Dr. D. Y. PATIL VIDYAPEETH, PUNE
(Deemed to be University)

DR. D. Y. PATIL VIDYAPEETH

PIMPRI, PUNE – 411 018

DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE

TATHAWADE, PUNE

SYLLABUS

B. TECH. BIOTECHNOLOGY

2023-2024

B. Tech Biotechnology Programme
Program Outcomes (PO)

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

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

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

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

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

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

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

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

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

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

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

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

Program Specific Outcomes (PSO)

PSO-1	Integrate the knowledge of biology, engineering, and technology for applications in industry, consultancy, and research.
PSO-2	Explore solutions to complex biological problems using the acquired in-depth practical knowledge and domain-specific skill set.
PSO-3	Innovate and design strategies to conduct research with ethical and professional responsibilities.

DR. D.Y. PATIL VIDYAPEETH, PUNE
DR. D. Y. PATIL BIOTECHNOLOGY & BIOINFORMATICS INSTITUTE, TATHAWADE, PUNE
COURSE STRUCTURE FOR B. TECH. BIOTECHNOLOGY

SEMESTER I						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BS101	Physics	3	0	2	5	4
BS102	Chemistry	3	0	2	5	4
BT101	Electronics & Instrumentation Engineering	2	0	2	4	3
BI101	Python for Biologists	2	0	4	6	4
HU101	Communication Skills	1	1	0	2	2
BS103	Maths I – Mathematics	2	0	0	2	2
BTAEC101	Aptitude Building-I	0	0	2	2	1
Total		**13**	**1**	**12**	**26**	**20**
SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT201	Biochemistry	3	0	4	7	5
BT202	Cell Biology	3	0	2	5	4
BS201	Maths II -Statistics	2	0	2	4	3
BT203	Engineering Mechanics	2	0	2	4	3
BS202	Environmental Sciences	2	0	2	4	3
BT204	Engineering Graphics	1	0	2	3	2
HU201	Disaster Management*	0	1	0	1	0
BTIKS201	History of Indian Science	1	0	0	1	1
BTAEC201	Aptitude Building-II	0	0	2	2	1
Total		**14**	**1**	**16**	**31**	**22**
Audit course, attendance is must						
SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT301	Analytical Techniques	2	0	4	6	4
BT302	Microbiology & Virology	2	0	4	6	4
BT303	Genetics	3	0	2	5	4
BI301	Concepts in Bioinformatics	2	0	4	6	4
BT304	Biosafety, Bioethics & IPR	2	0	0	2	2
HU301	Universal Human Values II	2	1	0	3	3

BTSEC301	NPTEL/SWAYAM/MOOC online course	2	0	0	2	2
BTAEC301	Aptitude Building-III	0	0	2	2	1
Total		**15**	**1**	**16**	**32**	**24**
SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT401	Molecular Biology	3	0	4	7	5
BT402	Stem cells & Animal Tissue culture	2	0	2	4	3
BT403	Plant Biotechnology	3	0	4	7	5
BT404	Immunology	3	0	2	5	4
BT405	Developmental Biology	2	0	2	4	3
BTIKS401	Indian Regional Biodiversity	0	1	0	1	1
BTAEC401	Aptitude Building-IV	0	0	2	2	1
BTOP401 Non-credit mandatory course	Social outreach program/ Science for Society	0	1	0	1	0
Total		**13**	**2**	**16**	**31**	**22**
SEMESTER V						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT501	Environmental Biotechnology	2	0	2	4	3
BT502	Recombinant DNA Technology	2	0	4	6	4
BT503	Biochemical Engineering & Bioprocess Technology	3	0	4	7	5
BT504	Enzymology & Enzyme Technology	2	0	2	4	3
BI501	R Programming	1	0	0	1	1
BT 505/BT506/ BT507	**Elective-I** BT505 Biopharmaceuticals BT506 Clinical Research BT507 Human Diseases and Pathobiology	3	0	2	5	4
BTSEC501	Science communication	0	0	2	2	1
BTAEC501	Aptitude Building-V	0	0	2	2	1
	Total	**13**	**0**	**18**	**31**	**22**
SEMESTER VI						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT601	Food Biotechnology	2	0	2	4	3
BT602	Marine Biotechnology	2	0	0	2	2
BT603	Basic Pharmacology & Toxicology	2	0	0	2	2
BT604	Genomics, Transcriptomics and Proteomics	3	0	4	7	5
BI601	Artificial Intelligence	1	0	2	3	2
BT605/BT606	Elective II: BT605 Perl & Bioperl BT606 Structural Biology	3	0	2	5	4
BTIKS601	Indian Constitution and Law	1	0	0	1	1

BTSEC601	Foreign Language Course German/French/Japanese/Korean/Spanish/ any other (online MOOCs/offline)	2	0	0	2	2
BTAEC601	Aptitude Building-VI	0	0	2	2	1
Total		**16**	**0**	**12**	**28**	**22**
SEMESTER VII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BI701	Molecular Modeling	2	0	4	6	4
BT701	Nanobiotechnology and Biosensors	2	0	2	4	3
HU701	Principles of Management & Entrepreneurial Development	2	0	0	2	2
HU702	Quality Control Management in Biotechnology	2	0	0	2	2
BT702	Seminars in Biotechnology	2	0	0	2	2
BT 703/BT704/ BT705	**Elective-III** BT703 Metabolic Engineering BT704 Agriculture Biotechnology BT705 Cancer Biology	3	0	2	5	4
BTAEC701	Aptitude Building-VII	0	0	2	2	1
Total		**13**	**0**	**10**	**23**	**18**
Semester VIII						
BTMP801	**Research Project/Industrial Training/ Review writing/Entrepreneurship Start-up (5 months)**	**22 Credits**				
TOTAL CREDITS		**172**				

SEMESTER I						
Course Code	**Course Name**	**L**	**T**	**P**	**H**	**C**
BS101	Physics	3	0	2	5	4
BS102	Chemistry	3	0	2	5	4
BT101	Electronics & Instrumentation Engineering	2	0	2	4	3
BI101	Python for Biologists	2	0	4	6	4
HU101	Communication Skills	1	1	0	2	2
BS103	Maths I – Mathematics	2	0	0	2	2
BTAEC101	Aptitude Building-I	0	0	2	2	1
Total		**13**	**1**	**12**	**26**	**20**

COURSE: PHYSICS
COURSE CODE: BS101 **L T P H C**
MARKS: (Theory 100 + Practical 50) **3 0 2 5 4**

OBJECTIVE

The objective of this course is:

- To create general understanding regarding basic physical principles involved in living systems.
- To familiarize the student with basic concepts in physics as: classical optics used in microscopes and telescopes, thermometry and heat, mechanical, fluid and solid state properties.
- To familiarize students with concepts in digital electronics, lasers, sound waves, electricity.
- To introduce them to concepts in modern physics such as: production of X-ray, X-ray crystallography, quantum mechanics etc.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BS101.1	Restate the fundamentals of optics and its usage in various biological instrumentation and analysis
BS101.2	Comprehend the principles and applications of thermometry
BS101.3	Apply the concepts of surface tension, viscosity, semiconductor devices in real life
BS101.4	Categorize materials on the basis of elastic and solid state properties
BS101.5	Determine and explain the properties of laser and sound
BS101.6	Demonstrate the applications of modern physics in biological sciences

PREREQUISITES

This is an introductory course. School level knowledge of physics is sufficient. There are no prerequisites.

COURSE DESCRIPTION

Unit	Topics	Detail syllabus	No. of Lectures
1	Optics: Interference Diffraction & Polarization	Introduction to optics, Principles of superposition, Constructive & Destructive Interference, Types of Interference, Newton's rings. Diffraction- Types of diffraction, Diffraction grating, Rayleigh's criterion, Resolving power of Microscope and Telescope. Polarization of light waves, Polaroid, Optical activity.	8
2	Thermometry and Heat	Principles of Thermometry, Temperature and its measurements, Platinum resistance Thermometer, Thermocouple and Thermistors, Modes of Heat Transfer.	5

3	Properties of Fluid: Surface Tension & Viscosity	Surface Tension, Surface Energy, Angle of Contact, Capillarity action, Determination of Surface tension by capillary rise method, Jaeger's method, Temperature dependence of surface tension and its applications. Viscosity, Coefficient of viscosity, streamline and turbulent flow, Reynold's number, Stoke's law, Terminal velocity, Determination of 'η' by falling sphere method.	7
4	Elasticity	Stress and Strain, Hook's law, Stress-strain curve, Young's modulus, Determination of Young's modulus.	3
	Solids and Semiconductor Devices	Classification of Solids (Conductor, Semiconductor and Insulators), intrinsic and extrinsic semiconductors, PN Junction Diode, Zener Diode, Junction Transistors (CE, CB mode)	5
5	Introduction to Digital Electronics	Introduction to Binary mathematics, BCD numbers, Basic logic gates, De-Morgan's Theorem	2
	Lasers	Properties of Lasers, Production mechanism, Ruby Laser, Helium Neon Laser, applications of Lasers.	3
	Sound waves	Types of sound waves (Longitudinal and Transverse), Audible, Ultrasonic and Infrasonic waves, Beats, Doppler effect, Applications of Ultrasonic waves.	3
	Electricity	Heating effect of electric current, Joule's law, Transformers, Types of Transformers.	2
6	Modern Physics: X-rays, Crystallography, Introduction to Quantum Mechanics	Introduction to X-Rays: Introduction, Production of X-rays, X-Ray diffraction and its Applications. Introduction to crystal structure, Unit cell, seven crystal systems. Plank's Quantum Theory, Properties of Photon, Photoelectric effect, wave particle duality of radiation, de Broglie's hypothesis, Heisenberg's Uncertainty principle.	7
Total Number of Lectures			**45**

METHODOLOGY

The course will be covered through lectures supported by practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		05
End Semester Exam	2 hours 30 minutes	60
Total		100

BOOKS RECOMMENDED:

1)David Halliday, Robert Resnick, J. Walker (2021)."Fundamentals of Physics" "John Wiley & Sons, Inc."

2) Arthur Beiser, Shobhit Mahajan and S Rai Choudhury (2015). “Concepts of modern physics”, McGraw Hill
3) Singh Devraj, “Fundamentals of Optics” PHI Learning Pvt. Ltd. , 2nd edition, 2015
4) Ajoy Ghatak, “Optics”, Mc Graw Hill Publication, 7th edition, 2020
5) Anil K. Maini, “Digital Electronics: Principles, Devices and Applications”, JOHN WILEY , 2007

1. Physics by D. Haliday and R. Resnik 5th edition, Wiley Eastern Pub, 2007.
2. Perspectives of Modern Physics by A. Beiser, 6th edition, Mc Graw Hill, 2003.
3. Fundamensls of optics by F. A. Jenkins and H. E. White, 4th edition, Mc Graw Hill, 1976.
4. Optics by A. Ghatak, 3rd edition, Tata Mc Graw Hill, 2006.
5. Digital Principles and Applications by A. P. Malvino, G. Saha and D. P. Leach, 7th edition, Mc Graw Hill, 2011.
6. David Halliday, Robert Resnick, J. Walker (2021).”Fundamentals of Physics” “John Wiley & Sons, Inc."
7. Arthur Beiser, Shobhit Mahajan and S Rai Choudhury (2015). “Concepts of modern physics”, McGraw Hill

PRACTICAL IN PHYSICS (2 H PER WEEK) MARKS 50

The practical training would be in the area of optics, electronics, thermometry, calorimeter, conductivity, measurement of physical properties as: viscosity and surface tension.

LIST OF EXPERIMENTS

1. Diffraction Grating: Use of diffraction grafting for determination of wavelength of spectral lining.
2. Resolving Power: To determine the resolving power of Microscope or telescope.
3. Diode Characteristics: Study of forward and reverse characteristics of Diode.
   Transistor Characteristics: Study of characteristics of Photocell.
4. Band gap of semiconductor: Study of input and output characteristics of a transistor and determination of band gap of a semiconductor.
5. Ultrasonic Interferometer: Determination of velocity of ultrasonic waves by ultrasonic
6. Study of logic gates (OR, AND, NOT).
7. Thermocouple: Study of variation of thermo emf (electromotive force) with temperature.
8. Surface Tension: Determination of the surface tension of a given solution.
11. Viscosity: Determination the coefficient of viscosity by Stoke's method and its practical application.
12. Joule's Law: Determine of Joule's constant.
13. Determination of wavelength of monochromatic light by Newton's rings experiments.
14. Thermal Conductivity: Determination of coefficient of thermal conductivity of given specimen.

