NOIDA INSTITUTE OF ENGG. & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Affiliated to

DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY UTTAR PRADESH, LUCKNOW

Evaluation Scheme & Syllabus

For

Bachelor of Technology

Biotechnology

Third Year

(Effective from the Session: 2023-24)

NOIDA INSTITUTE OF ENGG. & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology
Biotechnology
EVALUATION SCHEME
SEMESTER-V

Sl. No.	Subject Codes	Subject Name	Periods			Evaluation Scheme			End Semester			Total	Credit
			L	T	P	CT	TA	TOTAL	PS	TE	PE		
WEEKS COMPULSORY INDUCTION PROGRAM													
1	ABT0501	Analytical Techniques	3	0	0	30	20	50		100		150	3
2	ABT0502	Bioprocess Engineering	3	1	0	30	20	50		100		150	4
3	ABT0503	Plant Biotechnology	3	1	0	30	20	50		100		150	4
4	ACSE0503	Design Thinking-II	2	1	0	30	20	50		100		150	3
5		Departmental Elective-I	3	0	0	30	20	50		100		150	3
6		Departmental Elective-II	3	0	0	30	20	50		100		150	3
7	ABT0551	Analytical Techniques Lab	0	0	2				25		25	50	1
8	ABT0552N	Bioprocess Engineering Lab	0	0	2				25		25	50	1
9	ABT0553	Plant Biotechnology Lab	0	0	2				25		25	50	1
10	ABT0559	Internship Assessment	0	0	2				50			50	1
11	ANC0501 /ANC0502	Constitution of India, Law and Engineering / Essence of Indian Traditional Knowledge	2	0	0	30	20	50		50		100	
12		MOOCs (Essential for Hons. Degree)											
		GRAND TOTAL										**1100**	**24**

List of MOOCs (Coursera) Based Recommended Courses for Second Year (Semester-V) B. Tech Students

S. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	AMC0068	Creative thinking: Techniques and tools for success	Imperial College London	20	1.5
2	AMC0080	Industrial Biotechnology	University of Manchester	11	0.5

PLEASE NOTE:-

- **Internship (3-4 weeks) shall be conducted during summer break after semester-IV and will be assessed during semester-V**
- **Compulsory Audit Courses (Non Credit- ANC0501/ANC0502)**
  - All Compulsory Audit Courses (a qualifying exam) has no credit.
  - Total and obtained marks are not added in the Grand Total.

Abbreviation Used: -

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam., PE: Practical End Semester Exam.

List of Departmental Electives

Sl. No.	Departmental Electives	Subject Codes	Subject Name	Bucket Name	Branch	Semester
1	Elective-I	ABT0511	Biochemical Reaction Engineering	Core Biotech	BT	5
2	Elective-II	ABT0513	Bioenergy Technologies and Systems		BT	5
3	Elective-I	ABT0512	Artificial Intelligence in Biotechnology	Computational Biotech	BT	5
4	Elective-II	ABT0514N	Data Science		BT	5

NOIDA INSTITUTE OF ENGG. & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology

Biotechnology

EVALUATION SCHEME

SEMESTER-VI

Sl. No.	Subject Codes	Subject Name	Periods			Evaluation Scheme			End Semester			Total	Credit
			L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	ABT0601	Bioseparation Engineering	3	1	0	30	20	50		100		150	4
2	ABT0602	Metabolic Engineering	3	0	0	30	20	50		100		150	3
3	ABT0603	Nanobiotechnology	3	0	0	30	20	50		100		150	3
4		Departmental Elective -III	3	0	0	30	20	50		100		150	3
5		Departmental Elective -IV	3	0	0	30	20	50		100		150	3
6		Open Elective I	3	0	0	30	20	50		100		150	3
7	ABT0651	Bioseparation Engineering Lab	0	0	2				25		25	50	1
8	ABT0652	Metabolic Engineering Lab	0	0	2				25		25	50	1
9	ABT0653	Nanobiotechnology Lab	0	0	2				25		25	50	1
10	ABT0659	Mini Project	0	0	2				50			50	1
11	ANC0602 / ANC0601	Essence of Indian Traditional Knowledge / Constitution of India, Law and Engineering	2	0	0	30	20	50		50		100	
12		MOOCs (For B.Tech. Hons. Degree)											
		GRAND TOTAL										**1100**	**23**

List of MOOCs (Coursera) Based Recommended Courses for Second Year (Semester-VI) B. Tech Students

S. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	AMC0109	Drug Development: Product management specialization	University of California San Diego	28	2
2	AMC0111	Epigenetics: control of gene expression	The University of Melbourne	17	1

PLEASE NOTE:-

- **Internship (3-4 weeks) shall be conducted during summer break after semester-VI and will be assessed during semester-VII.**
- **Compulsory Audit Course (Non Credit - ANC0601/ANC0602)**
  - All Compulsory Audit Courses (a qualifying exam) has no credit.
  - Total and obtained marks are not added in the Grand Total.

Abbreviation Used: -

L: Lecture, T: Tutorial, P: Practical, CT: Class Test, TA: Teacher Assessment, PS: Practical Sessional, TE: Theory End Semester Exam., PE: Practical End Semester Exam.

List of Departmental Electives

Sl. No.	Departmental Electives	Subject Codes	Subject Name	Bucket Name	Branch	Semester
1	Elective-III	ABT0611	Bioreactor Analysis and Design	Core Biotech	BT	6
2	Elective-IV	ABT0613	Biofuels & Alcohol Technology		BT	6
3	Elective-III	ABT0612	Probability and Statistics using R in Biotechnology	Computational Biotech	BT	6
4	Elective-IV	ABT0614	Machine Learning		BT	6

NOIDA INSTITUTE OF ENGG. & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
(AN AUTONOMOUS INSTITUTE)

Bachelor of Technology
Biotechnology

AICTE Guidelines in Model Curriculum:

A student will be eligible to get Under Graduate degree with Honours only, if he/she completes the additional MOOCs courses such as Coursera certifications, or any other online courses recommended by the Institute (Equivalent to 20 credits). During Complete B.Tech. Program Guidelines for credit calculations are as follows.

1. For 6 to 12 Hours =0.5 Credit
2. For 13 to18 =1 Credit
3. For 19 to 24 =1.5 Credit
4. For 25 to 30 =2 Credit
5. For 31 to 35 =2.5 Credit
6. For 36 to 41 =3 Credit
7. For 42 to 47 =3.5 Credit
8. For 48 and above =4 Credit

For registration to MOOCs Courses, the students shall follow Coursera registration details as per the assigned login and password by the Institute these courses may be cleared during the B. Tech degree program (as per the list provided). After successful completion of these MOOCs courses, the students shall provide their successful completion status/certificates to the Controller of Examination (COE) of the Institute through their coordinators/Mentors only.

The students shall be awarded Honours Degree as per following criterion.

i. If he / she secures 7.50 as above CGPA.
ii. Passed each subject of that degree program in the single attempt without any grace.
iii. Successful completion of MOOCs based 20 credits.

Course Code	ABT0501	L T P	Credits
Course Title	Analytical Techniques	3 0 0	3

Course objective:

1	The primary objectives of this course are to develop the skills to understand the theory and practice of bio analytical techniques.	K1, K2, K3
2	To provide scientific understanding of analytical techniques and detail interpretation of results.	K1, K2, K3, K4
3	To demonstrate a broad understanding of life science technologies.	K1, K2, K3, K4, K5
4	To demonstrate ability to plan and execute experiments and analyse and interpret outcomes.	K1, K3, K4, K5, K6
5	To make them understand the use of different analytical techniques for the separation of biological sample.	K1, K2

Pre-requisites: Students should know about the basic techniques of biotechnology.

Course Contents / Syllabus

UNIT-I	Microscopy	8 hours

Light microscopy, Bright & Dark Field microscopy, Fluorescence microscopy, Phase Contrast microscopy, Electron microscopy: Transmission electron microscopy (TEM) and Scanning electron microscopy (SEM), Atomic force microscopy and confocal microscopy

UNIT-II	Chromatography	8 hours

Introduction & classification of chromatography, Ion-Exchange, Affinity, Hydrophobic, Size exclusion, High performance liquid chromatography (HPLC), Gas Chromatography (GC).

UNIT-III	Spectroscopy	8 hours

Electromagnetic radiation and spectrum, Atomic absorption and Atomic emission spectroscopy, Principle, working and applications of UV-VIS, NMR, and FTIR spectroscopy, Raman and Rayleigh spectroscopy, Fluorescence (steady-state and time resolved), Mass spectroscopy-MALDI, LC-MS, GC-MS, MS-MS, Surface Plasmon Resonance (SPR), Principle and applications of Positron Emission Tomography

UNIT-IV	Electrophoresis	8 hours

Theory of Electrophoresis, Factors affecting the migration of substances, Gel electrophoresis, SDS-PAGE, Native PAGE, Agarose gel electrophoresis of Nucleic Acid, Capillary Electrophoresis, 2-D Electrophoresis, Isoelectric Focusing of Protein.

UNIT-V	Centrifugation and Sedimentation	8 hours

Theory of centrifugation and sedimentation. Types of centrifuges, Ultracentrifugation, Density gradient centrifugation, Preparative and analytical centrifugation, Applications of centrifugation for preparative and analytical purpose.

