality control of food detection system**

  https://www.engineersgarage.com/Contribution/Arduino-based-Smart-IoT-Food-Quality-Monitoring-System

- **Food Preservation**

  https://sciencesamhita.com/methods-of-food-preservation/

- **Genetically modified food**

  https://www.nature.com/scitable/topicpage/genetically-modified-organisms-gmos-transgenic-crops-and-732/

BT 423 Genomics and Proteomics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the scope of genomics with special emphasis on functional and structural genomics.
- describe role of proteomics and various techniques associated.
- apply the gained knowledge in Proteomic and genomic research.

Section – A

- Introduction to genomics and proteomics.
- Gene prediction and counting.
- Genome similarity: SNPs and comparative genomics.
- Functional genomics: Microarray technique, fluorescence *in situ* hybridization, comparative genomic hybridization, microarray
- Mapping genome modifications for crop improvement, gene mining by transposons.

Section – B

- Proteomics and proteome: Proteomics and the new biology, the proteome method for measurement of gene (mRNA) expression.
- Analytical protein and peptide separations: Two-dimensional gel electrophoresis for proteome analysis, Image analysis of two dimensional gels, detection of proteins in polyacrylamide gels and on electroblot membranes.
- Mass-spectrometry based method for protein identification and phosphorylation site analysis.

Section – C

- Application of proteomics: Drug development and toxicology, mixing proteome, protein expression profile, identifying protein-protein interaction and protein complexes, mapping protein modifications as tool for plant genetics and breeding.

- Novel approaches to protein expression analysis.
- Protein arrays: Generation of cDNA expression Libraries, use of automated technologies to generate protein arrays and chips, application of protein arrays in proteomics.
- Characterization of protein complement of a specific cell type or tissue or a certain time by high-resolution 2DE.
- Bridging the current proteomics and genomic approaches by mass spectrometry, Future perspective and developments.

Suggested Books:

- Brown, S.M. (2015). *Next-generation DNA sequencing Informatics* (2nd ed.). Cold Spring Harbor Press.
- Lesk, A.M. (2015). *Introduction to Genomics* (2nd ed.). Oxford University Press.
- Liebler, D.C. (2001). *Introduction to proteomics tools for the new biology*. Humana Press.
- Pennington, S.R., Dunn, M.J., & Ebrary, Inc. (2001). *Proteomics: From protein sequence to function*. Oxford: BIOS.
- Pevsner, J. (2017). *Bioinformatics and Functional Genomics* (3rd ed.). John Wiley.
- Thangadurai, D. & Sangeetha, J. (2015). *Genomics and Proteomics: Principles, Technologies, and Applications*. CRC Press.
- Twyman, R.M. (2004). *Principles of Proteomics*. CBS Publishers.

Suggested e-Resources:

- **Protein array**

  https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3680110/pdf/nihms465562.pdf

- **Gene mining by transposon**

  http://transposonpsi.sourceforge.net/

- **Applications of proteomics in drug development**

https://onlinelibrary.wiley.com/doi/full/10.1002/jcb.10576

BT 424 Immunotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain fundamental knowledge of structure and function of the immune system at cellular and molecular level.
- understand immunization/vaccination, immunological disease and immunotherapy.
- apply the gained knowledge in clinical research.

Section – A

- General organization, expression and regulation of major histocompatibility complex. Structural organization and expression of immunoglobulin genes and generation of antibody diversity.
- Genomic organization, structure and isolation of TCR.
- Immune regulation, positive and negative selection in thymus, apoptosis.

Section – B

- Autoimmune diseases (organ specific and systemic autoimmune disease).
- Immune response to infectious diseases (viral, bacterial, protozoan and parasitic infections).
- Immunodeficiency diseases (phagocytic, humoral, cell mediated, combined cell mediated humoral deficiencies and complement deficiencies).
- Immune system in AIDS.

Section – C

- Tumor Biology.
- Transplantation immunology.
- Synthetic vaccines.

- Cloning techniques and engineered antibody production and application, T cell cloning.

Suggested Books:

- Abbas, A.K., Lichtman, A.H. & Pillai, S. (2017). *Cellular and Molecular Immunology* (9th ed.). Elsevier.
- Delves, P. J., Martin, S. J., Burton, D. R., & Roitt, I. M. (2006). *Roitt's Essential Immunology* (11th ed.). Wiley-Blackwell.
- Punt, J., Stranford, S., Jones, P., & Owen, J. (2018). *Kuby Immunology* (8th ed.). W. H. Freeman and Company.
- Tizard, I. R. (1995). *Immunology: Introduction* (4th ed.). Philadelphia: Saunders College Publishing.