PRACTICAL EVALUATION SCHEME

Examination	***Marks***
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

BOOKS RECOMMENDED:

1. Organic Chemistry by R. T. Morrison and R. N. Boyd, 7th Edition, Prentice Hall, 2011.
2. Organic Chemistry by I. L Finnar, 6th Edition Pearson Publications, 2002.
3. Physical Chemistry by A. Peter and P. Julio De 7th Edition, Oxford University Press, 2010.
4. Essentials of Physical Chemistry by B.S. Bahl & A. Tuli, S Chand & Co. 2000.
5. Biophysical Chemistry by A. Upadhyay, K. Upadhyay & N. Nath., Himalayan Publishing House. 2005.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 101.1	1	2	1	1	2	1	-	-	2	1	-	-	1	-	-
BS 101.2	1	1	1	1	1	1	-	-	1	1	-	0	1	-	-
BS 101.3	2	1	1	1	2	1	1	1	1	1	-	1	1	1	-
BS 101.4	2	2	1	1	1	1	-	-	-	1	-	1	1	1	-
BS 101.5	2	1	1	1	1	1	1	1	1	1	-	1	1	1	-
BS 101.6	2	1	1	1	1	1	2	2	1	1	-	1	1	1	1

COURSE: CHEMISTRY

COURSE CODE: BS102 **L T P H C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVES:

The objective of the course is:

- The objective of this course is to familiarize the student with the different concepts of physical and organic chemistry.
- The students will learn the structures of organic molecules as: alkanes, alkenes, alkynes, aliphatic and aromatic molecules and the stereochemistry behind the molecules with its importance in day today life
- They would learn the Basic concepts and principles with respect to physical chemistry, the bioenergetics of different reactions and the principles and applications of radioactivity.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BS102.1	Classify chemical structures of hydrocarbons
BS102.2	Determine the stereochemistry of organic molecules and assess their importance
BS102.3	Identify and compare electrophilic and nucleophilic reactions
BS102.4	Explain the concept of osmosis, viscosity, colloids, and prepare buffers for any biological system
BS102.5	Outline and apply the principles of thermodynamics in biological processes
BS102.6	Apply the knowledge of radioactivity and radioactive isotopes in biological and medical research and diagnosis

PREREQUISITES

This is the first introductory course and there are no prerequisites**.**

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1	Introduction to organic chemistry	Functional groups, Chemistry of alkanes, alkenes, alkynes, aromatic, alicyclic and heterocyclic compounds	7
2	Stereochemistry	Stereo isomers, Enantiomers, Chiral centers/ Optical activity, Geometric isomers Meso- isomers, Conformational isomers, Stereochemistry of Cyclic Aliphatic compounds,	8

3	Reaction mechanisms	Nucleophilic (SN1, SN2 , Electrophilic E1 and E2)	3
4	Basic concepts and principles of Physical Chemistry	Osmosis- Diffusion, Osmotic Pressure, Theories of Osmosis. Viscosity –Introduction & Types of viscometer. Colloids-Lyophilic & Lyophobic sols, Optical properties, Electrical properties of sols, Gold number. Donnan Equilibrium. Phase rule-Phase, Components & Degree of freedom. Derivation of Phase rule. Phase diagram. Water system. Acid-bases- Three concepts of acids & bases, pH meter & types of electrodes, Buffer solution, Acid base indicator, Law of mass action, Numerical.	11
5	Bioenergetics	First & Second laws of Thermodynamics, Internal energy, Enthalpy, Entropy, concept of free energy, Standard free energy change of a chemical reaction, ATP & high energy phosphates compounds. Chemical equilibrium constant, Nernst equation	6
6	Basic principles of radioactive isotopes	Isotopes in Biology- Properties, Half-life, Radioactive decay. Measurement of radioactivity-Methods based on Gas ionization (Ionization chamber, Proportional counter, Geiger counter), Photographic methods, Methods based on Excitation (Liquid & solid Scintillation counting), Quenching. Use of Isotopes-Tritium, Iodine-131, Nitrogen-15, Oxygen-18, Carbon-14, Phosphorus-32, Sulphur-35.	9
Total Number of Lectures			**45**

METHODOLOGY

The course will be covered through lectures, demonstration and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		05
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Organic Chemistry by R. T. Morrison and R. N. Boyd, 7th Edition, Prentice Hall, 2011.
2. Organic Chemistry by I. L Finnar, 6th Edition Pearson Publications, 2002.
3. Physical Chemistry by A. Peter and P. Julio De 7th Edition, Oxford University Press, 2010.
4. Essentials of Physical Chemistry by B.S. Bahl & A. Tuli, S Chand & Co. 2000.
5. Biophysical Chemistry by A. Upadhyay, K. Upadhyay & N. Nath., Himalayan Publishing House. 2005.

PRACTICAL IN CHEMISTRY (2 Hs. Per Week) MARKS 50

Sr. No.	Name of the experiment	Learning objective
1	Acid-Base Titration	To understand the concept of titration and how to calculate the strength of acid and base.
3	Back Titration	To analyze the concentration of analyte based upon chemical reaction.
4	Determination of optical activity using a Polarimeter	Help them to analyze the degree of rotation of plane polarised light
5	Viscosity, Osmosis and Diffusion techniques	To analyze the physical properties of compound by measuring i) hypotonic, isotonic and hypertonic nature ii)thickness, sticky and semifluid consistency
6	Demonstrate the procedure for determining Melting/Boiling point	The practical will teach them how to analyze the transition point from solid to liquid and ii) liquid to vapor phase.
7	To determine the pH of a solution using a polarimeter	It will guide them to measure the pH of a solution in terms of H+ ion concentration and to understand importance of pH in biological experiments.
8	Study of exothermic and endothermic reactions.	To understand the concept of thermodynamics of reaction based upon the absorption or release of heat energy.
9	Determine the heat of combustion of ethyl alcohol	To measure the amount of heat energy released during a chemical reaction.
10.	Determine the heat of neutralization of strong acid and strong base	To measure the change in enthalpy in a neutralization reaction to form water and a salt.

BOOKS RECOMMENDED:

1. Practical Organic Chemistry: Qualitative Analysis by S.P. Bhutani, A.Chhikara, ANE Books, 2009.
2. Laboratory Manuals In Biochemistry by J. Jayaraman, New Age International Private Ltd., 2000.
3. Experimental Physical Chemistry, By V. D. Athawale, P. Mathur, New Age International Private Ltd., 2000.
4. College Practical Chemistry, By V. K. Ahluwalia, S. Dhingra, Universities Press, 2005.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 102.1	3	1	1	1	0	1	0	0	1	1	0	0	3	2	1
BS 102.2	3	2	1	1	0	1	0	0		1	0	2	1	3	1
BS 102.3	3	2	1	1	0	1	1	0	1	1	0	2	3	1	1
BS 102.4	3	2	1	2	2	1	1	1	1	1	1	2	3	1	1
BS 102.5	3	2	1	1	1	1	1	1	1	1	1	2	3	1	1
BS 102.6	3	1	1	1	1	1	2	2	1	1	1	2	2	2	3

COURSE: ELECTRONICS AND INSTRUMENTATION ENGINEERING
COURSE CODE: BT101 **L T P H C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE:
Objective of the course is to familiarize students with the basic concepts of electronic engineering and electronics engineering.

This knowledge would help them in applying them in various biological techniques. Also the Knowledge of this subject will form a profound base for the instrumentation used in various advanced courses of Biotechnology and Bioinformatics.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT 101.1	Outline the basic concepts of electronics and semi-conductor devices
BT 101.2	Demonstrate the different applications of linear integrated circuits
BT 101.3	Examine and classify various digital electronic components for circuit designing
BT 101.4	Illustrate the working of temperature and pressure transducers

PREREQUISITES:
Since the course is very basic in nature, school level knowledge of physics and mathematics is required.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Basics	History and scope of electronics, Electrical signals, passive electronic components, resistors, capacitors, inductors, Bio signals	2
	Semiconductor devices	Diode circuits, P-N junction diode, biasing, half wave and full wave rectification	2
2	Linear integrated circuits	Introduction to operational –amplifiers, characteristics of op-amp, virtual short and virtual ground, concept of feedback, inverting and non-inverting amplifier, applications of op-amp, addition, subtraction, integration, and differentiation	8
3	Digital electronics	Digital circuits, AND, OR, NOT, NAND, NOR, EX-OR, EX-NOR, Boolean algebra, half adder, full adder, multiplexers and de-multiplexers, flip-flops, shift registers, counters, block diagram of microprocessor and microcontroller	8

4	Basic instrumentation	Sensors and transducers, basic measurement system, static and dynamic characteristics of an instrument, signal conditioning circuits	6
Total Number of lectures			**30**

METHODOLOGY:

The course will be covered through lectures, demonstration and practicals**.**

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. R. P. Jain (2010), Modern Digital Electronics, Tata Mc Graw Hill, 4th Edition
2. M. E. Schultz (2024), Grob's Basic Electronics , Tata McGraw Hill, 24th Edition
3. V. K. Mehta (2020), Principles of electronics, S. Chand Publisher , 12th Revised Edition
4. Ramakant A. Gayakwad (2015) ,Op-Amps and Linear Integrated Circuits By McGraw –Hill publishing company limited, 4th Edition
5. Millman and Halkias (2009), Integrated Electronics By. Mcgraw-Hill, 4th Edition
6. Ramesh Gaonkar (2013),Microprocessor Architecture, Programming, and Applications with the 8085,Penram Publisher , 6th Edition
7. A. K. Sawhney, Puneet Sawhney (2012), A course in electrical and electronic measurements and instrumentation , Rai publisher

PRACTICALS ELECTRONICS AND INSTRUMENTATION ENGINEERING (2 Hs. PER WEEK) MARKS 50

Sr no.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	Study of passive components in electronics Resistors, Inductors, capacitors, relay, switches, transformers and connectors.	Students should able to learn different passive components, their classification, symbol, and unit.	Principles of Electronics by V.K.Mehta and R. Mehta, S. Chand, 2005
2	Study of basic electronics measuring instruments DMM, CRO and function generator.	Students should able to operate CRO, function generator to generate different electrical signals. They should able to measure Voltage, current, frequency and time period of waveforms.	
3	Study of semiconductor devices, P-N junction Diode. Plot VI characteristics of P-N junction diode.	Students should able to learn different semiconductor devices like diode, transistors and also working of PN junction diode. They should able to plot VI characteristics graph.	
4	Study of operational amplifier Part I : Op-amp IC741 Part II: Op-amp as inverting and non-inverting amplifier.	Students should able to learn basic working principle of op-amp, pin diagram of IC 741.	
5	Study of digital logic circuits.	Students should able to learn different logic gates, their truth table and timing diagram.	
6	Study of pH electrode.	Students should able to understand operation of pH electrode for the measurement of pH.	
7	Study of resistance type temperature transducers.	Students should able to learn working principle of different resistance type temperature transducers like PRT, RTD, Thermistor, thermocouple	Basic electronics by J.S. Katre, Techmax publication, 2014

8	Study of conductivity meter electrode.	Students should able to understand the operation of conductivity meter electrode to measure conductivity of a solution.	Theory and applications of conductivity http://www.evisdom.com/
9	Study of 8085 microprocessor.	Students should able to understand pin diagram, block diagram and architecture of 8085 microprocessor.	http://8085projects.info/

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 101.1	3	1	1	1	2	3	2	-	-	3	-	3	2	1	-
BT 101.2	3	2	2	-	3	3	-	-	-	3	-	3	2	2	-
BT 101.3	3	3	3	-	-	3	-	-	-	3	-	-	3	2	-
BT 101.4	3	2	2	2	2	2	-	-	-	3	-	-	2	2	-

Course: PYTHON FOR BIOLOGISTS **L T P H C**
Course Code: BI101 **2 0 4 6 4**

Marks: 150

OBJECTIVE:

The course is designed to enable the students understand the basics of Python programming and design scripts for analysis of biological data.

COURSE OUTCOMES:

CO No.	At the end of the course, the learner should be able to:
BI101.1	Apply Primitive and Non-Primitive Data types and use conditional statements
BI101.2	Make use of functional libraries, modules, and platforms
BI101.3	Apply Regular Expressions and file handling
BI101.4	Demonstrate the capability of writing in-house scripts and analyze biological data.