Course outcome: After completion of this course students will be able to

CO 1	Demonstrate principles and various components of different microscope to analyse and characterize biomolecules	K1, K2, K3, K4,
CO 2	Describe the general principle of chromatographic separations and apply these techniques to the separation of a hypothetical protein sample	K1, K2, K3
CO 3	Analyse the regions of electromagnetic spectrum and relate it to spectroscopic methods	K1, K2, K3 K4
CO 4	Describe the basic principle of gel electrophoresis	K1, K2
CO 5	Apply centrifugation techniques for the separation of biological samples	K1, K2, K3

Text books

1	Wilson, K, Walker, J., Principles and Techniques of Practical	

	Biochemistry. 5th Ed. - Cambridge University Press,. Cambridge 1999.	
2	Bioanalytical Techniques by A. Shourie and S SChapadgaonkar. TERI Press. 2015	
3	3D Bioprinting in Regenerative Engineering: Principles and Applications, Ali Khademhosseini&Gulden Camci-Unal, CRC Press (2018)	
Reference Books		
1	Biophysical Chemistry, Vol II by Charles R. Canter and Paul R. Shimmel.	
2	Protein Purification: Principles and Practice by Robert K. Scopes (Narosa).	
3	Sabari Ghosal&Anupama Sharma Awasthi., Fundamentals of Bioanalytical Techniques and Instrumentation, PHI learning Second edition (2018)	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=n18jMutR_z0	
Unit 2	https://www.youtube.com/watch?v=PMq02umihQk	
Unit 3	https://www.youtube.com/watch?v=2Y8pSoS0d1g	
Unit 4	https://www.youtube.com/watch?v=BM9qQ_sHWP8	
Unit 5	https://www.youtube.com/watch?v=jn8iT31w9s4	

Course Code	ABT0502	L T P	Credits
Course Title	Bioprocess Engineering	3 1 0	4
Course objective: Knowledge of basic microbiology			
1	To develop the knowledge about growth of microbes in bioreactor system		K2
2	To gain the information about importance of enzyme in bioprocess.		K2, K3
3	To enhance the knowledge about different scale of reactors.		K1
4	To develop the information about manufacturing of antibiotic and proteins		K1
5	To gain the knowledge about control of bioreactor		K1
Pre-requisites: Students should know about the basic microbiology.			
Course Contents / Syllabus			
UNIT-I	Microbial Growth and Stoichiometry		8 hours
Microbial growth kinetics, Parameters affecting microbial growth, substrate utilization and product formation kinetics, stoichiometry of growth and product formation, Yield coefficients of biomass and product formation, Quantitative analysis of microbial growth by direct and indirect methods.			
UNIT-II	Enzymes and Ideal Reactor Operation		8 hours
Principles of enzyme catalysis, enzyme kinetics study, immobilized enzymes and their types, bioreactors-batch, fed-batch or continuous bioreactors, Immobilized cell systems.			
UNIT-III	Bioreactor control mechanism		8 hours
Solid-state fermentations, energy balance and mass transfer, operation and control of bioreactors (aeration, agitation, heat transfer, mass transfer scale-up and scale-down of bioreactors).			
UNIT-IV	Application of Bioprocess Engineering		8 hours
Bioprocessing significance, Bioprocesses for the production of antibiotics, proteins, polysaccharides, aroma etc. Case studies on production of antibiotics, enzymes, insulin, bio-ethanol.			
UNIT-V	Modelling and Optimization in bioprocess Engineering		8 hours
Instrumentation and monitoring, Concept of sterilization, Types of sterilization, Batch and continuous sterilization, Optimization and process/mathematical modelling for enhanced product formation, Types of mathematical models in bioprocess engineering, examples of industrial bioprocesses.			
Course outcome: After completion of this course students will be able to			
CO 1	Develop the equation for microbial cell growth.		K2
CO 2	Understand the importance of enzymes and its immobilization.		K2, K3
CO 3	Understand the scale up concepts for bioprocesses.		K1
CO 4	Review the manufacturing processes for antibiotic and proteins.		K1
CO 5	Identify sensors and instruments needed for measurement and control.		K1
Text books			
1	Michael Shuler, FikretKargi, Matthew DeLisa, Bioprocess Engineering: Basic Concepts, 3rd Edition		
2	Pauline Doran, Bioprocess engineering principles		
3	Colin Ratledge, Bjorn Kristiansen, Basic Biotechnology, 2nd Edition, Cambridge University Press, 2001.		
Reference Books			
1	Roger Harrison et al., Bioseparations Science and Engineering, Oxford University Press, 2003.		
2	Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl		

3	Introduction to Biochemical Engineering, D. G. Rao Tata McGraw-Hill Education, 2005	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=_jiY8av92nM	
Unit 2	https://www.youtube.com/watch?v=WeJeKwMUGXc	
Unit 3	https://www.youtube.com/watch?v=S49ZhytFyZs	
Unit 4	https://www.youtube.com/watch?v=E4mdKlWndHA	
Unit 5	https://www.youtube.com/watch?v=NakBHy7HXPU	

Course Code	ABT0503	L T P	Credits
Course Title	Plant Biotechnology	3 0 0	3

Course objective:

1	The students will learn the fundamentals of culturing plant cells and tissues, culture environment, cell proliferation, differentiation, and media formulation.	K1, K2
2	Student would be able to understand the Laboratory setup for a typical plant tissue culture facility	K1, K2, K3, K4
3	The students will acquire knowledge on various recombinant DNA techniques to produce genetically modified plants with novel characteristics and benefits to mankind	K1, K3, K4
4	Student will learn different techniques of crop improvement as well as their preservation for longer duration.	K1, K3, K4
5	The students will acquire knowledge on various genome editing technologies to make desire changes in plants.	K1, K3, K4

Pre-requisites: Student should have basic knowledge of Plant physiology, growth development and cell biology

.

Course Contents / Syllabus

UNIT-I	**Plant tissue culture:**	**8hours**

History of plant tissue culture, plasticity and totipotency; Laboratory setup for a typical plant tissue culture facility; Sterilization methods used in plant tissue culture; Types of nutrient media and plant growth regulators in plant regeneration; Pathways for in vitro regeneration: organogenesis, somatic and gametic embryogenesis; protoplast isolation, culture, and regeneration; culture of other explants, somatic hybridization; Haploid and triploid production and their applications. Applications of micro-propagation, meristem culture, embryo rescue, somaclonal variations.

UNIT-II	**Principles and methods of genetic transformation:**	**8hours**

Introduction to Agrobacterium biology and biotechnology; Mechanism of T-DNA transfer to plants and Agro infection: *A. rhizogenes* and its application; Methods for direct gene transfer, Marker, and reporter genes; Plant viral vectors; Molecular techniques for analysis of transgenics (copy number, transgene stability, silencing; segregation); Marker-free transgenics and environmental, social, and legal issues associated with transgenic plants.

UNIT-III	**Crop Improvement:**	**8 hours**

The need of crop improvement; Conventional methods of crop improvement: selection, mutation, polyploidy, and clonal selection; Green revolution in India; Introduction to marker assisted breeding and selection; Application of tissue culture for crop improvement.

UNIT-IV	**Molecular Farming:**	**8 hours**

Transgenic crops for production of antibodies, viral antigens, and peptide hormones in plants; Edible vaccines and Nutraceuticals; Plant Biotechnology for biofuels; Methods for Plant Conservation: Cryopreservation; Production of bio active secondary metabolites by plant tissue culture.

UNIT-V	**Genome Editing:**	**8 hours**

The history of targeted mutations in plants: Use of ZFNs and TALENs as early tools for genome editing; Discovery of CRISPR-Cas system and its applications; Recent innovations in the technology and case studies where CRISPR- Cas has been used for plant improvement.

Course outcome: After completion of this course students will be able to

CO 1	Explain the basic methodology and applications of plant tissue culture	K1,K2,K3
CO 2	Understand the different techniques for characterization of plant gene and to identify those suitable for creating beneficial traits	K1,K2,K3

CO 3	Understand the beneficial role of plant tissue culture in crop improvement	**K1,K3,K4**
CO 4	Understand the concept of plant transformation, cell line development and cryopreservation techniques	**K1,K3,K4,**
CO 5	Describe the concept of genome editing and their applications.	**K1,K2,K3**
Text books		
1	Principles of Plant Genetics and Breeding by George Acquaah 2007. Blackwell Publishing.	
2	An introduction to Plant Tissue culture by MK Razdan. M.K. 2003. Oxford & IBH Publishing Co, New Delhi, 2003.	
3	Plant Tissue and Organ Culture fundamental Methods. Gamburg OL and Philips GC	
Reference Books		
1	Plant Biotechnology: An Introduction to Genetic Engineering by Adrian Slater, Nigel W. Scott, Mark R. Fowler. Oxford University Press, 2008.	
2	Biochemistry & Molecular Biology of Plants. Bob Buchanan, Wilhelm Gruissem, Russell Jones. John Wiley & Sons, 2002.	
3	Plant Biochemistry. Hans-Walter Heldt	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://nptel.ac.in/courses/102103016/	
Unit 2	https://youtu.be/ZqTGvSFbnxk	
Unit 3	https://nptel.ac.in/courses/102106080/	
Unit 4	https://nptel.ac.in/courses/107108011/	
Unit 5	https://nptel.ac.in/courses/109105115/	

Course Code	ACSE0503	L T P	Credits
Course Title	Design Thinking II	2 1 0	3

Course Objectives:

The objective of this course is to upgrade Design Thinking skills by learning & applying advanced and contextual Design Thinking Tools. It aims to solve a Real-Life Problem by applying Design Thinking to create an impact for all the stakeholders

Pre-requisites: Student must complete Design Thinking-I course

Course Contents / Syllabus

UNIT-I	Introduction	10 hours.

Design thinking & Innovation, Design Thinking Mindset and Principles, recap of 5-Step Process of Design Thinking, Design Approaches, additional in-depth examples of each design approaches. Simon Sinek's – Start with Why, The Golden Circle, Asking the "Why" behind each example *(an in-class activity of asking 5-WHYS)* , The Higher Purpose, *in-class activity for LDO & sharing insights*

Visualization and it's importance in design thinking, reflections on wheel of life (*in-class activity for visualization & Wheel of Life*), Linking it with Balancing Priorities (*in class activity), DBS* Singapore and Bank of Americas' Keep the Change Campaign. Litter of Light & Arvind Eye Care Examples, understanding practical application of design thinking tools and concepts, case study on McDonald's Milkshake / Amazon India's Rural Ecommerce & Gillette

Working on 1-hour Design problem, Applying RCA, and Brainstorm on innovative solutions.

Main project allocation and expectations from the project

UNIT-II	Refinement and Prototyping	8 hours.

Refine and narrow down to the best idea, 10-100-1000gm, QBL, Design Tools for Convergence – SWOT Analysis for 1000gm discussion. *In-class activity for 10-100-1000gm & QBL*

Prototyping (Convergence): Prototyping mindset, tools for prototyping – Sketching, paper models, pseudo-codes, physical mockups, Interaction flows, storyboards, acting/role-playing etc, importance of garnering user feedback for revisiting Brainstormed ideas,

Napkin Pitch, Usability, Minimum Viable Prototype, Connecting Prototype with 3 Laws, A/B Testing, Learning Launch. Decision Making Tools and Approaches – Vroom Yetton Matrix, Shift-Left,Up,Right, Value Proposition, Case study: Careerbuddy,You-Me-Health Story & IBM Learning Launch.

In-class activities on prototyping- paper-pen / physical prototype/ digital prototype of project's 1000gm idea

UNIT-III	Storytelling, Testing and Assessment	8 hours.