Suggested e-Resources:

- **Cellular and Molecular Immunology**

  https://ocw.mit.edu/courses/health-sciences-and-technology/hst-176-cellular-and-molecular-immunology-fall-2005/lecture-notes/

- **Immunology**

  https://study.com/academy/topic/immunology.html

BT 425 Microbial Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand various strategies for isolation, strain improvement, maintenance and containment of microbes.
- gain fundamental concepts in large scale production of metabolites from microorganisms including over expression.
- understand advances in field of microbial technology for societal benefit.

Section – A

- Biotechnological innovation in pharmaceutical health, agricultural and industrial sectors.
- Strategies for selection and improvement of industrial strains.
- Measurement and control of bioprocess parameters.

- Metabolic pathways and metabolic control mechanism.

Section – B

- Industrial production of biofuel, steroids and single cell protein.
- Biofertilizers (*Rhizobium* and BGA) and biopesticides (Bt toxin)
- Biosensors (NH_4, Sulphide) and biofilms.
- Biopolymers: PHB, Xanthum gum.

Section - C

- Microbial overproduction of recombinant molecules: Selection of suitable promoter sequences, ribosome binding sites, transcription terminator, fusion protein tags, protease cleavage sites and enzymes, plasmid copy number, inducible expression systems.
- Large scale production using recombinant microorganisms.

Suggested Books:

- Braun,V. & Gotz, F. (Eds.). (2002). *Microbial Fundamentals of Biotechnology*. Wiley-Vch.
- Crueger, W., & Crueger, A. (1990). *Biotechnology, A Text Book of Industrial Microbiology* (2nd ed.). U.S: Sinauer Associates Inc
- Glazer, A.N. Nikaido, H. (2008). *Microbial Biotechnology*. Cambridge University Press.
- Kun, L.Y. (Ed.) (2003). *Microbial Biotechnology: Principles and Applications.* World Scientific Publication Co. Pvt. Ltd.

Suggested e-Resources:

- **Microbial Biotechnology**

  http://www.biologydiscussion.com/microbial-biotechnology-2/microbial-biotechnology-biotechnology-2/71609

- **Biosensor**

  https://www.nature.com/subjects/biosensors

- **Biofertilizer**

  www.krishisewa.com/articles/organic-agriculture/115-biofertilizers.html

- **Biopesticide**

  www.agriinfo.in/default.aspx?page=topic&superid=3&topicid=1950

BT 427 Molecular Modeling and Drug Designing

Max. Marks : 100	L	T	P	C
(CA: 40 + ESA: 60)	4	0	0	4

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the scope of pharmacokinetics and computer aided drug designing.
- identify and search potential drug leads using various tools of computational biology.
- understand the concept of drug designing relevant for pharmaceutical industries

Section – A

- Protein conformations, folding and mutation through modeling. The multi drug resistance proteins, drug carrier affecting drug response, pharmacokinetic basis of individual difference in response to drugs, pharmacokinetic properties, influence of structural modifications on pharmacokinetic properties, pharmacodynamics studies.

Section – B

- Introduction to semi-empirical, molecular mechanics and ab intio techniques, potential energy surfaces, docking and modeling substrate receptor interactions, software tools for modeling bimolecular, molecular electrostatic potentials, charge analysis. different docking methodologies, success stories in docking.

Section – C

- A brief introduction to drug design methodologies, structure based drug designing, ligand based drug designing. quantitative structure activity relationship (QSAR), present and future aids to drug design, structure and confirmation of drugs and receptors, drug receptor binding forces, structural aspects of drug-nucleic acid interactions.
- Pharmacophore identification, pharmacophore modeling, pharmacophore mapping, pharmacophore generation, hiphop and hypogen theories.

Suggested Books:

- Hinchliffe, A. (1998). *Modelling molecular structures*. Biochemical Education.
- Leech, A.R. (2001). *Molecular modeling: principles and applications* (2nd ed.). USA: Pearson.
- Perun, T.J., & Propst, C.L. (1989). *Computer-aided drug design: Methods and applications*. New York: Marcel Dekker.
- Tommy, L., Larsen, P.K., & Madsen, U. (2002). *Textbook of Drug Design and Discovery* (3rd ed.). USA: CRC Press.