PRE-REQUISITE

Basic Knowledge and Understanding of Computer.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	Lectures
1	Introduction to computer system and OOP	Basic Computer Architecture, operating systems etc., Feature(s) of object-oriented programming (OOP), Programming Languages used for biological data analysis with their relevance.	4
	Python Programming Fundamentals	A Brief History of Python, Applications areas of Python, Python data types, Python data structures – lists, tuples, strings, dictionaries, sets, type conversion in python, conditions and if statements - if else and elif, standard input & output, Python flow control: For loop, While Loop, Break: Breaking the Loop.	7
2	Python Functions and Modules	Python functions: string and list operations, list operations – concatenations, splice, add or remove elements, copy etc; Modules and Packages: Importing Modules, writing own modules, Standard library modules, dir () Function, Working with modules like Pandas, Numpy, Scipy etc., Functional Programming features like Lambda, Map, Filter, Reduce.	9
3	Python Regular Expressions and File Handling	Python regular Expressions – match, substitute, translate, binding operator; File handling in Python – opening a file in read only mode, write mode, append mode, A Special Kind of File: CSV, Functions from the CSV Module.	4
4	Biological Data analysis: Case studies	Use of Python packages and libraries relevant to the different biological data type, Python web integration -Python-CGI and working on Jupyter Notebook.	6
Total no. of Lectures			**30**

METHODOLOGY:

The course will be covered through lectures, demonstration, and practicals.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		05
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1.Python Programming for Beginners. Code One Publishing. 2023. ISBN-13:979-8361503742

2.Python Crash course,3rd Edition –December 2022,552pp A Hands-on, Project Based Introduction to Programming by Eric Matthes

3.Conceptual Programming with Python By Thorsten Altenkirch and Isaac Triguero, 2020, ISBN :9780244277567

4.Python for Bioinformatics By Sebastian Bassi 2nd edition,2017, ISBN-10 1138035262, ISBN-13 978-1138035263

5.Python for Bioinformatics By Sebastian Bassi 2nd edition 2018

6.Advanced Python for Biologists by Martin Jones ,2014, ISBN-10 1495244377, ISBN-13 978-1495244377

7.Martin Jones, PYTHON FOR BIOLOGISTS: A complete programming course for beginners. Createspace Independent Publishing Platform. 2013. ISBN-13: 978-1492346135

PRACTICALS for PYTHON FOR BIOLOGISTS (4 Hs. Per Week) MARKS 100

Sr. no.	Name of the experiment
1	Installation of Python on Windows desktops
2	Write a python script to take DNA sequence as input and calculate and print the length of input sequence
3	Write a Python script to take DNA sequence as input and convert it into RNA and print the RNA transcript
4	Write a Python script to take the DNA sequence as input and calculate the total number of A,T,G,C and the GC content of the input DNA sequence
5	Write a program to check whether the input recognition sequence is present in the input DNA sequence
6	Write a Python script to read a fasta format protein sequence from a file and calculate the protein composition - frequency of amino acid/total length of protein
7	Write a Python script to convert an input DNA sequence into an RNA sequence using the substitute operator
8	Using regular expressions, write a Python script to print the reverse complement of the input sequence
9	Write a Python script to check the quality of primer - length and melting temperature - calculate the melting temperature of an input primer sequence using the formula Tm=4(G+C)+2(A+T)
10	Write a Python script to identify the longest Open reading frame in a given DNA sequence read in all 6 frames
11	Reading a data frame through Pandas and basic biological data analysis using Jupyter notebook.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BI 101.1	1	1	-	-	-	-	-	-		-	-	-	1	-	-
BI 101.2	1	1	-	-	-	-	-	-	1	-	-	-	1	-	-
BI 101.3	1	1	-	-	-	-	-	-		-	-	-	1	-	-
BI 101.4	1	1	1	-	1	1	-	-	1	-	1	-	1	-	-

COURSE: COMMUNICATION SKILLS

COURSE CODE: HU101 **L T P H C**

MARKS: 50 **1 1 0 2 2**

OBJECTIVE:

The objective of this course is:

- To develop communication skills amongst students,
- To familiarize students with communication elements,
- To acquaint them with the scientific reading, Writing & Presentation skills.
- To familiarize students with concepts in plagiarism.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
HU101.1	Display skills in different and appropriate ways of communication
HU101.2	Proficiently compose well-structured and coherent documents such as emails, reports and essays
HU101.3	Demonstrate competence in verbal skills and different types of documentations like scientific report writing and research papers
HU101.4	Follow ethical practices of communication

PREREQUISITES:

This is an introductory course and there are no prerequisites.

COURSE DESCRIPTION:

Unit	Topics	Detail Syllabus	No. of Lectures
1	Introduction to communication	Elements, definitions Scope of communication and communication as part of science	02
2	Communication elements	Verbal and nonverbal communications. Principles of effective communication, Oral presentations, Barriers to communications, Use of good English: Introduction to English Grammar: parts of speech, use of articles & prepositions, use of correct tense, spellings etc.	03
3	Scientific reading, writing & presentation	Introduction to scientific reports and writings? Compilation of experimental data, Communication methods in science, Use of good English in science, Examples of Scientific and Unscientific writing. Process of Scientific writing: thinking, planning, rough drafts and revising context. Different styles of scientific writing APA, MLA or Chicago. Writing papers Reviews and Bibliography	07
4	Plagiarism	Introduction to Plagiarism Examples of Plagiarism	03
Total Number of Lectures			**15**

METHODOLOGY

The course will be covered through lectures supported by tutorials. During tutorials, students would be made to present scientific and nonscientific data/information using different communication skills. They would be corrected as and when needed and taught how to improve their skills in reading, writing and data presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	60
Total		**50**

BOOKS RECOMMENDED:

1. Technical Writing and Professional Communication by T. N. Huckin and L. O. London, William Collins and Sons, 1990.
2. Business English and Communication- By L. Clark and Zimmer, New York Mcgraw Hill, 1990.
3. Developing Communications by K. Mohan and M. Banerji, Macmillan India Limited, 2000.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HU 101.1	-	-	-	-	2	-	-	1	2	3	2	3	-	-	1
HU 101.2	-	-	-	-	2	-	-	-	2	3	1	3	1	1	1
HU 101.3	-	-	-	-	1	-	-	-	2	3	2	3	1	1	2
HU 101.4	-	-	-	-	2	-	-	-	3	3	2	3	1	1	3

COURSE: Maths I – MATHEMATICS

COURSE CODE: BS103 **L T P H C**

MARKS: 50 **2 0 0 2 2**

OBJECTIVE

The objective of the course is to familiarize the student with basic concepts in mathematics.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BS103.1	Recall the basics of logarithms and binomial expansions
BS103.2	Explain various trigonometric functions and their factorization
BS103.3	Illustrate various mathematical functions and evaluate their limits
BS103.4	Discuss the concepts of derivatives and their applications
BS103.5	Apply the fundamentals of integral calculus to determine area and volume
BS103.6	Analyze various types of differential equations

PREREQUISITES

Students should be familiar with school level mathematics to take up this course. In case they do not have mathematics at the 10+2 level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1	Algebra	**Logarithms:** Definition of Logarithm, Natural and common logarithm, Relation between Natural and Common logarithm, Laws of Logarithm (Logarithm of product, Logarithm of quotient, Logarithm of power, Rule of Change of Base). **Binomial Theorem:** Definition, Binomial Expansion, Properties of Binomial Coefficient, General term, Middle term, Binomial theorem for any index	**05**
2	Trigonometry	Trigonometry Basics, Trigonometric Ratios, T-ratios of standard angle, Measurement of T Ratios, Addition, subtraction, and transformation formula, Relation Between T ratios, Quadrants sign of T-ratios in various quadrants, Inverse Trigonometric Functions: Definition of Inverse t-functions	**05**
3	Function and Limit	**Function & Variable:** Definitions of variable, Constant. Definitions of function, value of function, domain & range of a function. **Limits:** Concepts and definition of Limit, Limits of algebraic functions, trigonometric functions, exponential functions, logarithmic function.	**05**
4	Derivatives	Definition of Derivatives, Notations, Rules of Derivatives, Derivatives of composite functions, Derivatives of Inverse trigonometric function, Derivatives of Implicit functions, Logarithmic differentiation.	**06**

		Application of Derivatives: Geometrical meaning of the derivatives.	
5	Integration	Definition of integration, Integration of Standard function; Rules of Integration, Integration of rational functions; Trigonometric functions to determine constant of Integration. Definite Integration: Definition of Definite integral, Definite integral with simple problems Application of Definite Integrals: Area under the curves.	**05**
6	Differential Equation (D.E.)	Definition of D.E, Order & degree of D.E, formation of D.E for function containing single constant. Solution of D.E. of first order & first degree such as: i) Variable separable type. ii) Equation reducible to variable separable form by substitution.	**04**
Total Number of Lectures			**30**

METHODOLOGY

The course will be covered through lectures supported by tutorials. In tutorials difficulties would be solved. Problems would be given. Students would be given assignments in the form of questions. There will be two class tests/ and surprise test conducted during the tutorial classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		05
End Semester Exam	1 hours 150 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1) Mathematics for Biological Science by J. Arya & Ladner, Prentice Hall, 1979.
2) Numerical methods by E. Balguruswamy, Tata Mc Graw Hill Publications Pvt Ltd., 1999.
3) Higher Engineering Mathematics by B. S. Grewal, Khana Publication, New Delhi, 2003.
4) Applied Mathematics by P. N. Wartikar, Pune Vidaypeeth, Griha Prakashan, Pune, 2010.
5) Introductory Methods of Numerical analysis by S. S. Sastry, Prentice Hall of India, New Delhi. 2005.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 103.1	3	3	2	-	-	-	-	-	-	1	-	-	1	2	-
BS 103.2	3	3	2	-	-	-	-	-	-	1	-	-	1	2	-
BS 103.3	2	1	2	-	-	-	-	-	-	1	-	-	1	1	-
BS 103.4	2	1	1	-	-	-	-	-	-	1	-	-	1	2	-
BS 103.5	3	2	2	-	-	-	-	-	-	1	-	-	1	2	-
BS 103.6	3	3	3	-	-	-	1	-	-	1	-	-	1	2	-

COURSE: APTITUDE BUILDING -I

COURSE CODE: BTAEC101 **L T P H C**

MARKS: 50 **0 0 2 2 1**

OBJECTIVE

1. To enhance the logical reasoning skills of the students and improve problem-solving abilities
2. To strengthen the ability of solving quantitative aptitude problems

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC101.1	Learn to defend and critique concepts of logical reasoning
BTAEC101.2	Develop expertise in solving problems of quantitative Aptitude
BTAEC101.3	Develop technical skills
BTAEC101.4	Develop analytical understanding

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr no.	Practical/Training/Tests/Interviews	No. of Lectures
1	Lessons on Excellence	02
2	Thinking Skill	02
3	Logical Reasoning	04
4	Puzzle solving	02
5	Attention to detail	02
6	Quantitative Aptitude	06
7	Technical Sessions on Biophysics	02
8	Technical Sessions on Chemistry and Biochemistry	02
9	Technical Sessions on Electricity and Biological System	02
10	Competitive Examination Preparation	02
11	Mock Interviews	02
12	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing

2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd. Reference Book(s):

3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC101.1	-	1	1	-	1	-	-	-	-	-	-	1	2	-	-
BTAEC101.2	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-
BTAEC101.3	1	1	1	-	1	-	-	-	-	-	-	-	1	-	-
BTAEC101.4	1	1	1	-	1	-	-	-	-	-	-	-	1	-	-

SEMESTER II						
Course Code	**Course Name**	**L**	**T**	**P**	**H**	**Cr**
BT201	Biochemistry	3	0	4	7	5
BT202	Cell Biology	3	0	2	5	4
BS201	Maths II -Statistics	2	0	2	4	3
BT203	Engineering Mechanics	2	0	2	4	3
BS202	Environmental Sciences	2	0	2	4	3
BT204	Engineering Graphics	1	0	2	3	2
HU201	Disaster Management*	0	1	0	1	-
BTIKS201	History of Indian Science	1	0	0	1	1
BTAEC201	Aptitude Building-II (includes Competitive exam preparation, placement related sessions and alumni interactions and trainings)	0	0	2	2	1
Total		**14**	**1**	**16**	**31**	**22**
Audit course, attendance is must						

COURSE: BIOCHEMISTRY
COURSE CODE: BT201 **L T P H C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE:
The objective of the course is to familiarize the students to

- Chemical reactions that occur in living organisms in order to maintain the cellular and physiological activities of life
- How to maintain homeostasis between the synthesis and degradation of products.