Storytelling: Elements of storytelling, Mapping personas with storytelling, Art of influencing, Elevator Pitch, Successful Campaigns of well-known examples, *in-class activity on storytelling.*

Testing of design with people, conducting usability test, testing as hypothesis, testing as empathy, observation and shadowing methods, Guerrilla Interviews, validation workshops, user feedback, record results, enhance, retest, and refine design, Software validation tools, design parameters, alpha &beta testing, Taguchi, defect classification, random sampling

Final Project Presentation and assessing the impact of using design thinking

UNIT-IV	Innovation, Quality and Leadership	6 hours.

Innovation: Need & Importance, Principles of innovations, Asking the Right Questions for innovation, Rationale for innovation, Quality: Principles & Philosophies, Customer perception on quality, Kaizen, 6 Sigma. *FinTech case study of Design Thinking application – CANVAS*

Leadership, types, qualities and traits of leaders and leadership styles, Leaders vs Manager, Personas of Leaders & Managers, Connecting Leaders-Managers with 13 Musical Notes, Trait theory, LSM (Leadership Situational Model), Team Building Models: Tuckman's and Belbin's. Importance of Spatial elements for innovation

UNIT-V	Understanding Human Desirability	8 hours.

Program needed to achieve the comprehensive human goal: the five dimensions of human endeavour(ManaviyaVyavstha) are: Education- Right living (Sikhsa- Sanskar), Health – Self-regulation (SwasthyaSanyam), Justice – Preservation (Nyaya- Suraksha), Production – Work (Utpadan – Karya), Exchange – Storage (Vinimya – Kosh), Darshan-Gyan-Charitra (Shifting the Thinking)

Interconnectedness and mutual fulfilment among the four orders of nature recyclability and self-regulation

in nature, thinking expansion for harmony: Self-exploration (Johari's window), group behaviour, interpersonal behaviour and skills, Myers-Briggs personality types (MBTI), FIRO-B test to repair relationships.

Course outcome: After completion of this course, students will be able to

CO 1	Learn sophisticated design tools to sharpen their problem-solving skills	K2
CO 2	Generate innovative ideas using design thinking tools and converge to feasible idea for breakthrough solution	K3, K4
CO 3	Implement storytelling for persuasive articulation	K3
CO 4	Understanding the nature of leadership empowerment	K2
CO 5	Understand the role of a human being in ensuring harmony in society and nature.	K2

Textbooks

1. Arun Jain, UnMukt : Science & Art of Design Thinking, 2020, Polaris
2. Gavin Ambrose and Paul Harris, Basics Design 08: Design Thinking, 2010, AVA Publishing SA
3. R R Gaur, R Sangal, G P Bagaria, A Foundation Course in Human Values and Professional Ethics, First Edition, 2009, Excel Books: New Delhi

Reference Books

1. Jeanne Liedta, Andrew King and Kevin Benett , Solving Problems with Design Thinking – Ten Stories of What Works, 2013, Columbia Business School Publishing
2. DrRituSoryan, Universal Human Values and Professional Ethics, 2022, Katson Books
3. Vijay Kumar, 101 Design Methods: A Structured Approach for Driving Innovation in Your Organization, 2013, John Wiley and Sons Inc, New Jersey
4. Roger L. Martin, Design of Business: Why Design Thinking is the Next Competitive Advantage, 2009, Harvard Business Press, Boston MA
5. Tim Brown, Change by Design, 2009, Harper Collins
6. PavanSoni, Design your Thinking : The Mindsets, Toolsets and Skill Sets for Creative Problem-Solving, 2020, Penguin Books

NPTEL/ YouTube/ Web Link

Unit I https://www.youtube.com/watch?v=6_mHCOAAEI8
https://nptel.ac.in/courses/110106124
https://designthinking.ideo.com/
https://blog.experiencepoint.com/how-mcdonalds-evolved-with-design-thinking

Unit II https://www.coursera.org/lecture/uva-darden-design-thinking-innovation/the-ibm-story-iq0kE
https://www.coursera.org/lecture/uva-darden-design-thinking-innovation/the-meyouhealth-story-part-i-what-is-W6tTs
https://onlinecourses.nptel.ac.in/noc19_mg60/preview

Unit III https://nptel.ac.in/courses/109/104/109104109/
https://www.d-thinking.com/2021/07/01/how-to-use-storytelling-in-design-thinking/

Unit IV https://www.worldofinsights.co/2020/10/infographic-8-design-thinking-skills-for-leadership-development/

Unit V https://www.youtube.com/watch?v=hFGVcx1Us5Y

Course Code	ABT0511	L T P	credits
Course Title	Biochemical Reaction Engineering	3 0 0	3
Course objective:			
1	To develop the knowledge about basics of biochemical reaction engineering		K2
2	To gain the information about kinetics of free and immobilized enzyme catalyzed reactions		K2, K3
3	To enhance the knowledge about kinetics of substrate utilization, product formation and biomass production		K1
4	To develop the information about type of reactors		K1
5	To gain the knowledge about kinetics of mixed cultures		K1
Pre-requisites: Students should know about the basic microbiology and cell biology			
Course Contents / Syllabus			
UNIT-I	**Introduction to Biochemical reaction engineering**		**8hours**
Kinetics of homogeneous reactions, reaction mechanism, Temperature dependency from Arrhenius law, Theoretical prediction of rate constant: Interpretation of batch kinetic data.			
UNIT-II	**Kinetics of enzyme catalyzed reactions in free and immobilized states**		**8hours**
Michaelis-Menten equation and its various modifications, Mechanism and application of Michaelis-Menten equation, Lineweaver-Burk plot, Effects of External mass transfer in immobilized enzyme systems, analysis of intraparticle diffusion and reaction.			
UNIT-III	**Kinetics of substrate utilization, product formation and biomass production**		**8hours**
Monod growth model and its various modifications, structured and unstructured kinetic rate models, Thermal death kinetics of cells & spores, Transport phenomena in bioprocess systems, gas-liquid mass transfer in cellular systems, Mass transfer for bubbles swarms.			
UNIT-IV	**Types of Reactors**		**8hours**
Batch, plug flow reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air life Fermenter etc., Concept and models of ideal and non-ideal reactor: residence time distribution, Operating considerations in bioreactors for suspension and immobilized cultures, modifying batch and continuous reactors, immobilized cell systems, solid state fermentation.			
UNIT-V	**Kinetics of mixed cultures**		**8hours**
Major classes of interaction in mixed cultures, models describing mixed-culture interactions, reaction dynamics, and industrial application of mixed cultures.			
Course outcome: After completion of this course students will be able to			
CO 1	develop the basics of biochemical reaction engineering		**K2**
CO 2	understand importance of kinetics of enzyme catalyzed reactions		**K2, K3**
CO 3	understand the importance of substrate utilization, biomass production and product formation in bioreactors		**K1**
CO 4	Understand the types of bioreactors		**K1**
CO 5	Understand the kinetics of mixed cultures and its industrial application		**K1**
Text books			
1	Levenspiel O, "Chemical Reaction Engineering", 3rd Ed , John Wiley & Sons, Singapore (1999).		
2	Pauline Doran, Bioprocess engineering principles		
3	Shuler M L, Kargi F, "Bioprocess Engineering- Basic Concepts" , 2nd ed, Prentice Hall of India Ltd. (2002)		
Reference Books			
1	Aiba S, Humphrey A E and Millis N F ,"Biochemical Engineering" , Academic Press (1973)		
2	Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schügerl		

3	Introduction to Biochemical Engineering, D. G. Rao Tata McGraw-Hill Education, 2005	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=J4Kd392YSaI	
Unit 2	https://www.youtube.com/watch?v=zHZBuXhq3Ug	
Unit 3	https://www.youtube.com/watch?v=SLw7yOVoGls	
Unit 4	https://www.youtube.com/watch?v=kpLJ3ou-W0I	
Unit 5	https://www.youtube.com/watch?v=GZVbXQzuAd8	

Course Code	ABT0512	L T P	Credits
Course Title	Artificial Intelligence in Biotechnology	3 0 0	3
Course objective:			
1	To introduce the basic principles and techniques of Artificial Intelligence		K1
2	Brief idea about search algorithms		K2
3	Overview of AI project life cycle		K2
4	To introduce data analysis using Excel		K3
5	To elaborate the areas where AI can be applied in Biotechnology		K3
Pre-requisites: Basic knowledge of data analysis and biotechnology areas			
Course Contents / Syllabus			
UNIT-I	**Introduction to AI**		**8 hours**
Concept of AI, history, current status, scope, agents, environments, Problem Formulations, Review of tree and graph structures, State space representation, Search graph and Search tree			
UNIT-II	**Search Algorithms**		**8 hours**
Uniformed Search - Depth and Breadth first search, Informed Search - Best first search, A*algorithm, Graph Search and Tree Search, Random search, Search with closed and open list, Heuristic search.			
UNIT-III	**AI Project Life Cycle**		**8 hours**
AI Project Cycle, Problem scoping, Data acquisition, Data Exploration, Modeling.			
UNIT-IV	**Data Analysis**		**8 hours**
Sort andfilter data, Conditional formatting, charts, pivot tables, tables, what if analysis, solver, descriptive statistics, correlation, regression.			
UNIT-V	**Application of AI in Biotechnology**		**8 hours**
Application of AI and ML in Biochemical Engineering, ML in Bioreactor Engineering, ML for Bioresource and Bioenergy, ML for Environmental Bioengineering, ML for Metabolic and Protein Engineering, ML for Biomaterial Engineering			
Course outcome:	**After completion of this course students will be able to**		
CO 1	Demonstrate fundamental understanding of the history of artificial intelligence (AI) and its foundations		K1
CO 2	Apply basic principles of AI in solutions that require problem solving, inference, perception, knowledge representation, and learning		K2
CO 3	Learn about search algorithms		K2
CO 4	Learn data analysis in Excel		K3
CO 5	Application of AI and ML in Biotechnology		K3
Text books			
1	Artificial Intelligence Basics: A Non-Technical Introduction Book by Tom Taulli		
2	Artificial Intelligence: The Basics; Book by Kevin Warwick		
3	Artificial Intelligence in Biotechnology, book by PreethiKartan, Publisher: Arcler Education Incorporated, 2020		
Reference Books			
1	Artificial Intelligence – A Modern Approach (3rd Edition) by – Stuart Russell and Peter Norvig		
2	Artificial Intelligence By Example by Danis Rothman		
NPTEL/ Youtube/ Faculty Video Link:			

B. TECH (Third Year)

Course Code	ABT0513	L T P	credits
Course Title	Bioenergy Technologies and Systems	3 0 0	3

Course objective:

The course provides the students the basics of bioenergy technologies, importance of biomass feedstocks towards bioenergy generation, concept of biorefinery and the ability to understand bio and thermochemical conversion of biomass to generate biofuels.