Suggested e-Resources:

- **Drug design and Discovery**
  https://nptel.ac.in/courses/104103071/pdf/mod15.pdf
- **Bioinformatic tools**
  https://nptel.ac.in/courses/102103044/pdf/mod6.pdf
- **Pharmacophore modeling**
  https://www.dovepress.com/pharmacophore-modeling-advances-limitations-and-current-utility-in-dru-peer-reviewed-fulltext-article-JRLCR

BT 428 Nanotechnology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the basic concepts of nanobiotechnology.
- apply engineering concepts to the nano-scale domain and design processing conditions.
- understand the legal issues in nanotechnology and environmental risk assessment.

Section – A

- Introduction to nanotechnology.

- Current and future market applications: Semiconductor manufacturing, advanced composites, advanced ceramics, catalytic and photocatalytic applications, gas sensors and other analytical devices, consumer products, drug delivery mechanisms and medical therapeutics, micro electronic applications.
- Legal considerations for nanotechnology.
- Environmental risk assessment, health risk assessment, hazards risk assessment.

Section – B

- Prime Materials: Metals, iron, aluminum, nickel, silver, gold, copper and their oxides, silica products.
- Nonmaterial Types: Nanowires, nanotubes and their synthesis, properties, applications.
- Fullerenes, quantum dots, dendrimers, Properties.
- Method of preparation: Top down, bottom up, plasma orcing, chemical vapour deposition, sol – gel methods.

Section – C

- Self assembled monolayers, bio molecular motors and their functions.
- Proteins and applications.
- Drug delivery systems - Nanofluidic, fluids at micro and nanometer scale, fabrication of nanoporous and nanofluidic devices, applications.

Suggested Books:

- Bhattacharya, S. (2013). *Introduction to Nanotechnology*. New Delhi: Wisdom Press.
- Bhushan, B. (2017). *Springer Handbook of Nanotechnology*. Berlin, Heidelberg: Springer Berlin Heidelberg.
- Di, V. M. (2008). *Introduction to Nanoscale Science and technology*. New York, NY: Springer.
- Wilson, M. (2004). *Nanotechnology: Basic Science and Emerging Technologies*. Boca Raton: Chapman & Hall/CRC.

Suggested e-Resources:

- **Nanofluidic devices**

  https://aip.scitation.org/doi/pdf/10.1063/1.4794973?class=pdf

- **Preparation of Nanomaterial**

  https://nptel.ac.in/courses/103103033/module9/lecture2.pdf

BT 430 Plant Secondary Metabolites

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand isolation techniques for plant secondary metabolites and their biosynthetic pathway.
- gain basic concepts in the production of secondary metabolites and factors affecting it
- understand large scale production and applications of various secondary metabolites.

Section – A

- Introduction to secondary metabolites.
- Plant products in nature.
- Occurrence, types and uses of plant products.
- Basic tools and techniques used in isolation & separations of plant secondary metabolites.
- Biosynthesis of secondary metabolites- Shikimate, Acetate-malonate and acetate-mevalonate pathways.

Section – B

- Secondary metabolite selection, effect of metabolism on secondary metabolite production.
- Production of secondary metabolites under stress factors.
- Production of alkaloids, steroids & saponins.
- Mechanism & control by different factors.

- Detoxification of secondary metabolites.

Section – C

- Production of secondary metabolites by bioconversion.
- Genetic transformation for production of secondary metabolites.
- Large scale production in bioreactors.
- Sources & types of antitumour compounds.
- Food additives and insecticides.

Suggested Books:

- Buchanan, B.B., Gruissem, W., & Jones, R.L. (2000). *Biochemistry & molecular biology of plants.* Rockville, Md.: American Society of Plant Physiologists.
- Noggle, G.R. and Fritz, C.J. (1986). *Introductory Plant Physiology*. (2nd ed.). New Delhi: Prentice Hall *of India* Pvt. Ltd.,
- Pandey, S.N. and Sinha, B.K. (1996). *Plant Physiology* (3rd revised ed.). New Delhi: Vikas Publishing House Pvt. Ltd.
- Ramavat, K.C. (2000). *Secondary Metabolites.* Oxford Press.
- Ross, C.W. (1974). *Plant Physiology Laboratory Manual*. California: Wadsworth Publishing Company.
- Salisbury, F.B. & Ross, C.W. (1991). *Plant Physiology* (4th ed.) Wadsworth Publishing Company.
- Taiz, L., & Zeiger, E. (2010). *Plant Physiology* (5th ed.). USA: Sinauer Associates lnc.,
- Witham, F.H., Devlin, R.M., & Blaydes, D.F. (1971). *Experiments in Plant Physiology*. New York: Van Nostrand Reinhold Co.