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COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BS201.1	Classify biomolecules based on their structure and function
BS201.2	Categorize cellular pathways of anabolism and catabolism
BS201.3	Illustrate pathways of carbohydrate metabolism and their significance
BS201.4	Illustrate the pathways of lipid and amino acid metabolism and their significance
BS201.5	Explain the concept of oxidative phosphorylation and electron transport chain for ATP synthesis
BS201.6	Perform isolation of important biomolecules and their qualitative analysis

PREREQUISITES:
The course requires that the students shall be aware about the basics of chemistry and biomolecules.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Biomolecules and Bioenergetics	Carbohydrate: Structure and classification of Monosaccharides, Oligosaccharides and Polysaccharides. Derived sugars.	3
		Amino acids: Structure, classification and properties	2
		Protein: Classification and functions Structure: Primary, Secondary, tertiary, quaternary	3
		Nucleic acids: Structure of nucleotides, DNA and RNA	2
		Fatty acids and lipids: Structure and classification. Compound lipids	2
		Enzymes: Classification and concept of regulation	2
		Vitamins and coenzymes	2
2.	Survey of metabolism	Introduction to metabolism-catabolism, anabolism and intermediary metabolism.	1

3.	Glycolysis	Glycolytic pathway and energetics	2
		Anaerobic pathway of glucose metabolism	1
	Gluconeogenesis and Glycogen Metabolism	Bypass reactions, Regulation of gluconeogenesis by enzymes and hormones.	2
		Glycogenolysis and glycogenesis	4
	Citric acid cycle	Aerobic pathway of glucose metabolism. Balance sheet. Regulation of the cycle.	3
4.	Lipid Metabolism	Requirement of carbon dioxide and citrate for biosynthesis, FAS complex and regulation of biosynthesis	3
		β-oxidation of monounsaturated and polyunsaturated fatty acids, Energetics of β oxidation.	3
	Amino acid metabolism	Transamination, deamination and decarboxylation reactions, Urea cycle	2
5.	Electron transport chain and Oxidative phosphorylation	Complexes I, II, III and IV, components of electron transport chain and their structure. Reactions of the electron transfer.	2
		Oxidative phosphorylation, structure of ATPase enzyme, chemiosmotic hypothesis.	2
6.	Biosynthesis of amino acids and its regulation	Glutamate, glutamine, arginine from α- ketoglutatrate	4
Total Number of lectures			**45**

METHODOLOGY:

The course should be taught through interactive lectures and demonstrations, which will help all the students to correlate the subject to everyday activity.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. The principles of Biochemistry, Lehninger by D. Nelson, and M. Cox, 7th edition, M. W.H. Freeman and Company, New York, 2017.
2. Metabolic Pathways by D. M. Greenberg, 3rd edition, Academic Press, Elsevier Science & Technology Books, 2014.
3. Biochemistry by L. Stryer, 7th edition, W.H. Freeman and Company, New York, 2012.
4. Biochemistry by J. M. Berg, J. L. Tymoczko, L. Stryer, 6th edition, W.H. Freeman and Company, New York, NY, 2007.
5. Biochemistry by G. Zubay, Addison-Wesley Educational Publishers Inc, 1983.

PRACTICAL IN BIOCHEMISTRY (4 Hs. PER WEEK) MARKS 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of standard solutions.	To understand the concepts of Normality, Molarity, Molality and ppm.	An Introduction to Practical Biochemistry by D. T. Plummer, 3rd edition, Tata McGraw Hill Education Private Limited, New Delhi, 2011.
2	Verification of Beer Lambert's law and determination of λmax of CuSO4/KMnO4 solution.	To understand the basic principles of colorimetry	
3	To find out the pka value of glycine using titrimetric method.	Study of principles of titrimetry and understanding the concepts of pH, pKa, and pKb.	
4	Qualitative analysis of carbohydrates (Monosaccharides, disaccharides and polysaccharides)	To understand the chemistry of a compound and the importance of different reagents.	1. Experimental Biochemistry, A student Companion by B. S. Rao and V. Deshpande, I.K. International Publishing House Pvt. Ltd, 2005. 2. Qualitative testing for carbohydrates by J. O. Schreck and W. M. Loffredo, Chemical Education Resources, Inc., 1994.
5	Qualitative analysis of amino acids	To confirm the presence of amino acids based upon the presence of functional group.	Practical manual of Biochemistry by S.P. Singh, 5th edition, 2011
6	Qualitative analysis of lipids (unsaturated oils, glycerol and cholesterol)	To study the physical properties of lipids as solubility, emulsification and other chemical characteristics such as acidic nature.	3. Experimental Biochemistry, A student Companion by B. S. Rao and V. Deshpande, I.K. International Publishing House Pvt. Ltd, 2005.
7	Qualitative analysis of proteins using different tests	To understand the biochemical properties of proteins.	www.biologydiscussion.com
8	Quantitative estimation of proteins using Biuret/ Lowry method/ Bradford method	To understand the method of quantification of proteins in mg/µg.	Hawk's physiological chemistry by B. L. Oser, 14th edition, McGraw-Hill Book Company.,New York, N. Y., 1996. Review of Physiological Chemistry by H.A. Harper, V.W. Rodwell, P.A. Mayes, Harold Anthony, 17th edition, Lange Medical Publications, Los Altos California, 1979.

9	Estimation of reducing sugar by DNSA method	To understand the method of quantification of sugars in mg/µg.	Use of dinitrosalicylic acid reagent for determination of reducing sugar, G.L. Miller, , *Anal. Chem.*, 31, 426, 1959.
10	Isolation of starch and casein	To understand the methods for isolation of biomolecules and their quantification	Hawk's physiological chemistry by B. L. Oser, 14th edition, McGraw-Hill Book Company.,New York, N. Y., 1996.
11	Acid value of oil / saponification value	To understand the quality of and nutritional value of lipids.	An Introduction To Practical Biochemistry by D. T. Plummer, 3rd edition, Tata McGRAW-HILL Edition, 1998.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 201.1	2	3	3	3	-	-	-	-	-	3	-	-	2	1	1
BS 201.2	3	3	3	2	2	2	-	-	-	2	-	-	3	3	1
BS 201.3	2	2	3	3	-	2	-	-	-	3	-	-	2	2	1
BS 201.4	2	3	3	3	-	2	-	-	-	2	-	-	3	2	1
BS 201.5	2	3	3	2	-	2	-	-	-	2	-	1	3	2	1
BS 201.6	2	2	3	3	2	3	-	-	2	1	-	1	3	3	3

COURSE: CELL BIOLOGY
COURSE CODE: BT202 **L T P H C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE :
The objective of the course is to familiarize the students with basic concepts of cell Biology. This is essential for taking further courses in Biotechnology during the next couple of years.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BS202.1	Explain the basic cell structure, classification, and pre-cellular evolution of prokaryotic and eukaryotic cells
BS202.2	Illustrate the instrumentation and application of different types of microscopic techniques to study cell structure
BS202.3	Outline the structure and function of cell organelles, membrane structures and different transportation models of biomolecules
BS202.4	Demonstrate cell cycle and division of prokaryotic and eukaryotic cells
BS202.5	Outline cell signalling molecules and their receptors and illustrate programmed cell death and its significance
BS202.6	Summarize importance of stem cells in cell differentiation and causes of neoplastic transformation

PREREQUISITES
This is an introductory course. There are no prerequisites for the course.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Introduction	Pre-cellular evolution: artificial evolution of cells, RNA world hypothesis, Postulates of cell theory, Endosymbiotic theory, Broad classification of cell types, Comparative study on Prokaryotic cell and Eukaryotic Cell (Animal and Plant Cell)	3
2.	Methods to study cell structure and function and model organisms used in cell biology	Light Microscopy, Electron Microscopy, Fluorescence Microscopy, Confocal Microscopy, Deconvolution Microscopy, Flow cytometry and Cell sorting, Subcellular Fractionation, Introduction to animal cell, plant cell and virus culture, Immunocytochemistry and immunohistochemistry. Model organisms: *E. coli*, *S. cerevisiae*, *D. discoideum*, Hydra. *C elegans*, *D. melanogaster*, Zebrafish, *A. thaliana*, etc. Emerging Model Organisms.	6
3.	Cell surface	Cell wall and extracellular matrix. Cell membrane: Structure and functions, Membrane proteins, lipids and sugar modifications for different membrane types. Ion channels. Transport across the membrane, Exo and Endocytosis Cell to cell interaction.	6
	Structure and function of cell organelles along with	Cytosol, Golgi bodies, ER (smooth and rough), Ribosomes, Cytoskeleton structures (Actin and cell movements,	10

	difference in membrane composition.	Microtubules and cell division, cytoskeleton dynamics and treadmilling), Nucleus (Structure of nuclear envelop, internal organization, nucleolus), Mitochondria (Structure, respiratory chain complexes, ETC, ATP synthase structure, Mitochondrial biogenesis, maternal inheritance, anterograde and retrograde signaling), Chloroplasts, Lysosomes, Peroxisome. Different diseases in relation to cell organelles.	
4.	Cell division (prokaryotic and eukaryotic) and cell cycle	Fission and fusion, budding. Eukaryotic Cell cycle stages (mitosis and meiosis), Nuclear organization during mitosis, Events of M phase, Regulators of cell cycle, Fertilization, Cell proliferation during development.	5
	Protein transport	Transportation of proteins into the nucleus and mitochondria, Vesicular transportation.	3
5.	Cell receptors and signal transduction	Signaling molecules and their receptors. Function of surface and intracellular receptors, Different pathways of signal transduction, Signaling in development and differentiation.	4
	Programmed cell death and Cellular senescence	Apoptosis (intrinsic and extrinsic pathways), Necrosis, Necroptosis, Autophagy (macroautophagy and microautophagy), Cellular senescence, Methods to study cell death.	4
6.	Basic Concepts in developmental biology	Cell lineage and cell-cell interaction, Embryonic induction, Types and importance of stem cells, Cell differentiation, Causes of abnormal cell division and neoplastic transformation	4
Total Number of Lectures			**45**

METHODOLOGY

The course would be taught through lectures, demonstrations and practical classes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Molecular Biology of the Cell; B. Alberts, A. Johnson, J. Lewis, M. Raff, K. Roberts, P. Walter; 6th Edition, Garland Sciences, 2015.
2. Molecular Cell Biology; H. Lodish, A. Berk, Chris A. Kaiser, Monty Krieger , Anthony Bretscher, Hidde Ploegh, Angelika Amon, Kelsey C. Martin; 8th Edition; 2016
3. The Cell: A Molecular Approach; Geoffrey M. Cooper, Robert E. Hausman; 7th Edition ; Sinauer Associates, Inc., 2015.

PRACTICAL IN CELL BIOLOGY (2 Hs. PER WEEK) MARKS 50

Sr. No	Name of Experiment	Learning objective	References
1.	Introduction to the instruments used in cell biology (Microscope, Biosafety Cabinets, Incubators, Centrifuges, Pipettes)	To get acquainted with the instruments and SOP for the various instruments. This Exercise focuses on how to develop a working knowledge of the microscopes and their uses. Students should identify the different parts of the Microscope and safe handling.	Fundamentals of Light microscopy And electronic Imaging by D. B. Murphy, John Wiley & Sons, Inc., Publication. 2001
2.	Study of different cell types under microscope	Students should be able to differentiate between prokaryote, eukaryote cells Should be able to differentiate between plant and animal cells Should be able to differentiate between cells from different tissues	
3.	Slide preparation and staining (plant)	Cross-sectioning of monocot and dicot plant root, stem and leaf Staining and slide preparation Identification of different anatomical features Preparation of permanent slide	A Text-Book of Histology Descriptive and Practical. For the Use of Students by A. Clarkson, 2nd edition, Science Direct, 2013. Methods in plant histology by C.Joseph, 3rd edition, The university of chicago press Chicago, Illinois, The Baker & Taylor Company, 2007
4.	Blood Smear Preparation and differential staining.	A classical method for identification of blood cell preparation.	Dacie and Lewis Practical Haematology by B. Bain, I. Bates, M. Laffan, 11th edition, Elsevier, 2016.
5.	Buccal smear – Identification of Barr Body	A quick cytological method for identification of sex in mammals- an extreme case of chromosomal condensation.	Cytological Assessment of Barr Bodies Using Aceto-Orcein and Papanicolaou Stains in Buccal Mucosal Smears and Their Sex Estimation Efficacy in an Indian Sample, D. U. Angadi P. V.