Pre-requisites: Basic knowledge of Biochemistry, Microbiology and Bioprocess Technology.

Course Contents / Syllabus

UNIT-I	**Bioenergy concepts- Introduction**	**8hours**
Fundamental definitions of biomass and biofuels, System thinking, Biopower, Bioheat, Biofuels, Advanced liquid fuels, drop in fuels, Biobased products, biomass production		
UNIT-II	**Biomass feedstocks (Harvested feedstock and residual feedstock)**	**8 hours**
Feedstock for first generation, second generation and third generation biofuel, Agricultural waste, Forestry waste, Farm waste, Organic components of residential, commercial and industrial waste, Advantages and Disadvantages of residual feedstock as biomass related fuel.		
UNIT-III	**Biomass Conversion Technologies-I**	**8hours**
Understanding Biorefinery concept, Biorefinery end products, Integrated Biorefinery, Biopolymers, Biopigments, Utilization of lignocellulosic biomass as a raw material basis of biorefinery, Types of biorefinery, Evaluating biorefinery performance, Life cycle assessment (LCA), **Pathway for biodiesel production, FAME analysis**		
UNIT-IV	**Biomass Conversion Technologies-II**	**8hours**
Biochemical conversion: Hydrolysis, enzyme and acid hydrolysis, Fermentation technologies in biofuel production, Bioconversion of sugar and starch to alcohols, Anaerobic digestion, Trans-esterification, Thermochemical conversion: Combustion, Gasification, Pyrolysis, **Pathway for biohydrogen production**		
UNIT-V	**Techno Economic Analysis (TEA) and optimization strategy**	**8hours**
General understanding of TEA, Super Pro Designer software for modelling bioenergy pathway, Mathematical modelling and statistical optimization using Minitab/Design Expert, Machine learning based optimization strategy.		

Course outcome:

CO 1	Understand the basics of bioenergy technologies	K1, K2
CO 2	Learn and understand importance of biomass feedstocks towards bioenergy generation	K2, K3
CO 3	Understand and learn the concept of the biomass conversion technology i.e. biorefinery	K2, K3
CO 4	Review and analyze the biochemical and thermochemical conversion of biomass	K3, K4
CO 5	Employ the knowledge gained to model biofuels production, its optimization and techno economic analysis	K4

Text books

1	Ashok Pandey, Rainer Hofer, Christian Larroche (Eds) Industrial Biorefineries and White Biotechnology, Elsevier, 2015	
2	G. N. Tiwari and M. K. Ghosal,, Fundamentals of Renewable Energy Sources, Narosa Publishing House, , 2007	
3	Kishore V V N, Renewable Energy Engineering and Technology, Principles and Practice, The Energy and Resources Institute (TERI) , 2009.	

Reference Books

1	Nijaguna, B.T.,, Biogas Technology, New Age International publishers (P) Ltd., , 2002	

2	Samir Kumar Khana,, Bioenergy and Biofuel from Biowastes and Biomass, ASCE Publications , 2010	
3	Mahendra S Seveda, PardeepNarale (Eds) Bioenergy Engineering . 2022	
Link:		
Unit 1	https://www.youtube.com/watch?v=VBp0yUKmRaY	
Unit 2	https://www.youtube.com/watch?v=Z2dPGn9Mwtk	
Unit 3	https://www.youtube.com/watch?v=YNqKyCtY2tc	
Unit 4	https://www.youtube.com/watch?v=rFWRVXJgIbI	
Unit 5	https://www.youtube.com/watch?v=IxmlI7gnN0g&t=139s	

B. TECH THIRD YEAR

Course Code	ABT0514N	L T P	Credits
Course Title	Data Science	3 0 0	3

Course objective

The goal is to grasp fundamental concepts of data science, encompassing data preprocessing and inferential statistics application to a provided dataset, followed by the utilization of linear and logistic regression models on the same dataset.

Pre-requisites: Basic knowledge of data analysis and visualization

Course Contents / Syllabus

UNIT-I	**Basics of Data Science:**	**8 hours**

What is Data Science, Buzzwords of Data Science, Evolution of Data Science, Info-graphic representation of terminologies, DS Life Cycle, Difference between Analysis and Analytics, Application, Types of Data, Tools & Technologies, Future of Data Science, Security Issues, Use cases.

UNIT-II	**Data Preprocessing**	**8 hours**

Attributes & its types, Understanding and Extracting Useful variables, Handling Missing data, Data cleaning, removing redundant variables, Variable Selection, identifying outliers, removing outliers, removing rows with missing values and human error, Analysing relation between variables, Data transformation and Dimensionality reduction.

UNIT-III	**Correlation and Regression**	**8 hours**

Population and Sample, Measurement Levels, Representation of categorical variables, Measures of Central Tendency (Mean, Median, Mode), Skewness, Variance, Standard Deviation, Coefficient of Variation, Covariance, Histogram Analysis, Introduction to Regression, Simple and Multiple Linear Regression, Correlation vs. Regression, SST (Sum of Squares Total), SSR (Sum of Squares Regression), SSE (Sum of Squares Error) R-Square, Adjusted R-Squared. Multiple Linear Regression, Significance of p-value.

UNIT-IV	**Data Analysis & Inferential Statistics**	**8 hours**

Statistical analysis, hypothesis testing- Null and Alternative hypothesis, significance of p-value, F-value, chi-square, T-test, ANOVA, Correlation, Bayesian Probability, Distribution, Normal Distribution, Standard Normal Distribution, Central Limit Theorem, Standard Error, Estimators and Estimates, Confidence Interval, Students T Distribution, Margin of Error.

UNIT-V	**Logistic Regression**	**8 hours**

Logistic regression, Logit vs logistic, Applications of logistic regression Introduction to data visualization and various graphical ways of data representation, Case studies: DS in biotechnology.

Course outcome: After completion of this course students will be able to

CO 1	Understand the basic concept of data science in biotechnology	K1
CO 2	Analyse the dataset and perform Descriptive Statistics	K2
CO 3	Apply linear regression on the given dataset	K2
CO 4	Analyse the dataset and perform an Inferential Statistics	K3
CO 5	Apply the logistic regression on the given dataset	K3

Text books

1	The Art of Statistics: Learning from Data (Pelican Books), by David Spiegelhalter	
2	Principles of Statistics by M. G. Bulmer, Dover Publications Inc.	
3	Statistics 101: From Data Analysis and Predictive Modeling to Measuring Distribution and Determining Probability, Your Essential Guide to Statistics by David Borman, Adams Media	

Reference Books

	Information Dashboard Design: Displaying Data for At-a-glance	
	Beautiful Visualization, by Noah Iliinsky, Julie Steele; Publisher(s): O'Reilly Media, Inc.	

Link:	
Unit 1	
Unit 2	
Unit 3	
Unit 4	
Unit 5	

Course Code	ABT0551	L T P	Credit
Course Title	Analytical Techniques Lab	0 0 2	1
Suggested list of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1.	To study principle and working of laboratory microscope.		**1**
2.	Preparation of solutions and buffers (Tris-HCl, Phosphate, Citrate) and pH measurements (Including pH meter Calibration).		**2**
3.	Separation of amino acids using thin layer chromatography.		**2**
4.	To analyse the isolated plant pigments using paper chromatography.		**2**
5.	Separation of a mixture of polar and non-polar compounds using column chromatographic technique.		**2**
6.	Absorption maxima-change in absorbance in potassium permanganate with wavelength		**3**
7.	Study of Beer-Lambert's law-using UV-Visible spectrophotometer.		**3**
8.	To study and analysis of DNA sample by agarose gel electrophoresis.		**4**
9.	To study and analysis of protein sample by SDS- PAGE		**4**
10.	To study the structure & function of laboratory centrifuge and its principle.		**5**
Lab Course Outcome: After completion of this course students will be able to:			
CO 1	Understand the use of various techniques for solving industrial and research problems.		
CO 2	Demonstrate principle and working of various instruments.		

B. TECH THIRD YEAR

Course Code	ABT0552N	L T P	Credit
Course Title	Bioprocess Engineering Lab	0 0 2	1
Suggested List of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1	To understand the key parts, control systems and functioning of a fermenter.		**CO2**
2	To determine batch growth kinetics of bacteria.		**CO1**
3	To perform media optimization using Plackett-Burmann method.		**CO5**
4	To produce ethanol from grape juice using yeast fermentation process.		**CO4**
5	Production of wine via Fermentation.		**CO4**
6	Production of amylase from micro-organism using solid-state fermentation.		**CO3**
7	To estimate the protein using Bradford method.		**CO4**
8	Immobilization of enzyme by sodium alginate method.		**CO2**
9	Upstream and downstream of bioprocess to produce citric acid by Aspergillus niger..		**CO3**
10	Estimation of volumetric oxygen transfer coefficient by sodium-sulphate method.		CO3
Lab Course Outcome:			
CO 1	At the end of the course the students will able to develop the equations for microbial cell growth		**K6**
CO 2	At the end of the course the students will able to understand importance of enzymes and its immobilization		**K2, K3**
CO 3	At the end of the course the students will able to understand the importance of using solid state fermentation for the fermented products.		**K2**
CO 4	At the end of the course the students will able to design methods to produce fermented products		**K1, K2**
CO 5	At the end of the course the students will able to optimize the bioreactor system for product formation.		**K1**

Course Code	ABT0553	L T P	Credit
Course Title	**Plant Biotechnology Lab**	**0 0 2**	**1**
Suggested list of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1	Preparation of stock solution for plant tissue culture media		1
2	Preparation and sterilization of standard tissue culture media.		1
3	Sterilization of explants and generation of undifferentiated mass of cells.		1
4	To learn culturing, sub culturing and maintenance using selected explants		1
5	Initiation of in vitro cultures through axillary bud induction		2
6	Initiation of callus culture from different explants		2
7	Plant Transformation using Agrobacterium.		2
8	Isolation of plant DNA using CTAB		2
9	To prepare hydrated synthetic seeds in vitro		2
10	Plant microbial interaction.		2
Lab Course Outcome: After completion of this course students will be able to:			
CO 1	Learn the laboratory organization, media formulation and sterilization protocol needed for the plant growth in tissue culture Laboratory.		K1,K2,K3,K4,K5,K6
CO 2	Implement the plant tissue culture techniques for crop improvement and secondary metabolites production		K1,K3,K4,K5,K6

B. TECH. THIRD YEAR					
Course Code	**ANC0501**	**L**	**T**	**P**	**Credits**
Course Title	**CONSTITUTION OF INDIA, LAW AND ENGINEERING**	**2**	**0**	**0**	**2**

Course objective: To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it.

