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

Affiliated to

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

Evaluation Scheme & Syllabus

For

Bachelor of Technology
Biotechnology

Third Year

(Effective from the Session: 2025-26)

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

Bachelor of Technology
Biotechnology

Evaluation Scheme

SEMESTER-V

Sl. No.	Subject Codes	Subject	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BBT0501	Bioprocess Engineering	Mandatory	3	1	0	30	20	50		100		150	4
2	BBT0502	Plant Biotechnology	Mandatory	3	0	0	30	20	50		100		150	3
3		Departmental Elective I	Departmental Elective	3	0	0	30	20	50		100		150	3
4		Departmental Elective II	Departmental Elective	3	0	0	30	20	50		100		150	3
5	BBT0553	r-DNA Technology Workshop Mode	Open Elective	0	0	6				50	100		150	3
6	BCSCC0501	Design Thinking -II	Mandatory	2	1	0			50		100		150	3
7	BBT0551	Bioprocess Engineering Lab	Mandatory	0	0	2				25		25	50	1
8	BBT0552	Plant Biotechnology Lab	Mandatory	0	0	2				25		25	50	1
9	BBT0559	Internship Assessment	Mandatory	0	0	2				50			50	1
10	BNC0502/ BNC0501	Essence of Indian Traditional Knowledge/ Constitution of India	Compulsory Audit	2	0	0	30	20	50		50			NA
11		MOOCs (Essential for Hons. Degree)	*MOOCs											
		TOTAL		**19**	**2**	**6**	**120**	**80**	**250**	**150**	**600**	**50**	**1050**	**22**

* List of MOOCs Based Recommended Courses for Second year (Semester-III) B. Tech Students

Sr. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0045	Microsoft Power BI	Infosys Wingspan (Infosys Springboard)	11h 32m	0.5
2	BMC0098	Strategic management	Infosys Wingspan (Infosys Springboard)	18 h 6m	1

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-II and will be assessed during semester-III**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0301/BNC0302)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The 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., CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit, MOOCs: Massive Open Online Courses.

List of Departmental Electives

Sl. No.	Subject Codes	Subject Name	Type of Subjects	Bucket Name	Branch	Semester
1	BBT0511	Biochemical Reaction Engineering	Departmental Elective-I	Core Biotech	BT	5
2	BBT0513	Bioenergy Technologies and Systems	Departmental Elective-II		BT	5
3	BBT0512	Artificial Intelligence in Biotechnology	Departmental Elective-I	Computational Biotech	BT	5
4	BBT0514	Data Science	Departmental Elective-II		BT	5

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Bachelor of Technology
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Evaluation Scheme
SEMESTER-VI

Sl. No.	Subject Codes	Subject	Types of Subjects	Periods			Evaluation Schemes				End Semester		Total	Credit
				L	T	P	CT	TA	TOTAL	PS	TE	PE		
1	BBT0601	Bioseparation Engineering	Mandatory	3	1	0	30	20	50		100		150	4
2	BBT0602	Metabolic Engineering	Mandatory	3	0	0	30	20	50		100		150	3
3	BBT0603	Nanobiotechnology	Mandatory	3	0	0	30	20	50		100		150	3
4		Departmental Elective -III	Departmental Elective	3	0	0	30	20	50		100		150	3
5		Departmental Elective -IV	Departmental Elective	3	0	0	30	20	50		100		150	3
6		Open Elective I	Open Elective	3	0	0	30	20	50		100		150	3
7	BBT0651	Bioseparation Engineering Lab	Mandatory	0	0	2				25		25	50	1
8	BBT0652	Metabolic Engineering Lab	Mandatory	0	0	2				25		25	50	1
9	BBT0653	Nanobiotechnology Lab	Mandatory	0	0	2				25		25	50	1
10	BBT0659	Mini Project	Mandatory	0	0	2				50			50	1
11	BNC0602/ BNC0601	Essence of Indian Traditional Knowledge / Constitution of India, Law and Engineering	Compulsory Audit	2	0	0	30	20	50		50			NA
12		*Massive Open Online Courses (For B.Tech. Hons. Degree)	*MOOCs											
		GRAND TOTAL		**20**	**1**	**8**	**270**	**160**		**125**	**600**	**75**	**1100**	**23**

*** List of MOOCs Based Recommended Courses for Second year (Semester-IV) B. Tech Students**

S. No.	Subject Code	Course Name	University / Industry Partner Name	No of Hours	Credits
1	BMC0066	Artificial Intelligence	Infosys Wingspan (Infosys Springboard)	69h 39m	4
2	BMC0078	Explore Machine Learning using Python	Infosys Wingspan (Infosys Springboard)	17h 7m	1

PLEASE NOTE: -

- **A 3-4 weeks Internship shall be conducted during summer break after semester-IV and will be assessed during Semester-V**
- **Compulsory Audit (CA) Courses (Non-Credit - BNC0401/BNC0402)**
  - All Compulsory Audit Courses (a qualifying exam) do not require any credit.
  - The 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., CE: Core Elective, OE: Open Elective, DE: Departmental Elective, PE: Practical End Semester Exam, CA: Compulsory Audit, MOOCs: Massive Open Online Courses.

List of Departmental Electives

Sl. No.	Subject Codes	Subject Name	Types of Subjects	Bucket Name	Branch	Semester
1	BBT0611	Bioreactor Analysis and Design	Departmental Elective-III	Core Biotech	BT	6
2	BBT0613	Biofuels & Alcohol Technology	Departmental Elective-IV		BT	6
3	BBT0612	Probability and Statistics using R in Biotechnology	Departmental Elective-III	Computational Biotech	BT	6
4	BBT0614	Machine Learning	Departmental Elective-IV		BT	6

NOIDA INSTITUTE OF ENGINEERING & TECHNOLOGY, GREATER NOIDA, GAUTAM BUDDH NAGAR
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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

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GREATER NOIDA-201306
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Bioprocess Engineering

Course Code: BBT0501	Course Name: Bioprocess Engineering	L	T	P	C
Course Offered in: Biotechnology		3	1	0	4

Pre-requisite: Students should know about the basics of microbiology.

Course Objectives: To develop an understanding of bioprocess principles, including upstream and midstream processing, for the design, operation, and optimization of biotechnological production systems.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Demonstrate the equation for microbial cell growth.	K3
CO2	Understand the importance of enzymes and its immobilization.	K2
CO3	Illustrate the scale up concepts for bioprocesses.	K3
CO4	Describe the manufacturing processes for antibiotic and proteins.	K1
CO5	Identify sensors and instruments needed for measurement and control.	K1

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	1	1	1	2	3	3	2
CO2	3	2	2	2	2	1	1	1	1	1	2	3	3	2
CO3	3	3	3	2	3	1	1	2	2	1	2	3	3	2
CO4	2	2	2	1	2	1	1	1	1	1	2	2	3	2
CO5	3	2	2	2	3	1	1	2	2	2	3	3	3	3

Course Contents / Syllabus

Module 1	**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.

Module 2	**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.

Module 3	**Bioreactor control mechanism**	**8 hours**

Principles of enzyme catalysis, enzyme kinetics study, immobilized enzymes and their types, bioreactors- batch, fed-batch or continuous bioreactors, Immobilized cell systems.

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).

Module 4	**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.