			Hallikerimath and S. Kale, *Acta Cytologica*, 57:516-521, 2013 (DOI:10.1159/000353216)
6.	Mitosis in Onion Root-Tip Cells	To study mitosis using Onion root tip cells.	Science Volume 61 of Methods in cell biology by Conly L. Rieder. Academic Press, 1999.
7.	Meiotic cell division in grasshopper testis/Hibiscus flower buds	To perform Meiotic cell division in the given sample	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 202.1	1	2	3	-	1	1	-	-	-	1	-	-	3	2	1
BS 202.2	3	3	3	-	3	2	-	-	-	2	2	3	1	3	1
BS 202.3	3	3	3	-	3	2	-	-	-	2	-	3	3	1	1
BS 202.4	3	3	3	3	3	2	-	-	-	2	-	3	3	1	1
BS 202.5	3	3	3	3	3	3	-	-	2	2	-	3	3	1	1
BS 202.6	3	3	2	3	3	3	2	3	3	2	-	3	2	2	3

COURSE: Maths II: STATISTICS
COURSE CODE: BS201 **L T P H C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE

The objective of the course is to familiarize the student with basic concepts in mathematics & statistics.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BS203.1	Define determinants and matrices for solving simultaneous equations
BS203.2	Outline the principles of complex numbers and numerical methods
BS203.3	Use the set theory, probability and probability distribution for solving statistical problems
BS203.4	Apply the concept of correlation, regression and various hypothesis testing methods to statistical data

PREREQUISITES

Students should be familiar with school level mathematics to take up this course. In case they do not have mathematics at the twelfth level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1	Determinant & Matrices :	Determinant: Definition & expansion of determinant of order 2 and 3, Cramer‟s rule Matrices: Definition of Matrix of order mxn and types of Matrices, Algebra of Matrices, Transpose of a Matrix, Inverse of a Matrix by adjoin method, Solution of simultaneous equations	**06**
2	Complex Number :	Definition of Complex number, Cartesian, polar, exponential forms of complex number. Algebra of Complex Number De - Moiyre‟s theorem (without proof) and simple problems.	**03**
	Numerical Methods :	Numerical Solution of Simultaneous Equations : Gauss elimination method Iterative Methods Gauss Seidal and Jacobi‟s Method	03
3	Set Theory and Probability	Set Theory Probability: Definition of random experiments,	06

		sample space, events, occurrence of event and types of events, Definition of probability, addition and multiplication theorem of probability. Probability Distribution: Binominal Distribution, Poisson‟s Distribution, Normal Distribution	
	Statistics	Frequency Distribution Measures of Control tendency (For Raw, Ungroup & group Data) Measures of Dispersion: Rauge, Variance, Coefficient of Cariance, Standard Derivation	01 03 02
4	Correlation & Regression	Correlation & Regression	02
	Hypothesis Testing	ANNOVA, Chi square Test	03
	F-Test	F-Test	01
Total Number of Lectures			30

METHODOLOGY

The course will be covered through lectures supported by practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Ravid, R. (2024). *Practical statistics for educators*. Rowman & Littlefield.
2. Dr. S.P.Gupta, 46th Edition,2021,ISBN 93-5161-176-9 .*Statistical Methods*
3. Bruce, P., Bruce, A., & Gedeck, P. (2020). *Practical statistics for data scientists: 50+ essential concepts using R and Python*. O'Reilly Media.
4. S. G. Gupta. 17th edition, Himalaya Publications 2000. *Fundamentals of Statistic*
5. Van Emden, H. F. (2019). *Statistics for terrified biologists*. John Wiley & Sons.

PRACTICAL IN Maths II: STATISTICS (2 Hs. Per Week) Marks: 50

Sr. No.	Name of experiment	Learning objectives
1.	Introduction to statistical computing.	Understand concepts and ideas behind mathematical and statistical computing.
2.	Exploring statistical packages such as SYSTAT/ SPSS/ SAS.	Explore statistical package environment: features, workspace, menu, and user interface.
3.	Biological data handling in statistical package.	Recognize the difference between biological and other data.
4.	Data exploration with graphs.	Draw various types of graphs.
5.	Computation of measures of central tendency.	Learn how to compute and interpret various measures of central tendency.
6.	Computation of measures of dispersion.	Learn how to compute and interpret various measures of dispersion.
7.	Computation of correlation coefficient.	Learn how to compute and interpret correlation coefficient.
8.	Curve fitting, construction of regression models and computation of regression coefficient.	Understand data modeling and learn to visualize and measure relationship between variables by constructing various models.
9.	Analysis of variance (ANOVA).	Understand and perform ANOVA test.

References:

1. Fundamental of Statistics by S.C. Gupta, 17th edition, Himalaya Publications, 2000 .
2. Fundamentals of Mathematical Statistics by S.C. Gupta and Kapoor, S. Chand Publications, 1987.
3. Fundamental of Biostatistics by B. Rosner, 7th edition, Cengage Learning Publisher, 2010.
4. Biostatistics: Bare essentials by G. R. Norman and D. L. Streiner, McGraw-Hill Medical Publisher, 2014.
5. Statistical methods in Bioinformatics by W. J. Ewens and G. R. Grant, 2nd edition, Springer, 2005.
6. The Practice of Business Statistics (w/CD) by Manish Sharma and Amit Gupta, Khanna Publishing House, 2010

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 203.1	1			2	1		1	1			2	1	2	1	
BS 203.2	2				1		1	2				1	2	2	
BS 203.3	2			2	2		2	2			2	2	2	2	1
BS 203.4	1	2		2	1	1	2	1	2		2	1	2	2	1

COURSE: ENGINEERING MECHANICS

COURSE CODE: BT203	**L**	**T**	**P**	**H**	**C**
MARKS: 100	**2**	**0**	**2**	**4**	**3**

OBJECTIVES:

The objective of the course is to familiarize the students with the basic concepts of engineering mechanics.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT203.1	Illustrate various force systems and their impacts using vector algebra
BT203.2	Analyze the equilibrium of rigid bodies using free body diagram and apply the laws of friction
BT203.3	Calculate impulse, momentum and impact of elastic bodies using principles of kinematics
BT203.4	Apply the concepts of mechanics in life sciences

PREREQUISITES:

Since the course is technical in nature the students must have the basic knowledge of Math and Physics.

COURSE DESCRIPTION:

Unit	Topic	Detail Syllabus	No. of Lectures
1	Basics of Mechanics	Introduction, Unit and Dimensions, Laws of Mechanics, Vectors – Victorian representation of forces and moments, Vector operations	3
2	Statics of particles	Principal of statics, force systems, Principle of transmissibility, Resolution and Composition of forces , Resultant of concurrent forces, Moment of a force, Resultant of parallel force system, Couple	6
3	Free body diagram	Free body diagram, Types of supports and their reactions, Requirements of stable equilibrium, Equilibrium of a particle, Equilibrium of a particle in space, Equilibrium of rigid bodies in two dimensions, Equilibrium of rigid bodies in three dimensions, Types of beams-Simple and compound beams	7
	Friction	Frictional Force, Laws of Coulomb friction, Simple Contact friction	3
4	Dynamics kinematics	Basics of Kinetics and kinematics, Relative motion, Newton's Law of Motion, Conservation of energy and Work Energy Equation of particles. Impulse and Momentum, Impact of	6

		elastic bodies, Direct central impact and coefficient of restitution	
	Basics of Biomechanics	Basic concept of Biomechanics, Biomechanics of tissues, muscles, bones and ligaments, Applications	5
Total Number of Lectures			**30**

METHODOLOGY:

The course would be taught through lectures, demonstrations and practicals

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Engineering Mechanics by Sanju Unadkat, Seventh edition,Tech-Max publications, 2012.
2. Engineering Mechanics by H.J. Sawant ,sixth Edition, Technical Publication ,2012.
3. Engineering Mechanics by DS Bedi, MP Poonia, Khanna Publications, New Delhi, 2018.

PRACTICALS IN ENGINEERING MECHANICS (2 Hs. Per Week) 50 Marks

Sr. No.	Name of the experiment	Learning objective	Literature / Web links for reference and videos
1	Study of different force systems.	Students should able to learn different types of force systems and their visual representation.	• Engineering Mechanics by S. Unadkat, 7th edition, Tech-Max publications, 2012. • Engineering Mechanics by H.J. Sawant, 6th edition, Technical Publication, 2012.
2	Study of Laws of coplanar forces a) Triangle law b) Parallelogram law c) Polygon law	Students should able to learn and prove 3 different laws for coplanar forces.	
3	Study of equilibrium of forces in space.	Students should able to understand the concept of equilibrium, requirements for stable equilibrium.	
4	Study of collision of elastic bodies.	Students should able to learn law of conservation of momentum and concept of Impact.	
5	Analysis of compound beam	Students should able to identify different supports and their reactions. They should able to draw FBD of simple and compound beams.	
6	Study of flywheel	Students should able to learn basic concepts of dynamics, Moment of inertia.	
7	Study of friction	Students should able to learn basic concept of friction, its types.	
8	To find coefficient of restitution.	Students should able to find coefficient of restitution for different materials.	https://physics.stackexchange.com/questions/172127/the-coefficient-of-restitution-of-a-bouncing-ball

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 203.1	-	-	-	2	-	-	1	-	-	-	2	-	2	-	-
BT 203.2	-	-	-	2	-	-	1	-	-	-	2	-	2	2	-
BT 203.3	-	-	-	2	-	-	1	-	-	-	2	-	3	3	3
BT 203.4	3	1	1	3	3	3	3	3	1	1	3	3	1	1	3

COURSE: ENVIRONMENTAL SCIENCE
COURSE CODE: BS202 **L T P H Cr**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE :
To familiarize the students with
- Problems related to environmental pollution, loss of natural resources, climate change, solid waste disposal, biodiversity and social issues due to environmental degradation.
- Develop clear understanding of biodiversity and its conservation.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BS201.1	Demonstrate basic understanding of natural resources, ecosystem, and its structural and functional aspects
BS201.2	Identify the measures to prevent environmental pollution and designstrategies for environment conservation
BS202.3	Comprehend different socio-environmental issues and explain the dynamics of human population
BS202.4	Explore environmental problems of local area and suggest sustainable solutions

PREREQUISITES
Since the course is very basic in nature there are no prerequisites.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Natural Resources and associated problems	Land, water, food, forest, mineral and energy resources, their use, over-exploitation and conservation.	3
	Ecosystems	Concept, structure and function of ecosystem. Producers, Consumers and decomposers Energy flow in ecosystem. Ecological succession and pyramids, Food chains, food webs and ecological pyramids. Characteristic features of Forest, Grassland, Desert and Aquatic Ecosystems.	4
2	Environmental Pollution	Definition, Causes, Effects and control measures of Air, Water, Soil, Noise, thermal and Marine Pollution. Nuclear hazards and Solid waste management. Role of an individual in prevention of Pollution and Pollution case studies	6

	Biodiversity and its Conservation	Genetic, species and ecosystem diversity. Value of Biodiversity: social, ethical, aesthetic and option values. India as a mega diversity nation. Hotspots of Biodiversity. Threats to Biodiversity: Habitat loss, poaching of wildlife, man wild life conflicts. Endangered and Endemic species of India. Conservation of Biodiversity: in situ and ex situ conservation of biodiversity. Biodiversity act 2002	4 2
3	Social Issues and the Environment	Urban problems related to energy. Water conservation, Rain water harvesting, and watershed management. Resettlement and rehabilitation of people. Climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, Wasteland reclamation: Case studies. Environment protection Acts: Air (Prevention and control of Pollution) Act. Water (Prevention and control of Pollution) Act. Wildlife protection Act. Forest Conservation Act. Issues involved in enforcement of environmental legislation. Environmental ethics: Issues and possible solutions. Public awareness	4
	Human Population and Environment	Population growth. Population explosion- family welfare programs. Environment and Human Health. Human Rights. HIV/ AIDS and Women and Child welfare. Role of Information and Technology in environment & human health.	3
4	Field work	Visit to a local area to document environmental assets River/forest/grassland/hill/mountain Visit to local polluted site- Urban/Rural/Industrial/Agricultural Study of Common plants, insects, birds. Study of simple ecosystems- pond, river, hill slopes, etc	4
Total number of lectures			**30**

METHODOLOGY

The course would be taught through lectures, demonstrations and field work. The students will undertake field trip to sensitive hot spots in Western Ghats to observe and collect samples of Flora and Fauna for on the spot studies, collection and identification of specimens. These would be evaluated on the basis of report presented by the students

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Environmental Biology, K. Agarwal, Nidi Publ. Ltd. Bikaner, 2001.
2. The Biodiversity of India, B. Erach, Mapin Publishing Pvt. Ltd., 2002.
3. Hazardous Waste Incineration, R.C. Brunner, McGraw Hill Inc., 1989.
4. Marine Pollution, R.S. Cark, 5th edition, Clanderson press Oxford (TB), 2001.