Pre-requisites: Computer Organization and Architecture

Course Contents / Syllabus

UNIT-I	**INTRODUCTION AND BASIC INFORMATION ABOUT INDIAN CONSTITUTION**	**8 Hours**

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947,Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

UNIT-II	**UNION EXECUTIVE AND STATE EXECUTIVE**	**8 Hours**

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of Vice-President, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

UNIT-III	**INTRODUCTION AND BASIC INFORMATION ABOUT LEGAL SYSTEM**	**8 Hours**

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law at workplace.

UNIT-IV	**INTELLECTUAL PROPERTY LAWS AND REGULATION TO INFORMATION**	**8 Hours**

Intellectual Property Laws: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright and its Ownership, Infringement of Copyright, Civil Remedies for Infringement, Regulation to Information, Introduction, Right to Information Act, 2005, Information Technology Act, 2000, Electronic Governance, Secure Electronic Records and Digital Signatures, Digital Signature Certificates, Cyber Regulations Appellate Tribunal, Offences, Limitations of the Information Technology Act.

UNIT-V	**BUSINESS ORGANIZATIONS AND E-GOVERNANCE**	**8 Hours**

Sole Traders, Partnerships: Companies: The Company's Act: Introduction, Formation of a Company, Memorandum of Association, Articles of Association, Prospectus, Shares, Directors, General Meetings and Proceedings, Auditor, Winding up. E-Governance and role of engineers in E-Governance, Need for reformed engineering serving at the Union and State level, Role of I.T. professionals in Judiciary, Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

COURSE OUTCOMES: After completion of this course students will be able to

CO 1	Identify and explore the basic features and modalities about Indian constitution.	K1
CO 2	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.	K2
CO 3	Differentiate different aspects of Indian Legal System and its related bodies.	K4
CO 4	Discover and apply different laws and regulations related to engineering practices.	K4
CO 5	Correlate role of engineers with different organizations and governance models	K4

Text Books:

1. M Laxmikanth: Indian Polity for civil services and other State Examination,6th Edition, Mc Graw Hill
2. Brij Kishore Sharma: Introduction to the Indian Constitution, 8th Edition, PHI Learning Pvt. Ltd.
3. Granville Austin: The Indian Constitution: Cornerstone of a Nation (Classic Reissue), Oxford University Press.

Reference Books:

1. Madhav Khosla: The Indian Constitution, Oxford University Press.
2. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing.
3. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)

B. TECH. THIRD YEAR

Course code	ANC0502	L T P	Credits
Course Title	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2 0 0	2

Course objective: This course aims to provide basic knowledge about different theories of society, state and polity in India, Indian literature, culture, Indian religion, philosophy, science, management, cultural heritage and different arts in India.s

Pre-requisites: Computer Organization and Architecture

Course Contents / Syllabus

UNIT-I	SOCIETY STATE AND POLITY IN INDIA	8 Hours

State in Ancient India: Evolutionary Theory, Force Theory, Mystical Theory Contract Theory, Stages of State Formation in Ancient India, Kingship , Council of Ministers Administration Political Ideals in Ancient India Conditions' of the Welfare of Societies, The Seven Limbs of the State, Society in Ancient India, Purusārtha, Varnāshrama System, Āshrama or the Stages of Life, Marriage, Understanding Gender as a social category, The representation of Women in Historical traditions, Challenges faced by Women.

UNIT-II	INDIAN LITERATURE, CULTURE, TRADITION, AND PRACTICES	8 Hours

Evolution of script and languages in India: Harappan Script and Brahmi Script. The Vedas, the Upanishads, the Ramayana and the Mahabharata, Puranas, Buddhist And Jain Literature in Pali,Prakrit And Sanskrit, Sikh Literature, Kautilya's Arthashastra, Famous Sanskrit Authors, Telugu Literature, Kannada Literature,Malayalam Literature ,Sangama Literature Northern Indian Languages & Literature, Persian And Urdu ,Hindi Literature

UNIT-III	INDIAN RELIGION, PHILOSOPHY, AND PRACTICES	8 Hours

Pre-Vedic and Vedic Religion, Buddhism, Jainism, Six System Indian Philosophy, Shankaracharya, Various Philosophical Doctrines , Other Heterodox Sects, Bhakti Movement, Sufi movement, Socio religious reform movement of 19th century, Modern religious practices.

UNIT-IV	SCIENCE, MANAGEMENT AND INDIAN KNOWLEDGE SYSTEM	8 Hours

Astronomy in India, Chemistry in India, Mathematics in India, Physics in India, Agriculture in India, Medicine in India , Metallurgy in India, Geography, Biology, Harappan Technologies, Water Management in India, Textile Technology in India ,Writing Technology in India Pyrotechnics in India Trade in Ancient India/,India's Dominance up to Pre-colonial Times.

UNIT-V	CULTURAL HERITAGE AND PERFORMING ARTS	8 Hours

Indian Architect, Engineering and Architecture in Ancient India, Sculptures, Pottery, Painting, Indian Handicraft, UNESCO'S List of World Heritage sites in India, Seals, coins, Puppetry, Dance, Music, Theatre, drama, Martial Arts Traditions, Fairs and Festivals, UNESCO'S List of Intangible Cultural Heritage, Calenders, Current developments in Arts and Cultural, Indian's Cultural Contribution to the World. Indian Cinema.

COURSE OUTCOMES: After completion of this course students will be able to

CO 1	Understand the basics of past Indian politics and state polity.	K2
CO 2	Understand the Vedas, Upanishads, languages & literature of Indian society.	K2
CO 3	Know the different religions and religious movements in India.	K4
CO 4	Identify and explore the basic knowledge about the ancient history of Indian	K4

	agriculture, science & technology, and ayurveda.	
CO 5	Identify Indian dances, fairs & festivals, and cinema.	K1

Text Books:

1. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014.
2. S. Baliyan, Indian Art and Culture, Oxford University Press, India
3. Nitin Singhania, Indian Art and Culture: for civil services and other competitive Examinations,3rd Edition,Mc Graw Hill

Reference Books:

1. Romila Thapar, Readings In Early Indian History Oxford University Press, India
2. Basham, A.L., The Wonder that was India (34th impression), New Delhi, Rupa & co.

Course Code	ABT0601	L T P	Credits
Course Title	Bioseparation Engineering	3 1 0	4
Course objective:			
1	To gain the knowledge about different separation techniques for biomolecules		K1
2	To gain information regarding optimization of biomolecule separation		K1
3	To enhance knowledge about different chromatography techniques		K3
4	To enhance knowledge about different membrane-based techniques		K2, K3
5	To gain information regarding importance of enzymes		K1
Pre-requisites:			
	Knowledge of basic cell structure.		
Course Contents / Syllabus			
UNIT-I	**Introduction to Bioseperation**		8hours
Introduction to separation of biomolecules and its importance in Biotechnology, Working principles of centrifugation, filtration, cell disruption, flocculation.			
UNIT-II	**Product Recovery**		8 hours
Extraction, adsorption, membrane-based separation, Separation of different types of DNA from cells, Separation of the different types of RNA from biological samples.			
UNIT-III	**Product Isolation**		8 hours
Ultrafiltration methods and separation of biomolecules, Polymer beads for immobilization of biomolecules, Magnetic Beads for Bio-separation, Cell Sorting, Microfluidics based separation.			
UNIT-IV	**Product Purification**		8 hours
Basics of chromatography and its use in separation of biomolecules, TLC, HPLC, GC etc., Methods for separation of the proteins based on size, charge and chemical nature of the proteins.			
UNIT-V	**Product Polishing**		8 hours
Product polishing: crystallization, drying; Case studies: illustrative examples pertaining to downstream processing of bioproducts, biopharmaceuticals and recombinant products.			
Course outcome: After completion of this course students will be able to			
CO 1	Understand separation techniques for biomolecules.		K1
CO 2	Understand the different separation techniques for DNA and RNA.		K1
CO 3	Understand the separatation of biomolecules using membrane-based techniques.		K3
CO 4	Describe the separation biomolecules using chromatographic techniques		K2, K3
CO 5	Apply the technology of Product Polishing & processing of bioproducts.		K1
Text books			
1	"Bioseparations: Principles and Techniques" by Sivasankar		
2	"Bioseparation: Volume 47 (Advances in Biochemical Engineering/Biotechnology)" by C A Heath and A L Nguyen		
3	"Bioseparation Engineering: A Comprehensive DSP Volumen" by Abhishek Awasthi and Ajay Kumar		
Reference Books			
1	"Bioseparations Downstream Processing for Biotechnology" by Paul A Belter and E L Cussler		
2	"Bioseparations Science and Engineering" by Roger G Harrison		
3	"Bioseparations Engineering: Principles, Practice, and Economics" by		

	Michael R Ladisch	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=_8gsbHzWMUU	
Unit 2	https://www.youtube.com/watch?v=aizKUoD-kYk	
Unit 3	https://www.youtube.com/watch?v=ZN7euA1fS4Y	
Unit 4	https://www.youtube.com/watch?v=e3lRt9XdV0s	
Unit 5	https://www.youtube.com/watch?v=PVvpEKeOzEM	

Course Code	ABT0602	L T P	Credits
Course Title	Metabolic Engineering	3 1 0	4

Course objective:		
1	To enable the students, understand the Introduction to metabolic engineering and its importance	K1, K2
2	To know the basic knowledge of Metabolic flux analysis	K1, K2, K3, K4
3	To familiarize the students about the various experimental determination of metabolic fluxes	K1, K3, K4
4	To impart Computational modelling of biological networks	K1, K3, K5
5	To understand Industrial applications of primary and secondary metabolites	K2, K3, K5, K6

Pre-requisites: Basics of Microbiology, Biochemistry and Genetics.

Course Contents / Syllabus

UNIT-I	Introduction to Metabolic Engineering and its importance	8 hours

Introduction to Enzymes and metabolism, Stoichiometry of cellular reactions,dynamic mass balance, yield coefficients and linear rate equations, Black box model, Heat balance, Different models for cellular Reactions-Induction-Jacob Monod Model and its regulation, Differential regulation by isoenzymes, Concerted or cumulative feedback regulation. Regulation in branched pathways, Permeability, and transport of metabolites.

UNIT-II	Metabolic flux analysis	8 hours

Introduction to Metabolic flux analysis (MFA), Isotopic steady state methods (^{13}C MFA) and Isotopic non-steady state methods, Dynamic metabolic flux analysis, Building stoichiometric matrix; Steady state and pseudo steady state assumptions; Using different optimizing functions to solve linear programming problem; understanding flux cone and constraints; Introducing additional constraints from thermodynamics.