Module 5	**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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	*Bioprocess Engineering: Basic Concepts* (3rd ed., Prentice Hall/Pearson, 2017)	Michael Shuler; Fikret Kargi; Matthew DeLisa
2	*Bioprocess Engineering Principles* (2nd ed., Academic Press, 2012)	Pauline M. Doran
3	*Basic Biotechnology* (2nd ed., Cambridge University Press, 2001)	Colin Ratledge; Bjorn Kristiansen

Reference Books:

S.No	Book Title with publication agency & year	Author
1	*Bioseparations Science and Engineering* (Oxford University Press, 2003)	Roger G. Harrison; Paul W. Todd; Scott R. Rudge; Demetri P. Petrides
2	*Bioreaction Engineering: Bioprocess Monitoring* (Vol. 3 in the Bioreaction Engineering series, Wiley, circa 1997)	Karl Schügerl (with D. A. John Wase)
3	*Introduction to Biochemical Engineering* (Tata McGraw-Hill Education, New Delhi, 2005)	D. G. Rao (amazon.in, Google Books, libcat.iitd.ac.in)

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=_jiY8av92nM
Module 2	https://www.youtube.com/watch?v=WeJeKwMUGXc
Module 3	https://www.youtube.com/watch?v=S49ZhytFyZs
Module 4	https://www.youtube.com/watch?v=E4mdKlWndHA
Module 5	https://www.youtube.com/watch?v=NakBHy7HXPU

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GREATER NOIDA-201306
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Plant Biotechnology

Course Code: BBT0502	Course Name: Plant Biotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

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

Course Objectives: To provide knowledge of genetic engineering, tissue culture, and molecular techniques for crop improvement and sustainable agricultural practices.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Remembering the fundamentals of culturing plant cells and tissues.	K1
CO2	Understanding the Principles and methods of genetic transformation.	K2
CO3	Illustrate the process and mechanism of crop improvement through tissue culturing.	K3
CO4	Explain the different methods and techniques of Molecular Farming.	K2
CO5	Acquire knowledge on various genome editing technologies.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	1	1	1	1	1	2	3	2	2
CO2	3	3	2	2	3	1	1	1	1	1	2	3	3	2
CO3	3	3	3	2	3	2	1	1	1	1	3	3	3	2
CO4	3	3	3	2	3	2	1	1	1	2	3	3	3	3
CO5	3	3	3	3	3	2	1	1	1	2	3	3	3	3

Course Contents / Syllabus

Module 1	Plant tissue culture	8 hours

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.

Module 2	Principles and methods of genetic transformation	8 hours

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.

Module 3	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.

Module 4	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 bioactive secondary metabolites by plant tissue culture.

Module 5	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.

Total Lecture Hours | **40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Principles of Plant Genetics and Breeding, Wiley-Blackwell, 2022 (3rd Edition, latest)	George Acquaah

2	An Introduction to Plant Tissue Culture, Oxford & IBH Publishing Co., 2003 (latest edition)	M. K. Razdan
3	Plant Tissue and Organ Culture: Fundamental Methods, Springer, 1995 (latest edition)	O. L. Gamburg; G. C. Phillips

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Plant Biotechnology: The Genetic Manipulation of Plants, Oxford University Press, 2008 (latest edition)	Adrian Slater; Nigel W. Scott; Mark R. Fowler
2	Biochemistry & Molecular Biology of Plants, Wiley Blackwell, 2015 (2nd Edition, latest)	Bob Buchanan; Wilhelm Gruissem; Russell Jones
3	Plant Biochemistry, Academic Press, 2021 (5th Edition, latest)	Hans-Walter Heldt; Birgit Piechulla; Donald Heldt

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://nptel.ac.in/courses/102103016/
Module 2	https://youtu.be/ZqTGvSFbnxk
Module 3	https://nptel.ac.in/courses/102106080/
Module 4	https://nptel.ac.in/courses/107108011/
Module 5	https://nptel.ac.in/courses/109105115/

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GREATER NOIDA-201306
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Biochemical Reaction Engineering

Course Code: BBT0511	Course Name: Biochemical Reaction Engineering	L	T	P	C
Course Offered in: Biotechnology		3	0	0	3

Pre-requisite: Students should know about the basic microbiology and cell biology

Course Objectives:

To impart knowledge of kinetics, reactor design, and analysis of biochemical processes for efficient scale-up and optimization in biotechnological industries.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the principles and kinetics of biochemical reaction engineering.	K2
CO2	Analyze the kinetics of enzyme catalyzed reactions in free and immobilized states.	K4
CO3	Evaluate the Kinetics of substrate utilization, product formation and biomass production.	K5
CO4	Differentiate between types of reactors.	K4
CO5	Understand the Kinetics of mixed cultures.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	1	1	2	3	2	2
CO2	3	3	2	3	3	1	1	2	1	1	2	3	3	2
CO3	3	3	3	3	3	1	1	2	1	1	2	3	3	3
CO4	3	3	2	2	3	1	1	2	1	1	2	3	3	2
CO5	2	2	1	2	2	1	1	1	1	1	2	2	2	2

Course Contents / Syllabus

Module 1	Introduction to Biochemical reaction engineering	8 hours

Kinetics of homogeneous reactions, reaction mechanism, Temperature dependency from Arrhenius law, Theoretical prediction of rate constant: Interpretation of batch kinetic data.

Module 2	Kinetics of enzyme catalyzed reactions in free and immobilized states	8 hours

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.

Module 3	Kinetics of substrate utilization, product formation and biomass production	8 hours

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.

Module 4	Types of Reactors	8 hours

Batch, plug flow reactor (PFR), continuous stirred rank reactors (CSTR), fluidized bed reactor, bubble column, air lift 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.

Module 5	Kinetics of mixed cultures	8 hours

Major classes of interaction in mixed cultures, models describing mixed-culture interactions, reaction dynamics, and industrial application of mixed cultures.

	Total Lecture Hours	48 hours

Textbook:

S.No	Book Title with publication agency & year	Author
1	Chemical Reaction Engineering, John Wiley & Sons, 1999 (3rd Edition, latest)	Octave Levenspiel
2	Bioprocess Engineering Principles, Academic Press, 2012 (2nd Edition, latest)	Pauline M. Doran

3	Bioprocess Engineering: Basic Concepts, Pearson, 2017 (3rd Edition, latest)	Michael L. Shuler; Fikret Kargi; Matthew DeLisa

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Biochemical Engineering, Academic Press, 1973 (latest edition)	S. Aiba; A. E. Humphrey; N. F. Millis
2	Bioreaction Engineering: Bioprocess Monitoring, Wiley-VCH, 1997 (latest edition)	Karl Schügerl
3	Introduction to Biochemical Engineering, Tata McGraw-Hill Education, 2005 (latest edition)	D. G. Rao

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=J4Kd392YSaI
Module 2	https://www.youtube.com/watch?v=zHZBuXhq3Ug
Module 3	https://www.youtube.com/watch?v=SLw7yOVoGls
Module 4	https://www.youtube.com/watch?v=kpLJ3ou-W0I
Module 5	https://www.youtube.com/watch?v=GZVbXQzuAd8

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
GREATER NOIDA-201306
(An Autonomous Institute)
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Bioenergy Technologies and Systems

Course Code: BBT0513	Course Name: Bioenergy Technologies and Systems	L	T	P	C
Course Offered in:		3	0	0	3

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

Course Objectives: 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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Define the bioenergy concept in biomass and biofuels.	K1
CO2	Explain the importance of harvested feedstock and residual feedstock.	K2
CO3	Understand the bio refinery concept and performance using life cycle assessment.	K2
CO4	Understand the mechanism of biochemical and thermo chemical conversion of biomass.	K2
CO5	Demonstrate the techno-economic analysis and optimization strategies for bioenergy pathways.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	3	2	1	1	1	2	3	2	2
CO2	3	3	2	1	2	3	2	1	1	1	2	3	3	2
CO3	2	2	2	2	2	3	2	2	1	1	3	3	3	2
CO4	3	3	2	2	3	3	2	1	1	1	3	3	3	3
CO5	3	3	3	3	3	3	3	2	2	2	3	3	3	3

Course Contents / Syllabus

Module 1	**Bioenergy concepts- Introduction**	**8 hours**

Fundamental definitions of biomass and biofuels, System thinking, Biopower, Bioheat, Biofuels, Advanced liquid fuels, drop in fuels, Biobased products, biomass production

Module 2	**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.