5. A Textbook of Environmental Science by Rimpi Mehani Ne'e Chopra, Jyotsna, Khanna Publishers, New Delhi, 2017.
6. Environmental Studies by MP Poonia and SC Sharma, Khanna Publishers, New Delhi, 2017.
7. Elements of Environmental Polluton Control by O. P. Gupta, Khanna Publishers, New Delhi, 2016.

PRACTICAL IN ENVIRONMENTAL SCIENCE (2 Hs. Per Week) MARKS 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To study physicochemical properties of soil (pH, conductivity, moisture content, carbonate content, salinity, porosity)	To know about variations of soil properties and to determine their suitability for a particular purpose	Soil Analysis by P. C. Bandyopadhyay Gene-Tech books, New Delhi, India. 2007. Handbook of Water Analysis by M. L. Leo, S. P. Nollet, S. P. Leen, De Gelder. , 3rd edition, CRC Press, United Kingdom, Publisher: Leen S. P. De Gelder, 2013. A Microbiology laboratory Manual by J. G. Cappuccino and N. Sherman, 10th edition, Dorling Kindersley, Pearson Benjamin Cummings, 2014. Principles and Practices of air pollution analysis by J. R. Mudakavi, I K International Publishing House Pvt. Ltd., New Delhi, India, 2010.
2.	Identification and enumeration of zooplanktons and phytoplanktons as indicator of water pollution	To differentiate polluted and non-polluted sites based on plankton data	
3.	To identify and characterize normal microflora in air, water and soil	To know presence of normal microflora within environment.	
4.	Determination of MPN from water samples	Determine potability of water	
5.	Estimation of chlorine in drinking water using colorimetric method	Understanding of residual amount of chlorine in water as a health hazard	
6.	Estimation of relative humidity of the atmosphere	To understand relationship between weather and humidity	
7.	Estimation of dissolved oxygen in the given water sample	To understand importance of BOD and COD	
8.	Study the effects of pollutants (e.g., heavy metals) on flora	To understand effect about pollution	
9.	Determination of NO_2 from the atmosphere by Colorimetric method using high volume sampler (Optional)	To understand more about atmospheric condition	
10.	Determination of K_2O value of soil by flame photometer (Optional)	To understand about Quality of soil	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 201.1	3	3	2	2	1	-	-	3	3	2	2	1	2	1	2
BS 201.2	3	3	1	2	2	2	2	3	3	1	2	2	2	2	1
BS 202.3	2	3	2	2	1	2	2	2	3	2	2	1	2	2	2
BS 202.4	2	3	2	1	1	2	3	2	3	2	1	1	3	2	2

COURSE: ENGINEERING GRAPHICS

COURSE CODE: – BT204 **L T P H C**

MARKS: 100 **1 0 2 3 2**

OBJECTIVE :

To familiarize the students

- basic engineering drawing formats.
- to take data and transform it into graphics drawings.
- to sketch and take field dimensions.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BS204.1	Outline the various drawing formats used in engineering graphics
BS204.2	Analyse detailed concepts of geometric tools, shapes and procedures
BS204.3	Sketch various orthographic, auxiliary and isometric projections
BS202.4	Identify lines and surfaces, interpret various views to apply these concepts in tissue engineering

PREREQUISITES

Since the course is very basic in nature, knowledge of mathematics is required.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Drafting Technology and Introduction to Any Drafting Software/Package	Layout of drawing sheets, sizes of drawing sheets, different types of lines used in drawing practice, Dimensioning – linear, angular, aligned system, unidirectional system, parallel dimensioning, chain dimensioning, location dimension and size dimension. Tolerances – methods of representing tolerances, unilateral and bilateral tolerances, tolerance on linear and angular dimensions, geometrical tolerances. Symbols used on drawing, surface finish symbols, welding symbols. Advantages of using Computer Aided Drafting (CAD) packages, applications of CAD, basic operation of drafting packages, use of various commands for drawing, dimensioning, editing, modifying, saving and printing/plotting the drawings. Introduction to 3D primitives.	2
2.	Curves used in Engineering Practice	Ellipse, Parabola, Hyperbola, normal and tangents to these curves, Involute, Cycloid, Epi-cycloid, Hypo-cycloid, Archimedean Spiral, Helix on cone and cylinder.	7

3	Orthographic Projections	Reference planes, types of orthographic projections – First angle projections, Third angle projections, methods of obtaining orthographic view s by First angle method, Sectional orthographic projections – full section, half section, offset section.	2
	Auxiliary Projections	Auxiliary planes – Auxiliary Vertical Plane (AVP), Auxiliary Inclined Plane (AIP), symmetrical auxiliary view, unilateral auxiliary view, bilateral auxiliary view.	2
	Isometric Projections	Isometric view, Isometric scale to draw Isometric projection, Non-Isometric lines, and construction of Isometric view from given orthographic views and to construct Isometric view of a Pyramid, Cone, and Sphere.	3
4	Interpretation of Given Views/Missing Views	Identification of lines/edges and surfaces, visualization of given orthographic views, adding a missing/third view, adding a sectional view, to convert a given view in to a sectional view.	2
Total number of Lectures			**18**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Elementary Engineering Drawing, by D. Bhatt, 53rd edition, Chartor Publishing house, 2014.
2. Engineering Drawing by P.S. Gill, S.K. KAtaria & sons, 2009.
3. Engineering Graphics and Drafting by P.S. Gill, S.K. KAtaria & sons, 2009.
4. Machine Drawing by N.D. Bhatt, 50th Edition, Chartor Publishing house, 2014.

PRACTICAL IN ENGINEERING GRAPHICS (2 Hs. PER WEEK) MARKS 50

Five A2 (594X420mm) (Half imperial) size drawing sheet as detailed below:

1. Sheet No. 1: CURVES
   - To draw any four curves mentioned in the detailed syllabus.
2. Sheet No. 2: ORTHOGRAPHIC VIEWS
   - To draw two principal views, one sectional view for two objects.
3. Sheet No. 3: AUXILIARY VIEWS
   - To draw auxiliary views from the given views for any two objects.
4. Sheet No. 4: ISOMETRIC VIEWS
   - Two problems on Isometric views.
   - *(minimum one problem by using CAD software/package)*
5. Sheet No. 5: INTERPRETATION OF GIVEN VIEWS/MISSING VIEWS
   - Two problems on Interpretation of given views.
   - *(minimum one problem by using CAD software/package)*

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BS 204.1	3	2	-	1	1	-	1	3	2	-	1	1	1	-	1
BS 204.2	2	1	-	2	2	-	2	2	1	-	2	2	2	1	1
BS 204.3	2	-	-	2	2	-	2	2	-	-	2	2	3	3	1
BS 202.4	3	2	2	2	3	3	3	3	2	2	2	3	3	3	2

COURSE: DISASTER MANAGEMENT
COURSE CODE: HU201 **L T P H C**
MARKS: 50 **0 1 0 1 -**

LEARNING OBJECTIVE:

- To provide student an exposure to disasters, their significance and types.
- To ensure that students begin to understand the relationship between vulnerability, disasters, disaster prevention and risk reduction
- To gain a preliminary understanding of approaches of Disaster Risk Reduction (DRR)
- To enhance awareness of institutional process in the country and
- To develop rudimentary ability to respond to their surroundings with potential disaster response in areas where they live, with due sensitivity

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
HU102.1	Interpret trends in disasters and their types
HU102.2	Demonstrate the relationship between vulnerability, disasters, disaster prevention and risk reduction
HU102.3	Sketch approaches of Disaster Risk Reduction with institutional arrangements
HU102.4	Demonstrate rudimentary ability to respond to the surroundings with potential disaster response

COURSE DESCRIPTION:

Unit	Topics	Detail Syllabus	No. of Lectures
1	Introduction to Disasters	Concepts and definitions (Disaster, Hazard, Vulnerability, Resilience, Risks)	04
	Disasters: Clarification, Causes, Impacts (Including social, economic, political, environmental, health, psychosocial, etc.)	Differential impacts – in terms of caste, class, gender, age, location, disability, Global trends in disasters urban disasters, pandemics, complex emergencies, Climate Change	08
2	Approaches to Disasters Risk reduction	Phases, Culture of safety, prevention, mitigation and preparedness, community based DRR, Structural – nonstructural measures, roles and responsibilities of community, Panchayati Raj Institution / Urban Local Bodies (PRIs/ULBs), states, centre and other Satke-holders	08

	Inter-relationship between Disasters and Development	Factor affecting Vulnerabilities, differential impacts, impact of Development project such as dams, embankments, changes in Land-ude etc. Climate Change Adaptation. Relevance of indigenous knowledge, appropriate technology and local resources	04
3	Disaster Risk in India	Hazard and Vulnerability profile of India Components of Disaster Relief : Water, Food, Sanitation, Shelter, Health, Waste Management, Institutional Arrangements (Mitigation, Response and Preparedness, DM Act and Policy, Other related policies, Plans, programmes and legislation)	06
4	Project Work	Field Work, Case Studies	06
Total Number of Lectures			**36**

METHODOLOGY

The course will be covered through lectures, project work & classroom discussion.

EVALUATION SCHEME (THEORY)

This course attendance is mandatory but university examination may not be conducted.

BOOKS RECOMMENDED:

1. Introduction in "Confronting Catastrophe' by A. David Oxford University Press, 2000.
2. Vulnerability in Disaster Discourse, by Andharia J. JTCDM, Tata Institute of Social Science working Paper no. 8, 2008
3. At Risk Natural Hazards, Peoples, Vulnerability and Disasters by Blaikie, P, Cannon T, Davis I, Wisner B, Rutledge. 1997
4. Introduction to International Disaster Management, C. P. Damon, 2007,
5. Disaster Management : A Disaster Manager's Handbook, Carter and Nick, Asian Development Bank, Manila Philippines, 1991.
6. Development and Disasters, Cuny, F., Oxford University Press, 1983.
7. Document on World Summit on Sustainable Development 2012
8. Govt. of India : Disasters Management Act 2005. Government of India, New Delhi
9. Government of India, National Disasters Management Policy, 2009.
10. Environmental Knowledge for Disasters Risk Management, A. K. Gupta, S. S. Nair, NIDM, New Delhi, 2011.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HU 102.1	-	1	-	-	-	-	1	-	1	1	-	-	-	-	1
HU 102.2	1	1	-	-	-	-	2	-	2	1	-	-	-	-	1
HU 102.3	-	1	-	-	-	-	2	-	2	1	-	-	-	-	1
HU 102.4	-	-	-	-	-	-	2	-	2	1	-	-	-	-	1

COURSE: INDIAN KNOWLEDGE SYSTEM: HISTORY OF INDIAN SCIENCE
COURSE CODE: BTIKS201 **L T P H C**

MARKS: 50 **1 0 0 1 1**

OBJECTIVE

The objective of the course is to familiarize students with the origin and development of science and technology in India.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTIKS201.1	Learn about science and technology during ancient, mediaeval, colonial and post- independence era of India
BTIKS201.2	Relate remarkable scientific discoveries and inventions by Indian rishis and innovators
BTIKS201.3	Recognize India's contribution in science and technology on a global scenario
BTIKS201.4	Identify notable Indian institutions and visionaries that contributed towards scientific and technological revolutions

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Unit	Topic	Detailed syllabus	No. of Lectures
1.	Introduction to Indian Knowledge System (IKS), definition, concept and scope of IKS	1.1 Definition, Concept and Scope of IKS 1.2 IKS based approaches on knowledge paradigms 1.3 IKS in ancient India, *Gurukul* -based education system, *Viharas* and Universities 1.4 Significance of IKS in modern India	**2**
2.	Science and technology in ancient India	2.1 Diverse scientific fields advanced in ancient India including astronomy, mathematics (geometry, arithmetic, and algebra), engineering, agriculture and medicine; ancient Indian temples: engineering and architectural marvels.	**6**