Suggested e-Resources:

- **Secondary metabolites**

  https://nptel.ac.in/courses/102103016/module4/lec32/3.html

- **Tools for production of secondary metabolites**

https://nptel.ac.in/courses/102103016/38

- **Industrial application**

  http://www.biologydiscussion.com/biotechnology/plant-biotechnology/secondary-metabolites-in-plant-cultures-applications-and-production/10646

RS 401 Geoinformatics

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course students will be able to

- describe spatial database, Co-ordinate and projection system
- analyze vector and raster based analysis in Geographical Information Sciences
- describe different types of satellite system and digital image processing
- describe global cover based global position systems i.e. GPS, GLONASS
- describe applications of remote sensing and GIS in natural resources management

Section A

Geographical Information System: Definition, Components of GIS, Hardware and software requirements for GIS, Coordinate system and projections, Database structure and formats, Spatial data models - raster and vector. Data inputting, Data base design - editing and topology creation. Linkage between spatial and Non spatial data, Query (Attribute/Spatial), Vector based analysis. Raster based analysis. Errors, Digital Elevation Model, Network analysis, O'pen source and WebGIS.

Section B

Remote Sensing: Definition - components of remote sensing - energy sensor, interacting body; Type - active and passive remote sensing. Satellite System - meteorological, communication and remote sensing. Platforms - aerial and space, synoptivity and repeativity. Electromagnetic Radiation (EMR) - EMR spectrum- visible, infrared [IR) middle IR, thermal IR and microwave. EMR interaction with earth surface material, radiance,

irradiance, incident, reflected, absorbed and transmitted energy, spectral response pattern - spectral signature curves (water, soil and vegetation].

Digital Image Processing : Digital Image, Satellite Image - characteristics and formats. Resolution - spatial, spectral, radiometric and temporal; Introduction to rectification, enhancement; Classification - Unsupervised and Supervised classification.

Section C

Global Positioning System: Global Navigation Satellite System (GNSS), GPS, GLONASS, GALILEO, Segments - space, control, user, GPS Satellite signals, sources of errors and corrections.

Applications of Remote Sensing and GIS:

Applications of GIS and Remote Sensing in resource management (forestry, agriculture, urban telecommunication, transportation, water resources and environment).

Suggested Books:

1. Lo, C. P., & Yeung, A. K. (2002). *Concepts and techniques of geographic information systems*. Upper Saddle River, NJ: Prentice Hall.
2. Ian, H. (2010). *An introduction to geographical information systems*. Pearson Education India.
3. Joseph, G. (2005). *Fundamentals of remote sensing*. Universities press.
4. Jensen, J. R., & Lulla, K. (1987). *Introductory digital image processing: a remote sensing perspective*. Prentice Hall.
5. Sabins, F. F., & Sensing, R. (1987). *Principles and interpretation: Remote sensing.* San Francisco.

Suggested E-Learning Material:

1. GIS in Civil Engineering
   https://nptel.ac.in/courses/105102015/
2. Geospatial Information and Services
   http://www.oc.nps.edu/oc2902w/gis/gisdemo/

BT 433 Bioethics and Biosafety

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- explain role of biotechnology in sustainable research and various ethical implications.
- understand biosafety–objective, implementation, necessity and legislations.
- develop preliminary understanding of Intellectual Property with emphasis on patents.

Section – A

- Global biotech issues: major categories and impact, convention of Biological Diversity- formation and scope, Bonn guidelines, Nagoya protocol, Cartagena protocol: history, conception and implementation of the protocol, impact on nations, main areas covered.
- Access and Benefit sharing: concept, convention on biological diversity and its impact on ABS, regulation of ABS and impact on developed and developing countries, main features of Indian Biodiversity Act and importance of traditional knowledge.
- Environmental sustainability: concept of sustainable development, types and factors, significance for development and developing countries.
- Concept of legality, morality and ethics; Concept and Principles of bioethics: expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology: interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, case studies: Abortion, euthanasia, organ donation.