Module 3	**Biomass Conversion Technologies-I**	**8 hours**

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

Module 4	**Biomass Conversion Technologies-II**	**8 hours**

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

Module 5	**Techno Economic Analysis (TEA) and optimization strategy**	**8 hours**

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.

	Total Lecture Hours	**48 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Industrial Biorefineries and White Biotechnology, Elsevier, 2015 (latest edition)	Ashok Pandey; Rainer Hofer; Christian Larroche (Eds)
2	Fundamentals of Renewable Energy Sources, Narosa Publishing House, 2007 (latest edition)	G. N. Tiwari; M. K. Ghosal
3	Renewable Energy Engineering and Technology: Principles and Practice, TERI, 2009 (latest edition)	Kishore V. V. N.

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Biogas Technology, New Age International Publishers, 2002 (latest edition)	B. T. Nijaguna
2	Bioenergy and Biofuel from Biowastes and Biomass, ASCE Publications, 2010 (latest edition)	Samir Kumar Khanal
3	Bioenergy Engineering, CRC Press, 2022 (latest edition)	Mahendra S. Seveda; Pardeep Narale (Eds)

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=VBp0yUKmRaY
Module 2	https://www.youtube.com/watch?v=Z2dPGn9Mwtk
Module 3	https://www.youtube.com/watch?v=YNqKyCtY2tc
Module 4	https://www.youtube.com/watch?v=rFWRVXJgIbI
Module 5	https://www.youtube.com/watch?v=IxmlI7gnN0g&t=139s

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Artificial Intelligence in Biotechnology

Course Code: BBT0512	**Course Name: Artificial Intelligence in Biotechnology**	**L**	**T**	**P**	**C**
Course Offered in:		**3**	**0**	**0**	**3**

Pre-requisite: Basic knowledge of data analysis and biotechnology areas

Course Objectives

To introduce AI concepts and tools for analyzing biological data, modeling bioprocesses, and enhancing decision-making in biotechnology applications.:

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the fundamental concepts, history, and scope of AI, including problem formulation.	K2
CO2	Analyze various search algorithms for AI problem-solving.	K4
CO3	Illustrate the stages of the AI project lifecycle.	K3
CO4	Apply data analysis techniques for AI-based problem-solving.	K3
CO5	Analyze the applications of AI and ML in biotechnology.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	1	1	1	1	1	2	2	1	2
CO2	3	3	2	2	3	1	1	1	1	1	2	3	2	2
CO3	2	2	2	1	2	1	1	2	2	1	2	2	2	2
CO4	2	2	3	2	3	1	1	1	1	1	2	3	3	3
CO5	3	3	2	2	3	2	2	1	2	1	3	3	3	3

Course Contents / Syllabus

Module 1	**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		
Module 2	**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.		
Module 3	**AI Project Life Cycle**	**8 hours**
AI Project Cycle, Problem scoping, Data acquisition, Data Exploration, Modeling.		
Module 4	**Data Analysis**	**8 hours**
Sort and filter data, Conditional formatting, charts, pivot tables, tables, what if analysis, solver, descriptive statistics, correlation, regression.		
Module 5	**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		
	Total Lecture Hours	**48 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Artificial Intelligence Basics: A Non-Technical Introduction, Apress, 2019 (latest edition)	Tom Taulli
2	Artificial Intelligence: The Basics, Routledge, 2011 (latest edition)	Kevin Warwick
3	Artificial Intelligence in Biotechnology, Arcler Education Incorporated, 2020 (latest edition)	Preethi Kartan

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Artificial Intelligence – A Modern Approach, Pearson, 2021 (4th Edition, latest)	Stuart Russell; Peter Norvig
2	Artificial Intelligence By Example, Packt Publishing, 2020 (2nd Edition, latest)	Denis Rothman

NPTEL/ Youtube/ Faculty Video Link:		
Module 1	https://www.youtube.com/watch?v=C6YtPJxNULA&pp=ygUXSW50cm9kdWN0aW9uIHRvIEFJICYgTUw%3D	
Module 2	https://www.youtube.com/watch?v=E0Hmnixke2g&pp=ygUuU2VhcmNoIEFsZ29yaXRobXMgJiBMaW5lYXIgQWxnZWJyYSBmb3IgQUkgJiBNTA%3D%3D	
Module 3		
Module 4	https://www.youtube.com/watch?v=E0Hmnixke2g&pp=ygVbU2VhcmNoIEFsZ29yaXRobXMgJiBMaW5lYXIgQWxnZWJyYSBmb3IgQUkgJiBNTE1hY2hpbmUgTGVhcm5pbmcgVGVjaG5pcXVlcyAmIE5ldXJhbCBOZXR3b3Jrcw%3D%3D	
Module 5	https://www.youtube.com/watch?v=z18nw4adsx4&pp=ygUcRGF0YSBBbmFseXNpcyAmIE1MIEFsZ29yaXRobdIHCQmLCQGHKiGM7w%3D%3D	

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
GREATER NOIDA-201306
(An Autonomous Institute)
School of Biotechnology

Data Science

Course Code: BBT0514	Course Name: Data Science	L	T	P	C
Course Offered in:		3	0	0	3

Pre-requisite: Basic knowledge of data analysis and visualization

Course Objectives: 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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the basic concept of data science in biotechnology.	K2
CO2	Analyze the dataset and perform Descriptive Statistics.	K4
CO3	Analyze the dataset and perform an Inferential Statistics.	K4
CO4	Apply linear regression on the given dataset.	K3
CO5	Apply the logistic regression on the given dataset.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	1	1	1	2	3	2	2
CO2	3	3	2	2	3	2	1	1	1	1	2	3	3	2
CO3	3	3	2	3	3	2	1	1	1	1	3	3	3	2
CO4	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO5	3	3	3	3	3	2	1	1	1	2	3	3	3	3

Course Contents / Syllabus

Module 1	**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.

Module 2	**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, Analyzing relation between variables, Data transformation and Dimensionality reduction.

Module 3	**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.

Module 4	**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.

Module 5	**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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	The Art of Statistics: Learning from Data, Pelican Books, 2019 (latest edition)	David Spiegelhalter
2	Principles of Statistics, Dover Publications Inc., 1979 (latest edition, reprint of 1965 original)	M. G. Bulmer

3	Statistics 101: From Data Analysis and Predictive Modeling to Measuring Distribution and Determining Probability, Adams Media, 2016 (latest edition)	David Borman

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Information Dashboard Design: Displaying Data for At-a-Glance Monitoring, O'Reilly Media, 2020 (2nd Edition, latest)	Stephen Few
2	Beautiful Visualization, O'Reilly Media, 2010 (latest edition)	Noah Iliinsky; Julie Steele (Eds)
3		

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=tA42nHmmEKw
Module 2	https://www.youtube.com/watch?v=ykZ-_UGcYWg&list=PLEAYkSg4uSQ2XjkkD8FSB84p_nCkT1dKY
Module 3	https://www.youtube.com/watch?v=SUXOFrhWsAQ&list=PLRueFtKLr0QN7MmQ8pdpQerOe_s8vGJG4&index=10
Module 4	https://www.youtube.com/watch?v=WMUMc2QJrPQ
Module 5	https://www.youtube.com/watch?v=H4986KDZkeI

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

r-DNA Technology

Course Code: BBT0553	**Course Name: r-DNA Technology**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**0**	**0**	**6**	**3**

Pre-requisite: Students should know about basic concept of molecular biology

Course Objectives: To provide foundational knowledge of recombinant DNA techniques, including gene cloning, vector design, transformation methods, and their applications in research, medicine, and industry.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the basic concept and procedure of gene cloning and the role of enzymes and vectors used for genetic manipulation and genetic engineering.	K2
CO2	Explain different types of vectors and their applications in genetic engineering.	K2
CO3	Demonstrate the PCR technique and applications.	K3
CO4	Perform in-silico cloning of the selected DNA.	K3
CO5	Understand the basic concept of genetic engineering techniques for selection of recombinants.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	1	1	1	2	3	2	2
CO2	3	3	2	2	3	1	1	1	1	1	2	3	3	2
CO3	3	3	3	2	3	2	1	1	1	1	3	3	3	3
CO4	3	3	3	3	3	2	1	1	1	2	3	3	3	3
CO5	3	2	2	2	2	1	1	1	1	1	2	3	2	2