		2.2 Notable developments in metallurgy and chemistry: use of copper, iron and bronze in ancient India 2.3 Development of geosciences: geographical concepts in ancient Indian literature 2.4 Hydrology and water resources management in ancient India 2.5 Role of acoustics in Vedic sciences	
3.	Developments in science and technology during medieval India	3.1 Scientific and technological advancements in medieval India; the influence of Islamic and European concepts; advancements in the field of mathematics, astronomy, and medicine. 3.2 Innovations in the field of agriculture: introduction of new crops and irrigation techniques.	**2**
4.	Scientific advancements in colonial and post-independence era	4.1 Scie ntific breakthroughs in pre-independent India 4.2 Contributions of Jamshedji Tata and Swami Vivekananda in nation building and scientific innovation. 4.3 Development of research organizations in modern India including CSIR, DRDO; Establishment of Atomic Energy Commission; Developments in space satellites	**2**
5.	Notable scientists, innovators and visionaries of India: standing on the shoulders of giants	5.1 Philosophy and Literature (e.g., Maharishi Kanad, Pingala) 5.2 Mathematics and Astronomy (Aryabhatta, Bhashkaracharya, Varahamihira and Brahmgupta) 5.3 Medicine and Yoga (Acharya Charak, Susruta, Maharishi Patanjali and Dhanwantri) 5.4 Scientists of Modern India including Srinivas Ramanujan, C V Raman, Jagdish Chandra Bose, S N Bose, Har Gobind Khurana, Homi J Bhabha, Vikram Sarabhai, M Visvesvaraya, Birbal Sahni, APJ Abdul Kalam, Yash Pal, Jayant Narlikar, CNR Rao) 5.5 Women in STEM including Anandibai Joshi, Janaki Ammal, Kamal Ranadive, Rajeshwari Chatterjee, Indira Hinduja)	**4**
Total no. of Lectures			**16**

METHODOLOGY

The course will be covered through lectures & assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Mahadevan, B., Bhat Vinayak Rajat, Nagendra Pavana R.N. (2022), "Introduction to Indian Knowledge System: Concepts and Applications", PHI Learning Private Ltd. Delhi.
2. Kapoor Kapil, Singh Avadhesh (2021). "Indian Knowledge Systems Vol – I & II", Indian Institute of Advanced Study, Shimla, H.P.
3. Acarya, P.K. (1996). Indian Architecture, Munshiram Manoharlal Publishers, New Delhi.
4. Sampad and Vijay (2011). "The Wonder that is Sanskrit", Sri Aurobindo Society, Puducherry.
5. Pride of India: A Glimpse into India's Scientific Heritage, Samskrita Bharati, New Delhi.
6. Datta, B. and Singh, A.N. (1962). History of Hindu Mathematics: Parts I and II, Asia Publishing House, Mumbai.
7. Kak, S.C. (1987). On Astronomy in Ancient India, Indian Journal of History of Science, 22(3), pp. 205–221.
8. Subbarayappa, B.V. and Sarma, K.V. (1985). Indian Astronomy: A Source Book, Nehru Centre, Mumbai.
9. Bag, A.K. (1997). History of Technology in India, Vol. I, Indian National Science Academy, New Delhi.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTIKS201.1	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-
BTIKS201.2	-	-	2	-	-	1	-	2	-	1	-	-	-	-	-
BTIKS201.3	1	1	1	-	-	1	1	-	1	-	-	-	-	-	-
BTIKS201.4	-	-	-	-	-	1	-	-	1	1	-	-	-	-	-

COURSE: APTITUDE BUILDING-II
COURSE CODE: BTAEC201 **L T P H C**
MARKS: 50 **0 0 2 2 1**

OBJECTIVE

1. To enhance the logical reasoning skills of the students and improve problem-solving abilities
2. To strengthen the ability of solving quantitative aptitude problems
3. To enrich the verbal ability of the students for academic purposes

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC201.1	Learn to defend and critique concepts of logical reasoning
BTAEC201.2	Develop expertise in solving problems of quantitative Aptitude
BTAEC201.3	Integrate and display verbal ability effectively
BTAEC201.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr no.	Practical/Training/Tests/Interviews	Contact Hours
1	Logical Reasoning	04
2	Reading Comprehension for placements	02
3	Quantitative Aptitude	04
4	Verbal Ability	04
5	Recruitment Essentials	04
6	Accuracy, Precision and Statistical Analysis	02
7	Biology, Engineering and Mechanics	02
8	Engineering Graphics-Anthropometry	02
9	Competitive Examination Preparation	02
10	Mock Interviews	02

11	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing
2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.
3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC201.1	-	1	1	-	1	-	-	-	-	-	-	1	1	-	-
BTAEC201.2	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-
BTAEC201.3	1	1	1	-	1	-	-	-	-	1	-	-	1	-	-
BTAEC201.4	1	1	1	-	1	-	-	-	-	-	-	-	1	-	-

SEMESTER III						
Course Code	**Course Name**	**L**	**T**	**P**	**H**	**Cr**
BT301	Analytical Techniques	2	0	4	6	4
BT302	Microbiology & Virology	2	0	4	6	4
BT303	Genetics	3	0	2	5	4
BI301	Concepts in Bioinformatics	2	0	4	6	4
BT304	Biosafety, Bioethics & IPR	2	0	0	2	2
HU301	Universal Human Values II	2	1	0	3	3
BTSEC301	NPTEL/SWAYAM/MOOC online course (Based on the courses offered on the MOOCs platform at that point of time)	2	0	0	2	2
BTAEC301	Aptitude Building-III (includes Competitive exam preparation, placement related sessions and alumni interactions and trainings)	0	0	2	2	1
Total		**15**	**1**	**16**	**32**	**24**

COURSE: ANALYTICAL TECHNIQUES
COURSE CODE: BT301 **L T P H C**
MARKS: 150 **2 0 4 6 4**

OBJECTIVE :
To create general understanding of centrifugation, chromatographic techniques, various spectroscopic techniques like absorption spectroscopy, fluorescence spectroscopy, Infra-red spectroscopy, Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) spectroscopy, Nuclear Magnetic Resonance (NMR) Spectroscopy, Electrophoretic techniques, and X-ray crystallography. They would also understand the importance of analytical tools in biotechnology & its applications in various industries.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT301.1	Explore various centrifugation techniques for separation of biological materials at analytical and preparatory level
BT301.2	Demonstrate the basic and advanced knowledge of various spectroscopic techniques for the analysis of biomolecules
BT301.3	Employ various chromatographic techniques for purification of biomolecules
BT301.4	Use different electrophoretic techniques for characterization of biomolecules
BT301.5	Explain X-ray crystallography for 3D structure determination
BT301.6	Apply Surface Plasmon Resonance and Isothermal Titration Calorimetry for studying intermolecular interactions

PREREQUISITES:
This is an introductory course. School level knowledge of physics is sufficient. There are no prerequisites.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Centrifugation	Introduction: Basic Principle of Sedimentation Types of centrifuges: Ultracentrifuge, Design and their working principle Types of Rotors, Wall-effect	4
2.	Spectroscopy : (i) Absorption Spectroscopy	Simple theory of absorption of light by molecules, Chromophore and terminologies associated with absorption of molecules The Beer-Lambert Law and its deviations Single and double beam spectrophotometers for measuring Visible and Ultraviolet light: Instrumentation and Parameters measured in absorption Spectroscopy	4

	(ii) Fluorescence Spectroscopy	Factors affecting the absorption properties of a chromophore Empirical rule for the absorption spectra of biological macromolecules Chemical Analysis by absorption spectroscopy using Visible and Ultraviolet light Structural studies of Proteins using absorption of Ultraviolet light Structural studies of DNA using absorption of Ultraviolet light Simple theory of Fluorescence Instrumentation and Technology of Fluorescence Spectroscopy Intrinsic Fluorescence measurements for information about the conformation and binding sites of proteins Extrinsic fluorescence measurements for information about the conformation and binding sites of proteins	2
	(iii) Infrared Spectroscopy	Infrared Spectroscopy: Basic Principle Instrumentation and Technology of Infrared Spectroscopy Information in Infrared Spectra and Applications of Infrared spectroscopy	2
	(iv) Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD)	Theory of Optical Rotatory Dispersion (ORD) & Circular Dichroism (CD) Relative values of ORD and CD measurements, Advantages of CD over ORD Instrumentation for measuring ORD and CD Applications of ORD and CD	2 2
	(v) Nuclear Magnetic Resonance (NMR) Spectroscopy	Nuclear Magnetic Resonance (NMR) Spectroscopy : Principle Basic Instrumentation of NMR Spectrometer Applications of NMR Spectroscopy	
	(vi) Mass spectrometry	Mass spectrometry: Basic Principle Instrumentation and main components of mass spectrometers Ionization source, Mass analyzers, and Detectors 4. Applications of Mass Spectrometry	2
3.	Chromatography	Partition Chromatography: Simple Theory, Concept of theoretical plates Adsorption Chromatography: Simple Theory & Types Operations of columns : Terminologies and concept Elution : Types of elution methods Supports : Concept of mesh size and mesh screen Paper Chromatography : Principle, Experimental Procedure, R_f value calculation, Ascending and Descending paper chromatography, 2-D paper chromatography Thin Layer Chromatography: : Principle, Experimental Procedure, R_f value calculation, Advantages of Thin layer chromatography over paper and column chromatography Gas-Liquid Chromatography: Principle, Basic set up of Gas-liquid chromatography system, Detectors and Uses of Gas-Liquid chromatography	8

		Gel Chromatography (molecular-sieve chromatography): Simple Theory, Materials (dextran, agarose and polyacrylamide gels), Advantages of gel chromatography, Estimation of molecular weight and applications of gel chromatography Ion-Exchange Chromatography: Principle, Properties of Ion Exchangers, Choice of Ion Exchangers, Technique and application of Ion Exchange chromatography. High-Performance of Liquid Chromatography (HPLC): Principle, Application of pressure in HPLC, Advantages and uses of HPLC. Affinity Chromatography: Principle, Methods of Ligand immobilization (Cyanogen-bromide-activated agarose, Aminoethyl- and hydrazide-activated polyacrylamide), uses of affinity chromatography	
4.	Electrophoresis	Electrophoresis : General Principle, Agarose and Polyacrylamide gels Sodium dodecyl sulfate-polyacrylamide gel electrophoresis (SDS-PAGE), Principle of separation, Techniques and molecular weight estimation via SDS-PAGE Iso-electric focusing (IEF): Principle, Technique and application 2-D PAGE: Steps involved in 2-D PAGE, application in proteomics Pulse-field gel electrophoresis: Principle, Technique and Application Capillary electrophoresis: Principle, Technique and Application	3
5.	X-ray crystallography	Interaction of X-ray with matter: Absorption, Scattering and diffraction (Bragg' s Law) Preparation of crystals : Hanging and sitting drop vapor diffusion methods X-ray diffraction methods Application of X-ray Diffraction in Crystal structure	2
6.	Techniques for Intermolecular Interactions	Surface Plasmon Resonance (SPR) Spectroscopy : Principle, Technique & Application Isothermal Titration Calorimetry (ITC) : Principle, Technique & Application	1
Total Number of Lectures			**30**

METHODOLOGY:

The course will be covered through lectures supported by Practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Physical Biochemistry, Applications to Biochemistry and Molecular Biology, D. Freifelder, 2nd edition, W.H. Freeman and Company, New York, 1992.
2. Biophysical Chemistry Principles and Techniques by A. Upadhyay, K. Upadhyay & N. Nath, 4th edition, Himalayan Publishing House. 2005.
3. Instrumental Methods of Chemical Analysis, G. R. Chatwal and A. K. Sham, 5th edition Himalaya Publishing House, 2005.
4. Instrumental Analysis, D. A. Skoog, F. J. Holler, S. R. Crouch, 11th edition, Brooks/Cole, a part of Cengage Learning, 2012.