Section – B

- Biosafety: concept and definition of risks, hazards and various terminologies associated with hazard assessment and management, Biotechnology and Biosafety concerns, public acceptance in biotechnology .
- Levels of Biosafety: concept, levels and their descriptions (specific for plants, animals and microbes).

- General concepts: Good lab practices (GLP), Good manufacturing practices (GMP), Good clinical practices (GCP) and Good large scale practices (GLSP), chemical and biological hazards: disposal and safeguards.
- Biosafety Assessment- A general perspective, Biotechnology safety regulations - India, U.S.A, European Union (EU), China. Ecological and food safety assessment of GM crops. Convention on biological weapons.

Section – C

- IPR: introduction, origin, history and types, role of WTO including TRIPS and WIPO in IPR, significance of Budapest Treaty
- Patents: brief description, types, basic idea of patent application and procedure, Patent Cooperation Treaty, challenges in Patents
- International Union for the protection of new varieties of plants (UPOV), plant breeder's rights, farmer's rights, ethical impacts of IPR,
- Technology transfer (concept and significance), ownership and monopoly, case studies in IPR

Suggested Books:

- Fleming D. O. & Hunt D. L (Eds.). (2006). *Biological Safety: Principles & Practices* (4th ed.). ASM Press
- Goel D. & Parashar S. (2013). *IPR, Biosafety and Bioethics* (1st ed.) Pearson Education India.
- Ignacimuthu, S. (2008). *Bioethics*. Alpha Science International Ltd.
- Pandey, N. & Dharni, K. (2014). *Intellectual Property Rights*. PHI Learning.
- Ramakrishna, B. & Kumar, A. (2017). *Fundamentals of Intellectual Property Rights: For Students, Industrialist and Patent Lawyers* (1st ed.). Notion Press.
- Rehm, H.J & Reed, G. (1995). *Biotechnology – A Comprehensive Treatise Legal, Economic and Ethical Dimensions.* Vch Verlagsgesellschaft Mbh.
- Sateesh, M.K. (2008). *Bioethics and Biosafet*y. New Delhi: I.K. International Publishing House.

Suggested e-Resources:

- **Access and Benefit sharing, Convention of Biological Diversity, Cartegena Protocol**

  https://www.cbd.int/convention

- **Bioethics**

  http://www.unesco-chair-bioethics.org/?page_id=43

- **Biosafety**

  https://ehs.missouri.edu/bio/principles

- **Biosafety, Risk assessment and management**

  http://www.fao.org/docrep/014/i1905e/i1905e02.pdf

- **IPR**

  https://www.wipo.int/portal/en/index.html

BT 316 Enzyme Engineering and Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
(CA: 40 + ESA: 60)	**4**	**0**	**0**	**4**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand structure, functions and the mechanisms of action of enzymes.
- develop concept of regulation of enzyme activity.
- identify industrially relevant enzymes and their application.

Section – A

- Brief history of enzymes, nomenclature and classification of enzymes.
- Specificity of enzymes: Types of specificity, the Koshland "induced fit" hypothesis.
- Strain or transition – state stabilization hypothesis.
- Mechanism of enzyme action: Chymotrypsin and carboxypeptidase A.
- Enzyme catalysis and kinetics: Factors affecting the rate of chemical reactions, kinetics of enzyme-catalyzed reaction, Michaelis-Menten laws, importance and determination of V_{max} and K_m values, Hofstee's

plot, L & B plots, Methods for investigating the kinetics of enzyme-catalyzed reactions (single and bisubstrate), nature of enzyme catalysis.

- Enzyme inhibition: types and their kinetics.

Section – B

- Extraction of soluble and membrane bound enzymes.
- Purification of enzymes: salt precipitation, gel filtration, ion exchange and affinity chromatography.
- Regulation of enzyme activity, various controls (metabolic compartmentation, covalent modifications and others), feedback regulation, allosteric enzymes.
- The investigation of active site structure and chemical nature of enzyme catalysis: The identification of binding sites and catalytic site, three dimensional structure of active site, mechanism of catalysis, mechanism of reaction catalyzed by enzyme without cofactors, metal-activated enzyme and metalloenzyme, coenzymes in enzyme catalyzed reactions.
- The impact of genetic engineering on enzyme production, modification of structural and catalytic properties by chemical methods and genetic engineering, enzymes from extremophiles, enzymes in organic solvent.