Course Contents / Syllabus

Module 1	**Basic Principles of rDNA Technology**	**8 hours**

Introduction to recombinant DNA technology and its uses, Restriction enzymes: Class I, II & III restriction enzymes, Nomenclature, Isoschizomers, Heterohypekomers, Unit of restriction enzymes, Restriction digestion: partial and complete, Star activity; Homopolymer tailing, Synthetic Linkers, Adaptors; Roles of DNA ligase, T4 DNA polymerase, Alkaline phosphatase, Reverse transcriptase in cloning

Module 2	**Vectors**	**8 hours**

Cloning, expression, and promoter less vectors Plasmids; Bacteriophages; Phage as a cloning vector: Advantage of using phage lambda vector, M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors, Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors; Expression vectors; Baculovirus and pichia vectors system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

Module 3	**The Polymer Chain Reaction**	**8 hours**

PCR based methods, Amplification of DNA using PCR, Principle & applications of PCR: RT PCR, Inverse PCR, Nested PCR, Multiplex PCR, Anchored PCR, RACE, DD-RTPCR, Degenerate PCR TA cloning, Real time PCR, Primer design; Fidelity of thermostable enzymes; DNA polymerases

Module 4	**Techniques in rDNA Technology**	**8 hours**

Gene bank / Genomic library and cDNA library construction; Overview of techniques for recombinant selection and screening: Functional and nutritional complementation, Colony/ plaque hybridization, Blotting techniques, Plus-Minus screening, Immunological screening, HART, HAT

Module 5	**Screening and Selection of Recombinants**	**8 hours**

Preparation of bacterial competent cells, Transformation of ligated (recombinant) DNA in selected host (e.g. Bacterial host), Screening of recombinant bacterial colonies using colony PCR, Rapid DNA and RNA sequencing techniques: Sanger method, Maxam and Gilbert procedure, automated DNA sequencing, pyrosequencing; Genomics: High throughput Sequencing: shot gun cloning, Clone contig cloning, Microarray, Purification and selected characterization (spectroscopic) of the purified recombinant proteins

	Total Lecture Hours	**40 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**

1	From Genes to Clones: Introduction to Gene Technology, VCH, 1987 (latest edition)	Ernst L. Winnacker
2	Genetic Engineering, Oxford University Press, 2017 (latest edition)	Smita Rastogi; Neelak Pathak
3	Genetic Engineering: Principles & Practice, McGraw Hill Education, 1992 (latest edition)	Sandhya Mitra

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Principles of Gene Manipulation and Genomics, Wiley-Blackwell, 2006 (7th Edition, latest)	S. B. Primrose; R. M. Twyman
2	Molecular Biology of the Cell, Garland Science, 2022 (7th Edition, latest)	Bruce Alberts; Alexander Johnson; Julian Lewis; et al.
3	Modern Genetic Analysis, W. H. Freeman, 2002 (latest edition)	Anthony J. F. Griffiths; William M. Gelbart; Jeffrey H. Miller; Richard C. Lewontin

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=Yh9w_fyvpUk
Module 2	https://www.youtube.com/watch?v=VXkw_U6mJpc
Module 3	https://www.youtube.com/watch?v=BIIWlZqWxKg
Module 4	https://www.youtube.com/watch?v=CgXtJ4ooaUU
Module 5	https://www.youtube.com/watch?v=OK7_ReXhVaQ

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Design Thinking II

Course Code: BCSCC0501	**Course Name: Design Thinking II**	**L**	**T**	**P**	**C**
Course Offered in: Biotechnology		**2**	**1**	**0**	**3**

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

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

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Learn sophisticated design tools to sharpen their problem-solving skills.	K2
CO2	Generate innovative ideas using design thinking tools and converge to feasible idea for breakthrough solution.	K3, K4
CO3	Implement storytelling for persuasive articulation.	K3
CO4	Understanding the nature of leadership empowerment.	K2
CO5	Understand the role of a human being in ensuring harmony in society and nature.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO\PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	1	1	3	1	1	2	2	1	3	2	2	1
CO2	3	3	3	2	3	1	1	2	2	2	3	2	3	2
CO3	1	1	2	1	2	1	1	2	3	2	2	1	1	2
CO4	1	1	1	1	1	1	1	3	3	2	2	1	1	1
CO5	1	1	1	1	1	3	3	2	2	1	2	1	1	1

Course Contents / Syllabus

Module 1	**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

Module 2	**Refinement and Prototyping**	**.08. 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

Module 3	**Storytelling, Testing and Assessment**	**..08 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

Module 4	**Innovation, Quality and Leadership**	**.06. 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

Module 5	**Understanding Human Desirability**	**.08. hours**

Program needed to achieve the comprehensive human goal: the five dimensions of human endeavor(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-regulationin 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.

	Total Lecture Hours	**48 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	*UnMukt: Science and Art of Design Thinking* (Polaris / School of Design Thinking, 2020)	Arun Jain
2	*Basics Design 08: Design Thinking* (AVA Publishing, 2010)	Gavin Ambrose; Paul Harris
3	*A Foundation Course in Human Values and Professional Ethics* (Excel Books, New Delhi, 2010)	R. R. Gaur; R. Sangal; G. P. Bagaria
S.No	**Book Title with publication agency & year**	**Author**
1	*Solving Problems with Design Thinking: Ten Stories of What Works* (Columbia Business School Publishing, 2013)	Jeanne Liedtka; Andrew King; Kevin Bennett
2	*Universal Human Values and Professional Ethics* (S. K. Kataria & Sons, New Delhi, 2022)	Dr. Ritu Soryan
3	*101 Design Methods: A Structured Approach for Driving Innovation in Your Organization* (John Wiley & Sons, 2013 per your data though first edition released Oct 2012)	Vijay Kumar
4	*The Design of Business: Why Design Thinking Is the Next Competitive Advantage* (Harvard Business Press, November 2009, Boston MA)	Roger L. Martin
5	*Change by Design: How Design Thinking Transforms Organizations and Inspires Innovation* (Harper Business / HarperCollins, 2009)	Tim Brown

NPTEL/ Youtube/ Faculty Video Link:

Module 1	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
Module 2	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
Module 3	https://nptel.ac.in/courses/109/104/109104109/ https://www.d-thinking.com/2021/07/01/how-to-use-storytelling-in-design-thinking/
Module 4	https://www.worldofinsights.co/2020/10/infographic-8-design-thinking-skills-for-leadership- development/
Module 5	https://www.youtube.com/watch?v=hFGVcx1Us5Y

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

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School of Biotechnology

Bioprocess Engineering Lab

LAB Course Code: BBT0551	LAB Course Name: Bioprocess Engineering Lab	L	T	P	C
Course Offered in: Department of Biotechnology		0	0	2	1

Pre-requisite:

Course Objectives:

To provide hands-on experience with bioprocess techniques, equipment, and analytical methods essential for the design, operation, and optimization of biotechnological processes.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the importance of enzymes and their immobilization	K2
CO2	Develop the equations for various bioreactor processes	K6
CO3	Understand the importance of mixing and agitation	K2
CO4	Optimize the bioreactor system for product formation.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	2	2	1	1	1	1	3	2	2
CO2	3	3	3	2	2	2	2	1	1	1	1	3	3	3
CO3	3	2	2	1	1	2	2	1	1	1	1	3	2	2
CO4	3	3	3	2	2	2	2	1	1	1	1	3	3	3

List Of Practical's (Indicative & Not Limited To)

1. To understand the key parts, control systems and functioning of a fermenter.
2. To determine batch growth kinetics of bacteria.
3. To perform media optimization using Plackett-Burmann method.
4. To produce ethanol from grape juice using yeast fermentation process.
5. Production of wine via Fermentation.
6. Production of amylase from microorganism using solid state fermentation.
7. To estimate the protein using Bradford method.
8. Immobilization of enzyme by sodium alginate method.
9. Upstream and downstream of bioprocess to produce citric acid by *Aspergillus niger*.
10. Estimation of volumetric oxygen transfer coefficient by sodium-sulphate method.