UNIT-III	Experimental determination of metabolic fluxes	8 hours

Technical developments in labels distribution analysis; Nuclear Magnetic Resonance spectroscopy (NMR) and Gas chromatography along with mass spectroscopy (GC-MS) based methods for flux determination, C13 labelling.

UNIT-IV	Computational modelling of biological networks	8 hours

Introduction to MATLAB, Creating MATLAB variables, Using MATLAB as a calculator, Main features of MATLAB and capabilities of MATLAB, Synthetic circuit design, MOMA (Minimization of Metabolic Adjustment), iFBA (Integrated Flux Balance Analysis), dFBA; Enhancement of product yield and productivity.

UNIT-V	Industrial Applications	8 hours

Pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites or industrially relevant enzymes and recombinant proteins, bioconversion- applications and factors affecting bioconversion, mixed or sequential bioconversions, regulation of enzyme production, strain selection and improvement, the modification of existing or the introduction of entirely new metabolic pathways.

Course outcome: After completion of this course students will be able to

CO 1	Identify the appropriate host and/or metabolic pathways to produce a desired product or remediate a toxin.	K1, K2
CO 2	Construct genome-scale metabolic flux models using available tools and software and perform simulations	K1, K2, K3, K4
CO 3	Design ^{13}C-labeling strategies and perform metabolic flux analysis to determine metabolic pathway utilization	K1, K3, K4
CO 4	Compare potential metabolic engineering strategies using quantitative metabolic modelling	K1, K3, K5
CO 5	Devise effective strategies to implement genetic manipulations and Pathway engineering strategies for industrial applications.	K2, K3, K5, K6

Text books		
1	Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen.	
2	Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit.	
3	The Metabolic Pathway Engineering Handbook by Christina D. Smolke.	
Reference Books		
1	Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark.	
2	Principles of Fermentation Technologies by Stanbury P and Whitaker A	
3	Fermentation and Enzyme Technology by Wang DIC	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=xF_WotEWJA0	
Unit 2	https://www.youtube.com/watch?v=x2URHbJfHDk	
Unit 3	https://www.youtube.com/watch?v=ndThuqVumAk	
Unit 4	https://www.youtube.com/watch?v=ndThuqVumAk	
Unit 5	https://www.youtube.com/watch?v=ndThuqVumAk	

Course Code	ABT0603	L T P	Credits
Course Title	Nanobiotechnology	3 0 0	3
Course objective:			
1	To classify the concept of Nanobiotechnology and nanofabrication techniques.		K1, K2
2	To develop understanding the synthesis process of nanomaterials		K2, K3
3	To focus the tools and techniques used for characterization of nanomaterials and their applications		K3, K4
4	To differentiate the different classes of biomedical polymers and their uses		K2, K4, K5
5	To conclude the concept of diagnosis, imagining and treatment of disease through nanotechnology tools and techniques		K4, K5
Pre-requisites: Students should know about the basic molecular and cell biology.			
Course Contents / Syllabus			
UNIT-I	Introduction to Nanobiotechnology:		**8 hours**
Nanobiotechnology, History, Origin, Fundamental Concepts, Approaches, Current research, Moore's Law, Discussion on Micro and Nanofabrication process.			
UNIT-II	Nanomaterials synthesis and applications:		**8 hours**
Carbon based nanomaterials types, Synthesis, Properties, Applications, Inorganic nanomaterials types, Synthesis, properties, Applications.			
UNIT-III	Nanocharecterization tool and techniques:		**8 hours**
Surface Plasmon Resonance (SPR), Spectroscopy (UV and FTIR), Zeta potential, Dynamic Light Scattering (DLS), X-ray diffraction (XRD), Transmission Electron Microscopy (TEM), Scanning Electron Microscope (SEM), Scanning Probe Microscopy (STM and AFM), Improved diagnostic devices (Nanowires and Cantilever)			
UNIT-IV	Biomaterials and polymers:		**8 hours**
Synthesis and characterization of different classes of biomaterials and polymers, their uses in Pharmaceutical, Cardiovascular Ophthalmologic and Orthopedic areas.			
UNIT-V	Application of Nanobiotechnology in Biological and Medical Sciences:		**8 hours**
Micro and Nano biosensor, Nano-imaging agents, Quantum dots technology and its applications, Carbon dots, Drug delivery tools through nanotechnology (Liposomes, Nanoparticles, Dendrimers). Case study of tumor targeting through nanotechnology.			
Course outcome: After completion of this course students will be able to			
CO 1	Explain and demonstrate the basics of nanoscience, nanobiotechnology, nanotechnology and its techniques.		**K2, K3, K4**
CO 2	Devise effective strategies of nanomaterials synthesis through physical, chemical, and biological process.		**K4**
CO 3	Compare potential tools and techniques used for characterization of nanomaterials and their applications		**K2, K5**
CO 4	Classify differentiate the synthesis and application of different classes of biomedical polymers and their uses		**K1, K4**
CO 5	Understanding and conclude the concept of diagnosis, imagining and treatment of disease through nanotechnology tools and techniques		**K2,K5**
Text books			
1	Nanotechnology by Mark Ratner and Daniel Ratner, Pearson Education-2003		
2	Guozhong Cao ,"Nanostructures and Nanomaterials , synthesis , properties and applications" , Imperial College Press ,2004.		
3	Hari Singh Nalwa, "Nanostructured Materials and Nanotechnology", Academic Press, 2002		
Reference Books			
1	Microfabrication and Nanomanufacturing-Mark James Jackson-2018		

2	MEMS and Nanotechnology –Based sensors and devices communication, Medical and Aerospace applications -A.R.Jha-2008	
3	Drug Delivery: Engineering Principles for Drug Therapy, M. Salzman-2001	
NPTEL/ Youtube/ Faculty Video Link:		

B. TECH (Third Year)

Course Code	ABT0611	L T P	Credits
Course Title	Bioreactor Analysis and Design	3 0 0	3

Course objective:

The course provides the students the basics of bioreactor analysis and design. The students will be able to understand various aspects of aeration and agitation in bioreactor. The students will be able to understand the importance of materials and components for bioreactor design and implementing it for bioreactor design to be used for various applications.

Pre-requisites: Students should have basic knowledge of Bioprocess engineering

Course Contents / Syllabus

UNIT-I	**Bioreactor design- concepts**	**8 hours**

Concepts of Bioreactor and Fermentor, general design information, design of bioreactors, basic function of a bioreactor design, mass and energy balance, mechanical design of process equipment, Sterilization of bioreactor.

UNIT-II	**Aeration and Agitation in Bioreactor**	**8 hours**

Mass transfer in agitated tanks, Power requirement for mixing, Agitation rate studies – Mixing time and residence time distribution, Bioreactor Geometry – Reactor, impeller, sparger and baffle design; shear damage, bubble damage, methods of minimizing cell damage, rheology of fermentation liquids.

UNIT-III	**Materials and Components for Bioreactor Design**	**8 hours**

Design of bioreactors, Materials of construction for bioreactor components - vessel, nozzles, ports, baffles, jackets, spargers, cooling coils, piping and valves, Design considerations for bioreactor components

UNIT-IV	**Bioreactor Design for various applications**	**8 hours**

Design of batch, fed batch and continuous bioreactors, Design considerations for plant and animal cell cultures and waste treatment processes, Immobilized biocatalytic reactors

UNIT-V	**Bioreactor scale up**	

Scale up criteria, Effect of scale up: aeration, agitation, mixing, sterilization, inoculum development, nutrient availability and supply, pH, shear, temperature maintenance, partial pressure, Case studies in Bioreactor scale up aspects.

Course outcome: After completion of this course students will be able to

CO 1	Develop the basics of bioreactor analysis and design	K1, K2
CO 2	Understand importance of aeration and agitation in bioreactor	K2, K3
CO 3	Understand the importance of materials and component for bioreactor design	K1, K2
CO 4	Implement the bioreactor design for various applications	K4, K5
CO 5	Devise and analyze strategies for scale up bioreactor cultivation and its various aspects	K3, K4, K5

Text books

1	Michael L. Shuler and FikretKargi, Bioprocess Engineering: Basic Concepts, Prentice Hall, 1992	
2	Pauline Doran, Bioprocess engineering principles	
3	James M. Lee, Biochemical Engineering, Prentice Hall, 1992	

Reference Books

1	James E. Bailey and David F. Ollis, Biochemical Engineering Fundamentals, McGraw Hill 1986.	
2	Bioreaction Engineering, Bioprocess Monitoring (Bioreaction Engineering) by Karl Schüger	
3	Introduction to Biochemical Engineering, D. G. Rao Tata McGraw-Hill Education, 2005	

Link:	
Unit 1	https://www.youtube.com/watch?v=tLE0aibuYX8
Unit 2	https://www.youtube.com/watch?v=2XQ2nuyD8Gg
Unit 3	https://www.youtube.com/watch?v=YCfnDpq8tYM
Unit 4	https://www.youtube.com/watch?v=8LEUksrrEfw
Unit 5	https://www.youtube.com/watch?v=Ndu3jpMzH14

Course Code	ABT0612	L T P	Credits
Course Title	Probability and Statistics using R in biotechnology	3 0 0	3
Course objective:			
1	To develop basic concepts of ANN and machine learning.		K1
2	To introduce R programming.		K2
3	To have a basic understanding of regression and distribution using R.		K2
4	To understand the overview of decision trees.		K3
5	To apply the R programming in Biotechnology.		K3
Pre-requisites: Basic knowledge of data analysis and data science			
Course Contents / Syllabus			
UNIT-I	Introduction to Artificial Neural Networks and Machine Learning		**8 hours**
Introduction to ANN, Biological Neural Network, Types of ANN and Applications, Machine learning basics, Examples of Machine learning applications, Types of machine learning**.**			
UNIT-II	Introduction to R programming		**8 hours**
R - Basic Syntax, Data Types, Variables, Operators, Decision Making, Loops, Functions, Strings, Vectors, Lists, Matrices, Arrays, Factors, Data Frames, Packages-chart & graphs.			
UNIT-III	Probability & Statistical Analysis-I		**8 hours**
Introduction to Bayesian Function, Mean, Median & Mode, Linear Regression, Multiple Regression, Logistic Regression, Normal Distribution, Binomial Distribution, Poisson Regression.			
UNIT-IV	Probability & Statistical Analysis-II		**8 hours**
Analysis of Covariance, Time Series Analysis, Nonlinear Least Square, Decision Tree, Random Forest, Survival Analysis, Chi Square Tests.			
UNIT-V	Application of R in Biotechnology		**8 hours**
Role of R in Biostatistics, Application of R in biological processes, Advantages of R language over other languages in biotechnology.			
Course outcome: After completion of this course students will be able to			
CO 1	Recall the basic concepts and techniques of artificial Intelligence & Machine Learning		K1
CO 2	Summarize and compare a range of machine learning algorithms along with their strengths and weaknesses		K2
CO 3	Develop skills of using recent machine learning software for solving practical problems		K2
CO 4	Classify machine learning algorithms to solve real time problems of moderate complexity		K3
CO 5	Gain experience of doing independent study and research through case studies		K3
Course Books			
1	Introduction to machine learning, EthemAlpaydin. — 2nd ed., The MIT Press, Cambridge, Massachusetts, London, England		
2	Introduction to artificial neural systems, J. Zurada, St. Paul: West.		
3	R in a Nutshell, 2nd Edition - O'Reilly Media		
Reference Books			
1	Machine Learning, Tom M Mitchell		
2	The Elements of Statistical Learning, Trevor Hastie, Robert Tibshirani, Jerome Friedman, Springer		
NPTEL/ YouTube/ Faculty Video Link:			
Unit 1			
Unit 2			
Unit 3			