Section – C

- Immobilization of enzymes: Concept, methods of immobilization, kinetics of immobilized enzymes, effect of solute partition and diffusion on kinetics of immobilized enzymes, bioreactors using immobilized enzyme.
- Industrial enzymes: traditional (non-recombinant) sources of industrial enzymes,
- Proteases and carbohydrases: Proteolytic enzymes, carbohydrases, lignocellulose degrading enzymes, pectin and pectic enzymes.
- Additional industrial enzymes: Lipases, penicillin acylase, amino acylase and amino acid production, cyclodextrins and cyclodextrin glycosyl transferase, enzymes in animal nutrition, oxidoreductases.
- Enzymes in molecular biology and clinical diagnostics.

Suggested Books:

- Bhaskar, A., Vidhya, V. G. (2014). *Enzyme Technology*. India: Mjp Publishers.
- Copeland, R. A. (2000). *Enzymes: A Practical Introduction to Structure, Mechanism, and Data Analysis*. USA: John Wiley & Sons.
- Devasena, T. (2010). *Enzymology* (3rd ed.). UK: Oxford University Press.
- Meena, M., & Chauhan, D. (2009). *Fundamentals of Enzymology*. Jaipur, India: Aavishkar publishers.
- Palmer, T., & Bonner, P. (2008). *Enzymes: Biochemistry, Biotechnology, Clinical Chemistry* (2nd ed.). India: East West Publications.
- Scopes, R. K. (2013). *Protein Purification: Principles and Practice* (3rd ed.). USA: Springer.
- Segel, I. H. (2010). *Biochemical Calculations* (Second Edition). India: Wiley India Pvt. Ltd.

Suggested e-Resources:

- **Mechanism of chymotrypsin**
  https://slideplayer.com/slide/5116894/
- **Factors affecting rate of chemical reaction**
  https://byjus.com/chemistry/rate-of-reaction/
- **Extraction and purification of enzyme**
  http://chemsites.chem.rutgers.edu/~kyc/Teaching/Files/543-05/09%20544-10%20ppt.pdf

Reading Elective

BT 426R Molecular Diagnostics

Max. Marks : 100	**L**	**T**	**P**	**C**
ESA : 100	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand techniques used to diagnose diseases.
- apply the gained knowledge in pursuing career in diagnostic labs and related research areas.

The successful treatment of diseases essentially depends on the early and accurate detection of pathogens. Conventional methods are available for detection of infectious agents but often they are time consuming and costly. Over the last decade, molecular diagnostics has become the gold standard to detect genetic disorders and infectious disease. These techniques are sensitive and allow detection of even lower amounts of infectious agents, thus, allowing early detection of infections. Molecular diagnostic methods include: immunological (ELISA), Monoclonal Antibodies, biofluorescent and bioluminescent systems (Colored fluorescent proteins, luciferase and microbial biosensors), nucleic acid diagnostic systems (hybridization probes, molecular beacons, DNA fingerprinting, RAPD, Real-Time PCR, Immunoquantitative Real-Time PCR and automated DNA analysis). Further, for the detection of genetic disorders like cystic fibrosis and sickle-cell anemia methods viz., PCR/OLA, padlock probes, genotyping with fluorescence labelled PCR primers and TaqMan assay and mutation detection (PCR-Single strand conformation polymorphism, PCR-denaturing gradient gel electrophoresis and mismatch chemical cleavage) are generally employed.

Suggested Books:

- Glick B.R., Pasternak J.J., & Patten C.L. (2010). *Molecular Biotechnology: Principles and applications of recombinant DNA* (4th ed). American Society for Microbiology.
- Primrose, S.B., Twyman R.H., & Old R.W. (2001). *Principles of Gene Manipulation* (6th ed). Wiley-Blackwell.

Suggested e-resources

- **PCR-Denatured gradient gel electrophoresis**
  https://www.scq.ubc.ca/denaturing-gradient-gel-electrophoresis-dgge-an-overview/
- **PCR-Single strand conformation polymorphism**
  https://genome.cshlp.org/content/1/1/34.long
- **Mismatch chemical cleavage**
  https://link.springer.com/protocol/10.1385/1-59259-870-6:183

BIO 601R Biodiversity and Conservation

Max. Marks : 100	**L**	**T**	**P**	**C**
ESA : 100	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- gain knowledge of various aspects of ecosystems.
- understand the physiological and ecological adaptations of different organisms for survival and growth in various types of natural and engineered ecosystems.