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

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School of Biotechnology

Plant Biotechnology Lab

LAB Course Code: BBT0552	**LAB Course Name: Plant Biotechnology Lab**	**L**	**T**	**P**	**C**
Course Offered in: ……..		**0**	**0**	**2**	**1**

Pre-requisite:

Course Objectives:

To develop practical skills in plant tissue culture, genetic transformation, and molecular techniques for plant improvement and research.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the process of media formulation and sterilization protocol.	K2
CO2	Implement the plant tissue culture techniques for crop improvement.	K3
CO3	Demonstrate the different techniques of culturing of explant.	K3
CO4	Understanding the Initiation of callus culture from different explants.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	1	1	1	2	1	2	3	2	1
CO2	3	3	3	2	3	2	2	3	3	2	2	3	3	2
CO3	3	2	3	2	3	2	2	3	2	1	2	3	3	2
CO4	3	2	2	2	3	1	1	2	2	1	2	3	2	2

List Of Practical's (Indicative & Not Limited To)

1. Preparation of stock solution for plant tissue culture media
2. Preparation and sterilization of standard tissue culture media.
3. Sterilization of explants and generation of undifferentiated mass of cells.
4. To learn culturing, sub culturing and maintenance using selected explants
5. Initiation of in vitro cultures through axillary bud induction
6. Initiation of callus culture from different explants
7. Plant Transformation using Agrobacterium.
8. Isolation of plant DNA using CTAB
9. To prepare hydrated synthetic seeds in vitro
10. Plant microbial interaction.

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
GREATER NOIDA-201306
(An Autonomous Institute)
School of Biotechnology

Essence of Indian Traditional Knowledge

Course Code: BNC0502	Course Name: Essence of Indian Traditional Knowledge	L	T	P	C
Course Offered in: Department of Biotechnology		2	0	0	1

Pre-requisite:

Course Objectives: 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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the basics of past Indian politics and state polity.	K2
CO2	Understand the Vedas, Upanishads, languages & literature of Indian society.	K2
CO3	Know the different religions and religious movements in India.	K4
CO4	Identify and explore the basic knowledge about the ancient history of Indian agriculture, science & technology, and Ayurveda.	K4
CO5	Identify Indian dances, fairs & festivals, and cinema.	K1

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	3	2	1	1	2	2	1	1
CO2	3	2	1	1	1	2	3	2	1	1	2	2	1	1
CO3	3	3	2	1	1	3	3	3	1	1	2	2	1	1
CO4	3	3	2	2	2	3	3	3	2	2	2	2	2	2
CO5	3	3	2	2	2	3	3	3	2	2	2	2	2	2

Course Contents / Syllabus

Module 1	Basic Principles of rDNA Technology	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.

Module 2	Vectors	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

Module 3	The Polymer Chain Reaction	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.

Module 4	Techniques in rDNA Technology	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.

Module 5	Screening and Selection of Recombinants	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.

Total Lecture Hours	40 hours

Textbook:

S.No	Book Title with publication agency & year	Author
1	Cultural Heritage of India – Course Material, Bharatiya Vidya Bhavan, 2014 (5th Edition, latest)	Sivaramakrishna (Ed.)

2	Indian Art and Culture, Oxford University Press, latest edition (year not clearly specified, likely after 2015)	S. Baliyan
3	Indian Art and Culture: For Civil Services and Other Competitive Examinations, McGraw Hill, 2021 (3rd Edition, latest)	Nitin Singhania

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Readings in Early Indian History, Oxford University Press, 2013 (latest edition)	Romila Thapar
2	The Wonder That Was India, Rupa & Co., 2014 (latest impression)	A. L. Basham
3		

NPTEL/ Youtube/ Faculty Video Link:

Module 1	
Module 2	
Module 3	
Module 4	
Module 5	

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Constitution of India, Law and Engineering

Course Code: BNC0501	**Course Name: Constitution of India, Law and Engineering**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**2**	**0**	**0**	**1**

Pre-requisite:

Course Objectives: 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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Identify and explore the basic features and modalities about Indian constitution.	K1
CO2	Differentiate and relate the functioning of Indian parliamentary system at the center and state level.	K2
CO3	Differentiate different aspects of Indian Legal System and its related bodies.	K4
CO4	Discover and apply different laws and regulations related to engineering practices.	K4
CO5	Correlate role of engineers with different organizations and governance models.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

COs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	2	3	2	1	1	2	2	1	1
CO2	3	2	1	1	1	2	3	2	1	1	2	2	1	1
CO3	3	3	2	1	1	3	3	3	1	1	2	2	1	1
CO4	3	3	2	2	2	3	3	3	2	2	2	2	2	2
CO5	3	3	2	2	2	3	3	3	2	2	2	2	2	2

Course Contents / Syllabus

Module 1	**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.

Module 2	**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.

Module 3	**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.

Module 4	**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.

Module 5	**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-

NIET Greater Noida Autonomous Institute	**NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY** **GREATER NOIDA-201306** **(An Autonomous Institute)** **School of Biotechnology**

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.

Total Lecture Hours | **40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Indian Polity for Civil Services and Other State Examinations, McGraw Hill, 2020 (6th Edition, latest)	M. Laxmikanth
2	Introduction to the Indian Constitution, PHI Learning Pvt. Ltd., 2018 (8th Edition, latest)	Brij Kishore Sharma
3	The Indian Constitution: Cornerstone of a Nation (Classic Reissue), Oxford University Press, 2019 (latest edition)	Granville Austin

Reference Books:

S.No	Book Title with publication agency & year	Author
1	The Indian Constitution, Oxford University Press, 2012 (latest edition)	Madhav Khosla
2	The Constitution of India, Universal Law Publishing, 2024 (latest edition)	P. M. Bakshi
3	Law Relating to Intellectual Property Rights, LexisNexis, 2017 (2nd Edition, latest)	V. K. Ahuja

NPTEL/ Youtube/ Faculty Video Link:

Module 1	
Module 2	
Module 3	
Module 4	
Module 5	

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Bioseparation Engineering

Course Code: BBT0601	**Course Name: Bioseparation Engineering**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**3**	**1**	**0**	**4**

Pre-requisite: Knowledge of basic cell structure

Course Objectives: The course aims to provide students with comprehensive knowledge of various separation techniques used for biomolecules, including chromatography and membrane-based methods. It also focuses on optimizing these processes for effective separation and highlights the significance of enzymes in bioprocessing and purification strategies.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand separation techniques of biomolecules.	K2
CO2	Demonstrate the different separation techniques of Nucleic Acids.	K3
CO3	Estimate the biomolecules with qualitative methods using membrane-based techniques.	K2
CO4	Analyze the separation techniques of biomolecules using chromatography.	K4
CO5	Demonstrate the different technology of Product Polishing	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	1	2	1	2	3	2	1
CO2	3	3	3	2	3	1	1	2	3	1	2	3	3	2
CO3	3	2	2	2	3	1	1	2	2	1	2	3	3	2
CO4	3	3	3	3	3	1	1	2	3	1	2	3	3	2
CO5	3	2	3	2	3	1	1	2	3	1	2	3	3	2

Course Contents / Syllabus

Module 1	**Introduction to Bioseperation**	**8 hours**

Introduction to separation of biomolecules and its importance in Biotechnology, Working principles of centrifugation, filtration, cell disruption, flocculation.

Module 2	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.

Module 3	**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.

Module 4	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.