Unit 4	
Unit 5	

Course Code	ABT0613	L T P	Credits
Course Title	Biofuels & Alcohol Technology	3 0 0	3
Course objective:			
1	To teach the concept and application biofuels and alcohol technology.		
2	To develop understanding different alcoholic fermentation techniques.		
3	To provide knowledge Biochemistry of alcohol production, recycling, and quality control.		
4	To provide concepts of Biomass conversion to heat and power.		
5	To develop understanding of clean fuel technology and fermentation criteria of molasses.		
Pre-requisites: General biology and basic knowledge of Fermentation and Bioconversion.			
Course Contents / Syllabus			
UNIT-I	Introduction		**8 hours**
Introduction to Alcohol Technology, Raw Material of Alcohol Industry, Storage & handling of Raw material in detail, Study of different yeast strains used in alcohol industries, Study of yeast production as single protein cell.			
UNIT-II	Fermentation Techniques		**8 hours**
Study of different alcoholic fermentation techniques, Batch fermentation, Continuous fermentation, Modern techniques of Continuous fermentation, Bio still fermentation, Encilium process, Wet milling of grain for alcohol production, Grain dry milling cooking for alcohol production, Use of cellulosic feed stocks for alcohol production, Scaling in distilleries, Fusel oil separation.			
UNIT-III	Process and parameters of Alcohol Production		**8 hours**
Study of different recycling process, Biochemistry of alcohol production, The management of fermentation in the production of alcohol. Alcohol distillation-The fundamental, Parameters & affecting alcoholic fermentations, By product of alcoholic fermentation, Distillery quality control, Alcoholometry.			
UNIT-IV	Types of Biofuels		**8 hours**
Various biofuels/ bioenergy from biomass. Biomass conversion to heat and power: thermal gasification of biomass, anaerobic digestion. Biomass conversion to biofuel: thermochemical conversion, syngas fermentation.			
UNIT-V	Lab concept of clean fuels		**8 hours**
Biodiesel production from oil seeds, waste oils and algae; microalgae cultivation, biomass harvesting/concentration, processing and extraction of value-added products (cell disruption and lipid extraction); and transesterification of the lipids to produce biodiesel. ;World biomass/bioenergy use. US, EU, Developing countries, etc.; the environmental aspects of biomass energy, economics and life-cycle analysis with case studies on biomass energy production.			
Course outcome: After completion of this course students will be able to			
CO 1	Explain basic concepts of metabolism and importance of metabolic engineering.		**K1,K2**
CO 2	Understand the production of metabolites and its regulatory mechanism.		**K1,K2**
CO 3	Explain the applications, specificity, and product inhibition of bioconversion.		**K1,K2**
CO 4	Understand regulation of enzyme production and strain improvement.		**K1,K2**
CO 5	Understand the process of Biodiesel production and environmental and economic aspects of bioenergy.		**K1,K2,K3**
Text books			
1	Chemical Process Principles – Part I, Material and Energy Balances by Olaf		

	A Hougen, Kwenneth M. Watson, and Roland A Ragatz, CBS Publishers and Distributors (1995).	
2	The alcohol text book by Kathryn AnnJacques, T. P. Lyons, D. R. Kelsall	
3	Product Recovery in Bioprocess Technology ", BIOTOL Series, VCH, 1990	
Reference Books		
1	Shreve's Chemical Process Industries, 5th Ed. Reference	
2	Outlines of Chemical Technology by Charles E. Dryden	
3	Alcoholometry – SatyanarayanaRao	
NPTEL/ Youtube/ Faculty Video Link:		
Unit 1	https://www.youtube.com/watch?v=niZls2dpHjM	
Unit 2	https://www.youtube.com/watch?v=mhwUc84xBZA	
Unit 3	https://www.youtube.com/watch?v=D6mRPgvAEOc	
Unit 4	https://www.youtube.com/watch?v=YbdkbCU20_M	
Unit 5	https://www.youtube.com/watch?v=GO1vk_fJ27Y	

Course Code	ABT0614	L T P	Credits
Course Title	Machine learning	3 0 0	3

Course objective		
1	To develop basic concept of machine learning (ML)	K1
2	To learn linear algebra for ML	K2
3	To have a thorough understanding of the machine learning techniques	K2
4	To have a thorough knowledge of ML algorithms	K3
5	To understand how to apply ML	K3

Pre-requisites: Basic knowledge of probability and linear algebra along with basic programming

Course Contents / Syllabus

UNIT-I	Introduction to Machine learning	8 hours

Learning – Types of Machine Learning, Supervised Learning, Concept Learning Task –Concept Learning as Search – Finding a Maximally Specific Hypothesis – Version Spaces and the Candidate Elimination Algorithm – Linear Discriminants – Perceptron – Linear Separability – Linear Regression.

UNIT-II	Linear Algebra	8 hours

Vector Arithmetic, L1 and L2 Norms, Matrix Arithmetic, Symmetric Matrix, Matrix Triangular,Matrix Diagonal, Matrix Identity, Matrix Orthogonal, Matrix Transpose, Inverse Trace,Determinant, Rank, Sparse Matrix, Eigenvectors and Eigen values, Singular-Value Decomposition, Confusion Matrix, weights, bias, and covariance.

UNIT-III	Machine Learning Techniques	8 hours

Linear Discriminant Analysis, Principal component analysis, Support Vector Machines, Neural Networks-Artificial Neural Networks, Convolutional Neural Networks, Recurrent Neural Networks and Deep Neural Network, Decision trees, Regression trees, Bayesian Estimation, Gaussian Processes, Ensemble learning, Introduction to Reinforcement Learning, Missing values, Bootstrapping and cross validation.

UNIT-IV	Machine learning algorithms	8 hours

Supervised Learning: Classification (Naïve Bayes, SVM), Regression (Neural Network); Unsupervised learning: Clustering (K-means); Reinforcement learning: Decision making.

UNIT-V	Application of Machine learning	8 hours

Application of ML in real world, application of ML in healthcare, Application of ML in Bioinformatics, Application of ML in business and cyber security.

Course outcome: After completion of this course students will be able to

CO 1	Understand the basic and advance concepts of machine learning	K1
CO 2	Differentiate between different machine learning algorithms	K2
CO 3	Understand importance of neural networks in machine learning	K2
CO 4	Understand significance of machine learning models	K3
CO 5	Learn applications of machine learning	K3

Course Books

1	The Elements of Statistical Learning, by Trevor Hastie, Robert Tibshirani, Jerome H. Friedman (available online)	
2	Jeeva Jose, - Introduction to Machine Learning using Python‖, First Edition, Khanna Publishing House, 2019.	
3	Tom M Mitchell, ―Machine Learning‖, First Edition, McGraw Hill Education, 2013.	

Reference Books

1	EthemAlpaydin, ―Introduction to Machine Learning 3e (Adaptive Computation and Machine Learning Series) ‖, Third Edition, MIT Press, 2014	
2	Rajiv Chopra, - Machine Learning ‖, Khanna Book Publishing Co. 2019	
3	Pattern Recognition and Machine Learning, by Christopher Bishop (optional)	

NPTEL/ YouTube/ Faculty Video Link:

Unit 1	
Unit 2	

Unit 3	
Unit 4	
Unit 5	

B. TECH (Third Year)			
Course Code	**ABT0651**	**L T P**	**Credit**
Course Title	**Bioseparation Engineering Lab**	**0 0 2**	**1**
Suggested list of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1	Isolation of the plant cell organelles using centrifugation methods.		CO4
2	Isolation and separation of plant/bacterial DNA using centrifugation and biochemical methods.		CO4
3	Separation of the proteins with suitable chromatography methods.		CO1
4	Apply filtration and ultrafiltration method for separation of proteins.		CO4
5	Use TLC for separation of the biolipids		CO3
6	Isolation of the photosynthetic pigments using centrifugation methods		CO4
7	Isolation and separation of plant/bacterial RNA using centrifugation and biochemical methods.		CO4
8	Isolation and separation of plant/bacterial protein using centrifugation and biochemical methods.		CO2
9	**Extraction of lactose from milk.**		CO4
10	Metabolic engineering of E. coli for high yield production of 1,3-butanediol		CO4
CO 1	At the end of the course the student will be able to separate proteins using chromatographic techniques		K3
CO 2	At the end of the course the student will be able to extract intra and extra cellular proteins from biological samples		K2,K3
CO 3	At the end of course the student will be able to apply chromatography technique for separation of lipids		K2,K3
CO 4	At the end of course the student will be able to differentiate between types of techniques used in bio-separation		K1,K2
CO 5			

B. TECH THIRD YEAR			
Course Code	**ABT0652**	**L T P**	**Credit**
Course Title	**Metabolic Engineering Lab**	**0 0 2**	**1**
Suggested list of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1.	Develop engineering strategies to boost production of industrially relevant compound in E. coli.		1
2.	Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.		1, 2
3.	Demonstration of feed-back regulation and product inhibition.		1, 3
4.	Development of a flux model and correlation of the model with experimental data.		1, 4
5.	Demonstration of effect of addition of supplement to enhance enzyme activity in fungal strain.		1, 2
6.	Demonstration of metabolic engineering approach for low cost antibiotics		1, 2
7.	Demonstration of metabolic engineering approach for low cost biofuel production		1,2
8.	To build stoichiometric matrix for glycolytic reactions		1, 2
9	Redirecting the metabolic pathway in E.coli towards increased succinic acid production as well as reducing formation of other metabolites.		1, 2
10	Bioprospecting of microbial strain to enhance bioethanol production		1, 2
Lab Course Outcome: After completion of this course students will be able to:			
CO 1	Learn and systematically analyze the complexities defining the regulation of various metabolic pathways.		
CO 2	They will be able to design and learn strain-engineering strategies to alter cellular behaviour, metabolic flux, and product formation.		
CO 3	Demonstrate feedback regulation and inhibition of products.		
CO 4	Develop flux model and to maintain flux model.		