India is considered as a mega diversity zone and falls among the major biodiversity hot spots of the world. It is necessary to understand distribution and types of biodiversity seen in India especially with respect to ecological diversity, species diversity and genetic diversity. However, due to several reasons, there has been severe biodiversity loss not only in India but globally. Thus, study of species extinction (local, ecological, biological, background extinction, anthropogenic extinction) based on IUCN status categories and Red Data Book is necessary to plan biodiversity preservation and conservation strategies. The knowledge of endangered species in India and various conservation strategies both *in situ* (biosphere reserve, national park, wildlife sanctuaries, sacred forests) and *ex situ* (cryo-preservation, Gene banks, DNA banks) are important aspects to maintain biodiversity.

Books Recommended:

- Krishnamurthy, K.V. (2003). *Textbook of Biodiversity* (1st ed). USA: CRC Press publisher.
- Sharma, A.K., Ray, D., Ghosh, S.N. (2012). *Biological Diversity: Origin, Evolution and Conservation*, New Delhi: Viva Books publisher.
- Wilson, E.O., Peter, F.M. (1988). *Biodiversity*. Washington, D.C., USA: National Academy press.

Suggested e-Resources:

- **Biodiversity conservation**

  https://link.springer.com/content/pdf/10.1007%2Fs10531-015-0860-5.pdf
- **Biodiversity**

  http://ncert.nic.in/ncerts/l/lebo115.pdf
- **Conservation**

  https://byjus.com/biology/biodiversity-conservation/

BT 432R Emerging Trends in Biofuel Technology

Max. Marks : 100	**L**	**T**	**P**	**C**
ESA : 100	**0**	**0**	**4**	**2**

Learning Outcomes:

After successful completion of the course, students should be able to:

- understand the production of different types of biofuel.
- understand the environmental and social sustainability aspects of biofuel.
- understand the present energy scenario and the analyze need for energy conservation.

Globally, fuel from biomass has immense potential as a commercially viable renewable energy source. Three generations of biomass identified for

energy use have been described (crop plants, lingo-cellulosic material and microbial systems). Biomass can be converted to fuels, electricity, and process heat. The study of different methodologies for biomass extraction (anaerobic digestion, gasification, fermentation, liquefaction) and their conversion to various fuels like biodiesel, bio-hydrogen, bio-ethanol and biogas is important. Considering the environmental ramifications, the study of biomass based energy is important for achieving environmental and social sustainability.

Suggested Books:

- Chiogioji, M. (1979). *Industrial Energy Conservation*. New York, USA: McGraw Hill.
- Gude, V.G. (2018). *Green chemistry for sustainable biofuel production*. Oakville, ON Waretown, NJ AAP, Apple Academic Press [Boca Raton] CRC Press, Taylor & Francis Group.
- In Gikonyo, B. (2015). *Efficiency and sustainability in biofuel production: Environmental and land-use research*. Oakville, ON Canada; Waretown, NJ, USA: Apple Academic Press.
- Singhal, R.K. (2013). *Non -conventional energy sources*. New Delhi: S.K. Kataria & Sons publishers.

Suggested e-Resources:

- **Technology for biofuel**

  https://nptel.ac.in/courses/108108078/7

- **Biofuel**

  http://www.teriin.org/policybrief/docs/biofuel.pdf

- **Biogas plant**

  http://cdn.intechopen.com/pdfs/31334/InTech-Biogas_plant_ constructions.pdf.

Online Discipline Elective Courses

Course Name and URL link
Bioreactor:
https://swayam.gov.in/course/1339-bioreactors
Principles of Downstream techniques in Bioprocess:
https://nptel.ac.in/syllabus/102106048/
Industrial Biotechnology:
https://www.courera.org/learn/industrial-biotech

Online Reading Elective Courses

Course Name and URL link
Drug Discovery:
https://www.coursera.org/learn/drug-discovery
Proteins and Gel-Basel Proteomics:
https://swayam.gov.in/course/1386-proteins-and-get-based-proteomics
Online course on IPR:
https://www.ili.ac.in/e-learnIPR.htm