Module 5	**Product Polishing**	**8 hours**

Product polishing: crystallization, drying; Case studies: illustrative examples pertaining to downstream processing of bioproducts, biopharmaceuticals and recombinant products.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	Bioseparations: Principles and Techniques, PHI Learning, 2010 (latest edition)	Sivasankar
2	Bioseparation: Volume 47 (Advances in Biochemical Engineering/Biotechnology), Springer, 1994 (latest edition)	C. A. Heath; A. L. Nguyen
3	Bioseparation Engineering: A Comprehensive DSP Volume, Wiley-Scrivener, 2022 (latest edition)	Abhishek Awasthi; Ajay Kumar

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Bioseparations: Downstream Processing for Biotechnology, Wiley, 1988 (latest edition)	Paul A. Belter; E. L. Cussler; Wei-Shou Hu

2	Bioseparations Science and Engineering, Oxford University Press, 2015 (2nd Edition, latest)	Roger G. Harrison; Paul W. Todd; Scott R. Rudge; Demetri P. Petrides
3	Bioseparations Engineering: Principles, Practice, and Economics, Wiley, 2017 (2nd Edition, latest)	Michael R. Ladisch

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

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
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School of Biotechnology

Metabolic Engineering

Course Code: BBT0602	Course Name: Metabolic Engineering	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

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

Course Objectives: This course aims to introduce students to the fundamentals of metabolic engineering and its significance in biotechnology. It provides foundational knowledge on metabolic flux analysis, experimental approaches for flux determination, and computational modeling of biological networks. The course also emphasizes the industrial applications of primary and secondary metabolites in various bioprocesses.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the metabolic engineering and its importance	K2
CO2	Evaluate the metabolic flux analysis.	K5
CO3	Design metabolic flux by using different analytic techniques.	K6
CO4	Illustrate the Computational modelling of biological networks	K3
CO5	Explain various Industrial Applications of Metabolic engineering.	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	1	2	1	2	3	2	1
CO2	3	3	3	3	2	1	1	1	2	1	2	3	3	2
CO3	3	3	3	3	2	1	1	1	2	1	2	3	3	2
CO4	3	3	3	3	3	1	1	1	3	1	2	3	3	2
CO5	3	2	3	2	2	1	1	1	3	1	2	3	3	2

Course Contents / Syllabus

Module 1	**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.

Module 2	Metabolic flux analysis	**8 hours**

Introduction to Metabolic flux analysis (MFA), Isotopic steady state methods (13C 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.

Module 3	**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.

Module 4	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.

Module 5	**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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Metabolic Engineering: Principles and Methodologies, Academic Press, 1998 (latest edition)	Gregory N. Stephanopoulos; Aristos A. Aristidou; Jens Nielsen
2	Pathway Analysis and Optimization in Metabolic Engineering, Cambridge University Press, 2002 (latest edition)	Néstor V. Torres; Eberhard O. Voit

3	The Metabolic Pathway Engineering Handbook, CRC Press, 2010 (latest edition)	Christina D. Smolke

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Biochemical Engineering, CRC Press, 1997 (latest edition)	Harvey W. Blanch; Douglas S. Clark
2	Principles of Fermentation Technology, Elsevier, 2016 (3rd Edition, latest)	Peter F. Stanbury; Allan Whitaker; Stephen J. Hall
3	Fermentation and Enzyme Technology, Wiley, 1979 (latest edition)	Daniel I. C. Wang; Cooney, Demain, Dunnill, Humphrey, Lilly

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=xF_WotEWJA0
Module 2	https://www.youtube.com/watch?v=x2URHbJfHDk
Module 3	https://www.youtube.com/watch?v=ndThuqVumAk
Module 4	https://www.youtube.com/watch?v=ndThuqVumAk
Module 5	https://www.youtube.com/watch?v=ndThuqVumAk

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

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School of Biotechnology

Nanobiotechnology

Course Code: BBT0603	**Course Name: Nanobiotechnology**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

Pre-requisite: Students should know about the basic molecular and cell biology

Course Objectives: This course aims to provide students with a foundational understanding of nanobiotechnology and nanofabrication techniques, along with the synthesis of nanomaterials. It emphasizes the tools and methods used for nano-characterization and their practical applications, explores various biomedical polymers and their roles, and highlights the use of nanotechnology in diagnosis, imaging, and disease treatment.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain the basics of nanoscience, nanobiotechnology, nanotechnology and its techniques.	K2
CO2	Devise effective strategies of nanomaterials synthesis.	K6
CO3	Compare potential tools and techniques for nano material characterization.	K2
CO4	Differentiate the synthesis process of different classes of biomaterial.	K4
CO5	Conclude the concept of diagnosis, imagining and treatment of disease through nanotechnology tools and techniques.	K5

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	3	1	1	1	2	1	2	3	2	1
CO2	3	3	3	2	3	1	1	1	2	1	2	3	3	2
CO3	3	2	2	2	3	1	1	1	2	1	2	3	2	2
CO4	3	3	3	3	3	1	1	1	2	1	2	3	3	2
CO5	3	2	3	3	3	1	1	1	3	1	2	3	3	2

Course Contents / Syllabus

Module 1	Introduction to Nanobiotechnology	**8 hours**

Nanobiotechnology, History, Origin, Fundamental Concepts, Approaches, Current research, Moore's Law, Discussion on Micro and Nanofabrication process.

Module 2	Nanocharacterization tool and techniques	**8 hours**

Carbon based nanomaterials types, Synthesis, Properties, Applications, Inorganic nanomaterials types, Synthesis, properties, Applications.

Module 3	Application of Nanobiotechnology in Biological and Medical Sciences:	**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)

Module 4	Nanomaterials synthesis and applications	**8 hours**

Synthesis and characterization of different classes of biomaterials and polymers, and their uses in Pharmaceutical, Cardiovascular Ophthalmologic and Orthopedic areas.

Module 5	Biomaterials and polymers	**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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Nanotechnology, Pearson Education, 2003 (latest edition)	Mark Ratner; Daniel Ratner
2	Nanostructures and Nanomaterials: Synthesis, Properties and Applications, World Scientific (Imperial College Press), 2011 (2nd Edition, latest)	Guozhong Cao
3	Nanostructured Materials and Nanotechnology, Academic Press, 2002 (latest edition)	Hari Singh Nalwa

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Microfabrication and Nanomanufacturing, CRC Press, 2018 (latest edition)	Mark James Jackson
2	MEMS and Nanotechnology-Based Sensors and Devices: Applications in Communication, Medicine, and Aerospace, CRC Press, 2008 (latest edition)	A. R. Jha
3	Drug Delivery: Engineering Principles for Drug Therapy, Oxford University Press, 2001 (latest edition)	Mark Saltzman

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://nptel.ac.in/courses/117101003
Module 2	https://nptel.ac.in/courses/113102017
Module 3	https://www.youtube.com/watch?v=9eRJ6NOrZqY
Module 4	https://nptel.ac.in/courses/123106008
Module 5	https://www.youtube.com/watch?v=5hVA6TWQEd4

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Bioreactor Analysis and Design

Course Code: BBT0611	**Course Name: Bioreactor Analysis and Design**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

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

Course Objectives: 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.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the basics of bioreactor analysis and design	K2
CO2	Illustrate the importance of aeration and agitation in bioreactor	K3
CO3	Understand the importance of materials and components for bioreactor	K2
CO4	Demonstrate the bioreactor scale up strategies	K3
CO5	Illustrate the control and instrumentation in bioreactor	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	1	2	1	2	3	2	1
CO2	3	3	3	2	3	1	1	1	2	1	2	3	3	2
CO3	3	2	2	2	3	1	1	1	2	1	2	3	2	1
CO4	3	3	3	3	3	1	1	2	2	1	2	3	3	2
CO5	3	3	3	3	3	1	1	2	3	1	2	3	3	2

Course Contents / Syllabus

Module 1	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.

Module 2	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.

Module 3	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.