Course Code	ABT0653	L T P	Credit
Course Title	Nanobiotechnology Lab	0 0 2	1
Suggested list of Experiment			
Sr. No.	**Name of Experiment**		**CO**
1.	Demonstration of Nanoscience and nanobiotechnology (Size comparative analysis)		1
2.	Synthesis of carbon nanotubes from carbon source.		1, 2,4
3.	Chemical synthesis of metallic nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.		1, 2,4
4.	Biological synthesis of metallic nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.		1, 2,4
5.	Nanoparticles toxicity estimation in percentage as *in vitro* methods		2,3,4
6.	Synthesis of carbon dots from microwave pyrolysis method.		2,3,4
7.	Sol gel synthesis of zinc oxide nanoparticles.		2,3,4
8.	Nature of Interaction between nanoparticles & Bacterial Cell (E. coli and B. subtilis).		3,4
9.	Demonstration of nano characterization tools and techniques.		3,4
10.	Antibacterial activities of silver and zinc nanoparticles, against bacterial cultures performed by standard disc diffusion method		2,4
Lab Course Outcome: After completion of this course students will be able to:			
CO 1	Learn the basics of nanoscience, nanobiotechnology, nanotechnology.		
CO 2	Understanding the different strategies of nanomaterials synthesis.		
CO3	Gain knowledge of tools and techniques used for nano-characterization		
CO4	Develop the hands-on skills for working into laboratories		

B. TECH. THIRD YEAR

Course Code	ANC0601	L T P	Credits
Course Title	CONSTITUTION OF INDIA, LAW AND ENGINEERING	2 0 0	2

Course objective: To acquaint the students with legacies of constitutional development in India and help them to understand the most diversified legal document of India and philosophy behind it.

Pre-requisites: Computer Organization and Architecture

Course Contents / Syllabus

UNIT-I	INTRODUCTION AND BASIC INFORMATION ABOUT INDIAN CONSTITUTION	8 Hours

Meaning of the constitution law and constitutionalism, Historical Background of the Constituent Assembly, Government of India Act of 1935 and Indian Independence Act of 1947,Enforcement of the Constitution, Indian Constitution and its Salient Features, The Preamble of the Constitution, Fundamental Rights, Fundamental Duties, Directive Principles of State Policy, Parliamentary System, Federal System, Centre-State Relations, Amendment of the Constitutional Powers and Procedure, The historical perspectives of the constitutional amendments in India, Emergency Provisions: National Emergency, President Rule, Financial Emergency, and Local Self Government – Constitutional Scheme in India.

UNIT-II	UNION EXECUTIVE AND STATE EXECUTIVE	8 Hours

Powers of Indian Parliament Functions of Rajya Sabha, Functions of Lok Sabha, Powers and Functions of the President, Comparison of powers of Indian President with the United States, Powers and Functions of Vice-President, Powers and Functions of the Prime Minister, Judiciary – The Independence of the Supreme Court, Appointment of Judges, Judicial Review, Public Interest Litigation, Judicial Activism, LokPal, Lok Ayukta, The Lokpal and Lok ayuktas Act 2013, State Executives – Powers and Functions of the Governor, Powers and Functions of the Chief Minister, Functions of State Cabinet, Functions of State Legislature, Functions of High Court and Subordinate Courts.

UNIT-III	INTRODUCTION AND BASIC INFORMATION ABOUT LEGAL SYSTEM	8 Hours

The Legal System: Sources of Law and the Court Structure: Enacted law -Acts of Parliament are of primary legislation, Common Law or Case law, Principles taken from decisions of judges constitute binding legal rules. The Court System in India and Foreign Courtiers (District Court, District Consumer Forum, Tribunals, High Courts, Supreme Court). Arbitration: As an alternative to resolving disputes in the normal courts, parties who are in dispute can agree that this will instead be referred to arbitration. Contract law, Tort, Law at workplace.

UNIT-IV	INTELLECTUAL PROPERTY LAWS AND REGULATION TO INFORMATION	8 Hours

Intellectual Property Laws: Introduction, Legal Aspects of Patents, Filing of Patent Applications, Rights from Patents, Infringement of Patents, Copyright and its Ownership, Infringement of Copyright, Civil Remedies for Infringement, Regulation to Information, Introduction, Right to Information Act, 2005, Information Technology Act, 2000, Electronic Governance, Secure Electronic Records and Digital Signatures, Digital Signature Certificates, Cyber Regulations Appellate Tribunal, Offences, Limitations of the Information Technology Act.

UNIT-V	BUSINESS ORGANIZATIONS AND E-GOVERNANCE	8 Hours

Sole Traders, Partnerships: Companies: The Company's Act: Introduction, Formation of a Company, Memorandum of Association, Articles of Association, Prospectus, Shares, Directors, General Meetings and Proceedings, Auditor, Winding up. E-Governance and role of engineers in E-Governance, Need for reformed engineering serving at the Union and State level, Role of I.T. professionals in Judiciary, Problem of Alienation and Secessionism in few states creating hurdles in Industrial development.

COURSE OUTCOMES: After completion of this course students will be able to

CO 1	Identify and explore the basic features and modalities about Indian constitution.	K1
CO 2	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.	K2
CO 3	Differentiate different aspects of Indian Legal System and its related bodies.	K4
CO 4	Discover and apply different laws and regulations related to engineering practices.	K4
CO 5	Correlate role of engineers with different organizations and governance models	K4

Text Books:

4. M Laxmikanth: Indian Polity for civil services and other State Examination,6th Edition, Mc Graw Hill
5. Brij Kishore Sharma: Introduction to the Indian Constitution, 8th Edition, PHI Learning Pvt. Ltd.
6. Granville Austin: The Indian Constitution: Cornerstone of a Nation (Classic Reissue), Oxford University Press.

Reference Books:

1. Madhav Khosla: The Indian Constitution, Oxford University Press.
2. PM Bakshi: The Constitution of India, Latest Edition, Universal Law Publishing.
3. V.K. Ahuja: Law Relating to Intellectual Property Rights (2007)

B. TECH. THIRD YEAR

Course Code	ANC0602	L T P	Credits
Course Title	ESSENCE OF INDIAN TRADITIONAL KNOWLEDGE	2 0 0	2

Course objective: This course aims to provide basic knowledge about different theories of society, state and polity in India, Indian literature, culture, Indian religion, philosophy, science, management, cultural heritage and different arts in India

Pre-requisites: Computer Organization and Architecture

Course Contents / Syllabus

UNIT-I	**SOCIETY STATE AND POLITY IN INDIA**	**8 Hours**

State in Ancient India: Evolutionary Theory, Force Theory, Mystical Theory Contract Theory, Stages of State Formation in Ancient India, Kingship , Council of Ministers Administration Political Ideals in Ancient India Conditions' of the Welfare of Societies, The Seven Limbs of the State, Society in Ancient India, Purusārtha, Varnāshrama System, Āshrama or the Stages of Life, Marriage, Understanding Gender as a social category, The representation of Women in Historical traditions, Challenges faced by Women.

UNIT-II	**INDIAN LITERATURE, CULTURE, TRADITION, AND PRACTICES**	**8 Hours**

Evolution of script and languages in India: Harappan Script and Brahmi Script. The Vedas, the Upanishads, the Ramayana and the Mahabharata, Puranas, Buddhist And Jain Literature in Pali,Prakrit And Sanskrit, Sikh Literature, Kautilya's Arthashastra, Famous Sanskrit Authors, Telugu Literature, Kannada Literature,Malayalam Literature ,Sangama Literature Northern Indian Languages & Literature, Persian And Urdu ,Hindi Literature

UNIT-III	**INDIAN RELIGION, PHILOSOPHY, AND PRACTICES**	**8 Hours**

Pre-Vedic and Vedic Religion, Buddhism, Jainism, Six System Indian Philosophy, Shankaracharya, Various Philosophical Doctrines, Other Heterodox Sects, Bhakti Movement, Sufi movement, Socio religious reform movement of 19th century, Modern religious practices.

UNIT-IV	**SCIENCE, MANAGEMENT AND INDIAN KNOWLEDGE SYSTEM**	**8 Hours**

Astronomy in India, Chemistry in India, Mathematics in India, Physics in India, Agriculture in India, Medicine in India, Metallurgy in India, Geography, Biology, Harappan Technologies, Water Management in India, Textile Technology in India ,Writing Technology in India Pyrotechnics in India Trade in Ancient India/,India's Dominance up to Pre-colonial Times.

UNIT-V	**CULTURAL HERITAGE AND PERFORMING ARTS**	**8 Hours**

Indian Architect, Engineering and Architecture in Ancient India, Sculptures, Pottery, Painting, Indian Handicraft, UNESCO'S List of World Heritage sites in India, Seals, coins, Puppetry, Dance, Music, Theatre, drama, Martial Arts Traditions, Fairs and Festivals, UNESCO'S List of Intangible Cultural Heritage, Calenders, Current developments in Arts and Cultural, Indian's Cultural Contribution to the World. Indian Cinema.

COURSE OUTCOMES: After completion of this course students will be able to

CO 1	Understand the basics of past Indian politics and state polity.	K2
CO 2	Understand the Vedas, Upanishads, languages & literature of Indian society.	K2

CO 3	Know the different religions and religious movements in India.	K4
CO 4	Identify and explore the basic knowledge about the ancient history of Indian agriculture, science & technology, and ayurveda.	K4
CO 5	Identify Indian dances, fairs & festivals, and cinema.	K1

Text Books:

3. Sivaramakrishna (Ed.), Cultural Heritage of India-Course Material, Bharatiya Vidya Bhavan, Mumbai, 5th Edition, 2014.
4. S. Baliyan, Indian Art and Culture, Oxford University Press, India
5. Nitin Singhania, Indian Art and Culture: for civil services and other competitive Examinations,3rd Edition,Mc Graw Hill

Reference Books:

1. Romila Thapar, Readings In Early Indian History Oxford University Press, India
2. Basham, A.L., The Wonder that was India (34th impression), New Delhi, Rupa & co.