Module 4	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

Module 5	Bioreactor scale up	**8 hours**

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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	Bioprocess Engineering: Basic Concepts, Pearson, 2017 (3rd Edition, latest)	Michael L. Shuler; Fikret Kargi; Matthew DeLisa
2	Bioprocess Engineering Principles, Academic Press, 2012 (2nd Edition, latest)	Pauline M. Doran
3	Biochemical Engineering, Prentice Hall, 1992 (latest edition)	James M. Lee

Reference Books:

S.No	**Book Title with publication agency & year**	**Author**
1	Biochemical Engineering Fundamentals, McGraw Hill, 1986 (2nd Edition, latest)	James E. Bailey; David F. Ollis

2	Bioreaction Engineering: Bioprocess Monitoring, Wiley-VCH, 1997 (latest edition)	Karl Schügerl
3	Introduction to Biochemical Engineering, Tata McGraw-Hill Education, 2005 (latest edition)	D. G. Rao

NPTEL/ Youtube/ Faculty Video Link:

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

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
GREATER NOIDA-201306
(An Autonomous Institute)
School of Biotechnology

Biofuels & Alcohol Technology

Course Code: BBT0613	Course Name: Biofuels & Alcohol Technology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: General biology and basic knowledge of Fermentation and Bioconversion

Course Objectives: This course is designed to introduce students to the concepts and applications of biofuels and alcohol technology. It covers various alcoholic fermentation techniques, the biochemistry of alcohol production, recycling methods, and quality control measures. Additionally, it focuses on biomass conversion for energy generation and explores clean fuel technologies and fermentation criteria for molasses.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Explain basic concepts and importance of metabolic engineering.	K2
CO2	Understand the production of metabolites and its regulatory mechanism.	K2
CO3	Explain the applications, specificity and product inhibition of bioconversion.	K2
CO4	Understand regulation of enzyme production and strain improvement.	K2
CO5	Understand fermentation section of alcohol technology	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	2	2	1	2	1	2	3	2	1
CO2	3	2	2	2	2	2	2	1	2	1	2	3	2	1
CO3	3	2	2	2	2	2	2	1	2	1	2	3	2	2
CO4	3	2	2	2	2	3	2	1	2	1	2	3	2	2
CO5	3	2	2	2	2	3	2	1	2	1	2	3	2	2

Course Contents / Syllabus

Module 1	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.

Module 2	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.

Module 3	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.

Module 4	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.

Module 5	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.

	Total Lecture Hours	40 hours

Textbook:

S.No	Book Title with publication agency & year	Author
1	Chemical Process Principles – Part I: Material and Energy Balances, CBS Publishers & Distributors, 1995 (latest Indian reprint)	Olaf A. Hougen; Kenneth M. Watson; Roland A. Ragatz
2	The Alcohol Textbook, Nottingham University Press, 2003 (4th Edition, latest widely used)	Kathryn Ann Jacques; T. P. Lyons; D. R. Kelsall

3	Product Recovery in Bioprocess Technology, VCH, 1990 (latest edition)	BIOTOL Series Editors

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Shreve's Chemical Process Industries, McGraw Hill, 1984 (5th Edition, latest)	George T. Austin (based on R. Norris Shreve)
2	Outlines of Chemical Technology, Affiliated East-West Press, 2008 (3rd Edition, latest revised by M. Gopala Rao & Marshall Sittig)	Charles E. Dryden
3		

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://www.youtube.com/watch?v=niZls2dpHjM
Module 2	https://www.youtube.com/watch?v=mhwUc84xBZA
Module 3	https://www.youtube.com/watch?v=D6mRPgvAEOc
Module 4	https://www.youtube.com/watch?v=YbdkbCU20_M
Module 5	https://www.youtube.com/watch?v=GO1vk_fJ27Y

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY
GREATER NOIDA-201306
(An Autonomous Institute)
School of Biotechnology

Probability and Statistics using R in biotechnology

Course Code: BBT0612	Course Name: Probability and Statistics using R in biotechnology	L	T	P	C
Course Offered in: Department of Biotechnology		3	0	0	3

Pre-requisite: Basic knowledge of data analysis and data science

Course Objectives: This course aims to introduce students to the fundamental concepts of Artificial Neural Networks (ANN) and machine learning, along with hands-on learning of R programming. It covers basic statistical techniques like regression and distribution using R, provides an overview of decision trees, and emphasizes the application of R programming in solving biotechnology-related problems.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand basic concepts of ANN and machine learning.	K2
CO2	Understand R programming	K2
CO3	Apply R in regression and distribution	K3
CO4	Interpret the decision trees	K2
CO5	Apply R programming in Biotechnology.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	1	2	1	3	3	2	2
CO2	3	2	2	2	3	1	1	1	2	1	3	3	2	2
CO3	3	3	3	3	3	1	1	1	2	1	3	3	3	2
CO4	3	2	2	3	3	1	1	1	2	1	3	3	2	2
CO5	3	3	3	3	3	1	1	2	3	1	3	3	3	3

Course Contents / Syllabus

Module 1	**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.

Module 2	**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.

Module 3	**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

Module 4	**Probability & Statistical Analysis-II**	**8 hours**

Analysis of Covariance, Time Series Analysis, Nonlinear Least Square, Decision Tree, Random Forest, Survival Analysis, Chi Square Tests.

Module 5	**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

	Total Lecture Hours	**40 hours**

Textbook:

S.No	Book Title with publication agency & year	Author
1	Introduction to Machine Learning, MIT Press, 2020 (4th Edition, latest)	Ethem Alpaydin
2	Introduction to Artificial Neural Systems, West Publishing, 1992 (latest edition)	Jacek M. Zurada
3	R in a Nutshell, O'Reilly Media, 2012 (2nd Edition, latest)	Joseph Adler

Reference Books:

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S.No	**Book Title with publication agency & year**	**Author**
1	Machine Learning, McGraw-Hill, 1997 (latest edition)	Tom M. Mitchell
2	The Elements of Statistical Learning, Springer, 2017 (2nd Edition, corrected 12th printing, latest)	Trevor Hastie; Robert Tibshirani; Jerome Friedman
3		

NPTEL/ Youtube/ Faculty Video Link:	
Module 1	https://www.youtube.com/watch?v=xbYgKoG4x2g&list=PL53BE265CE4A6C056
Module 2	https://www.youtube.com/watch?v=3iSKFCKLUsI
Module 3	https://www.youtube.com/watch?v=COI0BUmNHT8&list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE
Module 4	https://www.youtube.com/watch?v=4Uj5hhnX4hs&list=PLyqSpQzTE6M_JcleDbrVyPnE0PixKs2JE&index=14
Module 5	https://www.youtube.com/watch?v=rjl34x9TqAQ&list=PLwdnzlV3ogoXmoCXczKiu6WGW0r05Zw02&index=18

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Machine learning

Course Code: BBT0614	**Course Name: Machine learning**	**L**	**T**	**P**	**C**
Course Offered in: Department of Biotechnology		**3**	**0**	**0**	**3**

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

Course Objectives: This course aims to build a strong foundation in machine learning (ML) by introducing its basic concepts and the essential linear algebra underlying ML models. It provides in-depth knowledge of various machine learning techniques and algorithms, along with practical insights into applying ML to real-world problems.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand basic concept of machine learning (ML)	K2
CO2	Demonstrate linear algebra for ML	K3
CO3	Illustration of the machine learning techniques	K3
CO4	Interpret ML algorithms	K2
CO5	Understand the application of ML in Biotechnology	K2

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO No	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	1	1	1	2	1	3	3	2	2
CO2	3	3	3	2	3	1	1	1	2	1	3	3	3	2
CO3	3	3	3	3	3	1	1	2	2	1	3	3	3	3
CO4	3	2	2	3	3	1	1	1	2	1	3	3	2	2
CO5	3	3	3	3	3	1	1	2	3	1	3	3	3	3

Course Contents / Syllabus

Module 1	**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.

Module 2	**Machine Learning Techniques**	**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.

Module 3	**Application of Machine learning**	**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.

Module 4	**Linear Algebra**	**8 hours**

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

Module 5	**Machine learning algorithms**	**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.

	Total Lecture Hours	**40 hours**

Textbook:

S.No	**Book Title with publication agency & year**	**Author**
1	The Elements of Statistical Learning, Springer, 2017 (2nd Edition, corrected 12th printing, latest)	Trevor Hastie; Robert Tibshirani; Jerome H. Friedman
2	Introduction to Machine Learning using Python, Khanna Publishing House, 2019 (1st Edition, latest)	Jeeva Jose
3	Machine Learning, McGraw Hill Education, 1997 (1st Edition, latest)	Tom M. Mitchell

Reference Books:

S.No	Book Title with publication agency & year	Author
1	Introduction to Machine Learning, MIT Press, 2020 (4th Edition, latest)	Ethem Alpaydin
2	Machine Learning, Khanna Book Publishing Co., 2019 (latest edition)	Rajiv Chopra
3	Pattern Recognition and Machine Learning, Springer, 2006 (latest edition)	Christopher M. Bishop

NPTEL/ Youtube/ Faculty Video Link:

Module 1	https://youtu.be/ukzFI9rgwfU?si=FX01GftRdyIzqoGH
Module 2	https://youtu.be/SioiFuMRiv4?si=xRGj9qzhd35S-H8p
Module 3	https://youtu.be/NUXdtN1W1FE?si=alAvyccuSubZhG1r
Module 4	https://youtu.be/eM4uJ6XGnSM?si=iOTWYopnESnV-P4b
Module 5	https://youtu.be/LvC68w9JS4Y?si=gaYAMnV-Cv392GBU

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Bioseparation Engineering Lab

LAB Course Code: BBT0651	LAB Course Name: Bioseparation Engineering Lab	L	T	P	C
Course Offered in: ……..		0	0	2	1

Pre-requisite:

Course Objectives:

This course aims to equip students with a comprehensive understanding of protein separation processes using various chromatographic techniques. It includes hands-on training in extracting intracellular and extracellular proteins from biological samples, estimating lipids through chromatography, and analyzing diverse biomolecule separation methods for practical applications in biotechnology.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Understand the separation process of proteins using chromatographic techniques.	K2
CO2	Demonstrate the extraction process of intra and extra cellular proteins from biological samples.	K3
CO3	Estimate the lipids through chromatographic techniques.	K2
CO4	Analyse the separation techniques of biomolecules using chromatography.	K4

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	1	-	2	1	-	3	3	3
CO2	3	3	3	2	3	2	2	2	3	2	2	3	3	3
CO3	3	3	3	2	3	2	2	2	3	2	2	3	3	3
CO4	3	3	3	2	3	2	2	2	3	2	3	3	3	3

List Of Practical's (Indicative & Not Limited To)

1. Isolation of the plant cell organelles using centrifugation methods.
2. Isolation and separation of plant/bacterial DNA using centrifugation and biochemical methods.
3. Separation of the proteins with suitable chromatography methods.
4. Apply filtration and ultrafiltration method for separation of proteins.
5. Use TLC for separation of the biolipids
6. Isolation of the photosynthetic pigments using centrifugation methods
7. Isolation and separation of plant/bacterial RNA using centrifugation and biochemical methods.
8. Isolation and separation of plant/bacterial protein using centrifugation and biochemical methods.
9. Extraction of lactose from milk.
10. Metabolic engineering of E. coli for high yield production of 1,3-butanediol

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

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School of Biotechnology

Metabolic Engineering Lab

LAB Course Code: BBT0652	LAB Course Name: Metabolic Engineering Lab	L	T	P	C
Course Offered in: ……..		0	0	2	1

Pre-requisite:

Course Objectives:

This course is designed to provide students with practical and theoretical knowledge of metabolic and strain engineering techniques to enhance microbial production of valuable compounds. It covers modeling metabolic fluxes, applying genetic tools for metabolite synthesis, and exploring optimization strategies for industrial applications like antibiotics and biofuel production..

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Demonstrate strain engineering techniques to enhance microbial production of target compounds.	K3
CO2	Analyze metabolic flux models for correlating experimental data with predicted pathways.	K4
CO3	Illustrate metabolic engineering for cost-effective production of antibiotics and biofuels.	K2
CO4	Demonstrate cloning and heterologous expression for secondary metabolite biosynthesis.	K3

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	2	2	2	3	3	3	3
CO2	3	3	3	2	3	2	2	2	2	2	3	2	2	3
CO3	3	3	3	2	3	2	2	2	2	2	3	2	3	3
CO4	3	3	3	2	3	3	3	2	2	2	2	3	3	3

List Of Practical's (Indicative & Not Limited To)

1. Develop engineering strategies to boost production of industrially relevant compound in E. coli.
2. Strain engineering (deletion or overexpression of genes) to boost production of target compound followed by metabolite extraction and quantification.
3. Demonstration of feed-back regulation and product inhibition.
4. Development of a flux model and correlation of the model with experimental data.
5. Demonstration of effect of addition of supplement to enhance enzyme activity in fungal strain.
6. Demonstration of metabolic engineering approach for low cost antibiotics
7. Demonstration of metabolic engineering approach for low cost biofuel production
8. To build stoichiometric matrix for glycolytic reactions
9. Redirecting the metabolic pathway in E.coli towards increased succinic acid production as well as reducing formation of other metabolites.
10. Bioprospecting of microbial strain to enhance bioethanol production

Total Hours: 48 hrs.

NOIDA INSTITUTE OF ENGINEERING AND TECHNOLOGY

GREATER NOIDA-201306

(An Autonomous Institute)

School of Biotechnology

Nanobiotechnology Lab

LAB Course Code: BBT0653	LAB Course Name: Nanobiotechnology Lab	L	T	P	C
Course Offered in: ……..		0	0	2	1

Pre-requisite:

Course Objectives:

This course aims to introduce students to the foundational concepts of nanoscience, nanobiotechnology, and nanotechnology. It covers various synthesis strategies for nanomaterials, provides knowledge of advanced tools and techniques used in nano-characterization, and focuses on developing practical laboratory skills essential for working in the field of nanotechnology.

Course Outcome: After completion of the course, the student will be able to		Bloom's Knowledge Level (KL)
CO1	Learn the basics of nanoscience, nanobiotechnology, nanotechnology.	K1
CO2	Understanding the different strategies of nanomaterials synthesis.	K2
CO3	Gain knowledge of tools and techniques used for nano-characterization	K1
CO4	Develop the hands-on skills for working into laboratories	K6

CO-PO Mapping (Scale 1: Low, 2: Medium, 3: High)

CO-PO Mapping	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	3	2	3	2	2	2	2	3	2	3	3	3
CO2	3	3	3	2	3	2	2	2	2	3	2	2	2	2
CO3	3	3	3	2	3	2	2	2	2	3	2	2	3	2
CO4	3	3	3	2	3	3	3	2	2	2	2	3	3	2

List Of Practical's (Indicative & Not Limited To)

1. Demonstration of Nanoscience and nanobiotechnology (Size comparative analysis)
2. Synthesis of carbon nanotubes from carbon source.
3. Chemical synthesis of metallic nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.
4. Biological synthesis of metallic nanoparticles; UV-Visible absorption of the colloidal solution and estimation of size by curve fitting.
5. Nanoparticles toxicity estimation in percentage as *in vitro* methods
6. Synthesis of carbon dots from microwave pyrolysis method.
7. Sol gel synthesis of zinc oxide nanoparticles.
8. Nature of Interaction between nanoparticles & Bacterial Cell (*E. coli* and *B. subtilis*).
9. Demonstration of nano characterization tools and techniques.
10. Antibacterial activities of silver and zinc nanoparticles, against bacterial cultures performed by standard disc diffusion method

Total Hours: 48 hrs.