PRACTICAL IN ANALYTICAL TECHNIQUES (4 Hs. Per Week) MARKS: 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	Lab orientation, acquaintance with infrastructure and instruments.	Developing competence and encourage hands on usage and maintenance of facilities and equipment's. SOPs and safety practices.	1. Physical Biochemistry, Applications to Biochemistry and Molecular Biology, D. Freifelder, 2nd edition, W.H. Freeman and Company, New York, 1992. 2. An introduction to practical Biochemistry, 3rd edition by D. T. Plummer, Tata McGraw-Hill, 2004. 3. Laboratory manual in Biochemistry by J. Jayaraman, New Age International (P) Limited, Publishers, 2011. 4. Introductory Practical Biochemistry by S.K. Sawhney and R. Singh, 2nd edition, Narosa Publishing House, 1999. 5. Calbiochem buffer booklet
2.	Preparation of various common buffers such as Phosphate buffer saline (PBS), Tris buffer saline (TBS), Tris acetate buffer	To understand the preparation of various common buffers and its use in biological system, To understand the concept of molarity, normality etc., Measurement of pH, To understand, why a particular buffer is preferred for a particular range of pH	
3.	To study and understand the process of dialysis	Knowhow of preparation and usage of dialysis bag. Application of dialysis process, molecular weight cut off and desalting of proteins. REFER:	
4.	Separation of various amino acids using paper chromatography and calculation of retention factor (R_f) value	To understand the principle of partition chromatography, technique of paper chromatography and calculation of R_f value of given unknown amino acids using the standard amino acids.	
5.	Separation of various amino acids using Thin Layer chromatography (TLC) and calculation of Retention factor (R_f) value	To understand the principle of partition chromatography, techniques of thin layer chromatography and calculation of R_f value of given unknown amino acids using the standard amino acids.	
6.	To study the elution profile of given proteins (e.g. BSA, ovalbumin, lysozyme) on Sephadex G-50 / G-100 column	1. To know the preparation of the matrix, column packing, calculation of the bed volume, void volume and flow rate etc. 2. To determine the elution profile of given protein by taking absorbance at 280 nm and to understand the principle of molecular- sieving. 3. Various application, desalting, protein separation etc.	
7.	To study and determine the functioning of high performance liquid chromatography (HPLC)	1. To understand the principle of HPLC and functioning of the various parts of HPLC system. 2. To study the elution profile of the BSA using gel filtration column (on TSK-GEL gel filtration column from Tosoh Bioscience)	

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
8	Estimation of protein by various methods such as Lowry's and Bradford.	To understand the principle of method, preparation of calibration curve with standard protein and calculation of concentration of unknown protein sample.	
9.	To find out the concentration of given bovine serum albumin (BSA) solution in mg/ml.	1. What is percent extinction coefficient? 2. What is the percent extinction coefficient of BSA and standard proteins? 3. How will you calculate the concentration of given protein solution using percent extinction coefficient in mg/ml?	
10.	To estimate the molecular weight of given protein using Sodium dodecyl sulfate - Polyacrylamide Gel Electrophoresis (SDS-PAGE)	1.To study the principle and technique of SDS-PAGE for the separation of proteins 2. To check the purity of the protein using SDS-PAGE 3. Preparation of the standard curve (using standard protein provided) for estimation molecular weight of protein.	
11.	Centrifugation: Cell pelleting, sub-cellular fractionation of cell extract, handling of various type of centrifuges.	1. To understand the basics of centrifugation. 2. Demonstration of various type rotors, their function and use. 3. Demonstration of functioning of various types of centrifuges.	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 301.1	2	-	-	3	3	3	2	2	-	-	3	3	2	1	1
BT 301.2	2	-	-	3	3	-	3	2	-	-	3	3	2	1	1
BT 301.3	2	-	-	3	3	-	3	2	-	-	3	3	2	1	1
BT 301.4	2	-	-	3	2	-	3	2	-	-	3	2	2	1	1
BT 301.5	2	-	-	-	2	-	2	2	-	-	-	2	1	1	1
BT 301.6	1	-	-	-	2	-	3	1	-	-	-	2	1	1	1

COURSE: MICROBIOLOGY AND VIROLOGY
COURSE CODE: BT302 **L T P H C**
MARKS: 150 **2 0 4 6 4**

OBJECTIVE :
The objective of the course is to familiarize the students with microorganisms and viruses, their structures, diseases caused by bacteria and viruses and their control.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT302.1	Operate basic and advanced microscopes to identify and differentiate prokaryotes and eukaryotes based on their structure and characteristics
BT302.2	Demonstrate the processes involved in the replication and survival of bacteria and viruses and their interaction with the environment and hosts
BT302.3	Employ different methods for controlling the growth of microorganisms in physical and biological settings
BT302.4	Evaluate microbial diseases and infections in humans and their pathogenesis
BT302.5	Characterize bacteriophages, plant and animal viruses using basic and advanced methods
BT302.6	Demonstrate the growth and differentiation of fungi and study their industrial applications

PREREQUISITES:
Since the course is very basic in nature, school level knowledge in biology is sufficient to take the course and there are no prerequisites.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction to Microbiology	Scope and history of Microbiology. Characterization, classification and identification of microorganism. Microscopic examination (Staining and microscopic techniques)	4
2	Microorganism-Bacteria	Morphology and fine structure of bacteria. Cell wall structure in details. Cultivation of bacteria. Reproduction and growth. Growth kinetics. Isolation and preservation.	5

	The Viruses	Discovery, virus structure, classification, viral replication cycle, detection and enumeration of viruses, virus cultivation in lab, viriods, prions.	4
3	Control of Microorganisms	Control of By physical and chemical agents. Role of antibiotics and chemotherapeutic agents	5
4	Micro –organisms and Human diseases	Multiple drug resistant bacteria and their biofilm lifestyle. Microbial diseases of skin and eye, nervous system, cardiovascular & lymphatic system, respiratory, and digestive system.	4
5	Bacteriophages	Morphology, reproduction of ds DNA phages, ss DNA phages and RNA phages.	2
	Plant Viruses	Nomenclature and classification, viruses infecting fruits and vegetables	2
	Animal Viruses	Viruses containing ss(+) RNA, ss(-) RNA, ds RNA and DNA and ssDNA, RNA tumor viruses requiring DNA intermediate for synthesis.	3
6.	The major group of Eukaryotic micro-organism-Fungi.	Growth and differentiation in fungi, Industrial application of fungal cultures.	1
Total Number of lectures			**30**

METHODOLOGY:

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1) Microbiology: An introduction, G.J. Tortora, B.R. Funke, C.L. Case, 5th Edition, Benjamin Pub. Co. NY, 1992.
2) Medical Bacteriology, N.C. Dey, and T. K. Dey, Allied Agency, Calcutta, 17th Edition, 1988.
3) Text book of microbiology, R. Ananthnarayana, and C.E, Jayaram Panikar, 5th edition, Orient Longman, 1996.
4) Fields Virology D. Knipe and P. Howley. Vol.1 and 2- 4th Edition. Lippincott-Raven Publishers, 2006.
5) Fundamentals of Molecular Virology, N. H. Acheson 2nd Edition. Wiley Publisher, 2011.

PRACTICAL IN MICROBIOLOGY AND VIROLOGY (4 Hs per week) Marks 100

Sr. No.	Name of the experiment	Learning objective
	Introduction to Microscopy	
1	Introduction to Microscopy	a) To study the microscope and to observe different microorganisms like bacteria, protozoa, fungi and yeasts, algae – from natural habitat. b) Demonstration: Students will get familiar with different microscopic techniques such as TEM, SEM, Confocal-Microscopy, Flow cytometry and applications of these microscopic techniques in observation of bacterial biofilms.
	Introduction to Microbiology	
2	Introduction to Microbiology Lab instruments	To understand the principle and use of different microbiology lab instruments such as incubator, oven, colorimeter, autoclave, pH meter, water-bath, analytical balance, biosafety cabinet, refrigerator, deep freezer (-80^{o}C), magnetic stirrer, vortex mixer.
3 (a)	Introduction to Microbiology Lab practices- Preparation and autoclaving of different type lab media	□ To become familiar with the necessary nutritional and environmental factors for culturing microorganisms in the laboratory. □ To understand the decontamination or sterilization process using an autoclave. □ To learn the procedures used in preparing media needed for culturing microorganisms.
3 (b)	Preparation of Petri plate and slant. Handling and Examining Cultures	□ To learn the procedure used in preparing plate and slant for culturing microorganisms. □ To make aseptic transfers of pure cultures and to examine them for important gross features.
4	Isolation of bacteria and study bacterial colony characteristics	□ To isolate pure cultures from a specimen containing mixed flora by using streak and spread plate technique. □ To study the different bacterial colony characteristics and to be able to differentiate between the general morphological types of bacteria.

5	Microbial staining techniques- (a) Simple and (b) differential staining	□ To learn the value of simple stains in studying basic microbial morphology □ To learn the Gram-stain technique and to understand its value in the study of bacterial morphology
Control of Microorganisms		
6	Antimicrobial activity (natural and synthetic) testing using - Disc Diffusion Assay, Well diffusion assay.	To learn the agar disk and well diffusion technique for antimicrobial susceptibility testing of different synthetic drugs and plant derived natural compounds against different Gram positive and Gram negative bacteria.
7	MIC and MBC of antibacterial compounds.	To learn MIC and MBC assay for antimicrobial susceptibility testing of different synthetic drugs and natural compounds against different Gram positive and Gram negative bacteria.
8	Biofilm inhibition activity of synthetic antibiotics and plant derived natural compounds by microtitre plate assay.	To learn the anti-biofilm activity of different drugs against different antibiotic resistance biofilm forming Gram positive and Gram negative bacteria by using crystal violate microtitre plate.
9	Oligodynamic action of heavy metals.	To understand a biocidal effect of metals against different microorganisms, especially heavy metals, that occurs even in low concentrations.
10	Growth curve and how curve is disrupted by an antimicrobial agent.	To understand the growth pattern of bacterial cells and the effect of antimicrobial agents on its growth.
11	Personal Hygiene – Effect of soap and disinfectant washing.	To study the activity of some disinfectants and to learn the importance disinfectant in skin cleaning.
Microbial organisms and diseases		
12 (a)	Isolation, identification of pathogens from clinical samples (urine, stool, pus)	To understand the clinical microbiology (Physical, chemical and microscopic examination of clinical samples). Isolation and identification of pathogens such as *E. coli*, *Salmonella* spp., *Pseudomonas* spp., *Proteus* spp., *Klebsiella* spp., *Shigella* spp., *Staphylococcus*, *Streptococcus* spp., etc.
12 (b)	Demonstration of permanent slides of parasites	To identify and study parasites such as *Entamoeba histolytica*, *Ascaris* spp. *Plasmodium* spp. and *Leishmania* spp.
Mycology		
13 (a)	Distinguish between beneficial and harmful fungi and yeast.	To become familiar with essential and disease causing fungi and yeasts.

13 (b)	Isolation and microscopic observation of fungal cultures.	To become familiar with mycological culture techniques. To visualize and identify the structural components of fungi.
14	Enumeration of yeast cells by Neubaeur chamber. (Source of yeast – Oral thrush or vaginal thrush).	To determine the concentration of yeast cells in a given sample by Neubaeur chamber method.
15	Demonstration of permanent slides – Tissue section with fungal infection.	To become familiar with fungal infection to different human tissue.
Virology		
16	Isolation of bacteriophages by Plaque method	This assay is the most widely used technique for the isolation of virus and its purification, and to optimize the viral titers.
17	Viral infection diagnosis - Cytopathic effect (CPE)	To become familiar with morphological changes in cells caused by viral infections; the responsible virus is said to be cytopathogenic effect.
18	Visit to a viral research institute – such as NARI or NIV, Pune	To become familiar with the research on animal viruses and viral diseases of human Preparation and production of antigens, diagnostic sera, vaccines, nucleic acid probe/s, etc.

References:

1) Basic Practical Microbiology: A manual 2006 Society for General Microbiology (SGM), 2006.
2) Medical Laboratory Technology by K. L. Mukherjee, Vol III, 10th Edition, Tata Mc. Graw-Hill Pub Co., 1988.
3) Antimicrobial Chemotherapy by D. Greenwood, 3rd Edition, Oxford University Press, 1995.
4) Laboratory Manual and Workbook in Microbiology Applications to Patient Care by J. A. Morello, P. A. Granato, and H. E. Mizer, 7th Edition, The McGraw Hill Companies, 2003.
5) Textbook of Medical Laboratory Technology by P. B. Godkar and D. P. Godkar Vol 1 and 2 Bhalani Publishing, 2005.
6) Bergey's Manual of Systematic Bacteriology, Vol 1 and 2 Published by Springer, New York, 2015.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3

BT 302.1	-	-	-	2	2	-	3	-	-	-	2	2	3	1	1
BT 302.2	2	2	2	2	3	-	3	2	2	2	2	3	2	2	1
BT 302.3	2	2	2	2	2	2	3	2	2	2	2	2	2	2	2
BT 302.4	2	2	3	2	2	2	3	2	2	3	2	2	3	3	3
BT 302.5	2	2	2	2	2	3	3	2	2	2	2	2	2	2	2
BT 302.6	3	3	2	2	2	3	3	3	3	2	2	2	3	2	2

COURSE: GENETICS
COURSE CODE: BT303 **L T P H C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE :
The students would understand Mendelian Genetics, its extensions, Non-Mendelian genetics, Sex determination, Genetic diseases, Syndromes, Chromosomal Aberrations, and Population Genetics

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT303.1	Outline the fundamental principles of inheritance
BT303.2	Examine the extension and deviations in Mendelian inheritance patterns
BT303.3	Illustrate different types of Non-Mendelian inheritance
BT303.4	Analyse the chromosomal basis of inheritance, pedigrees, importance of cytogenetics and explain genetic mapping
BT303.5	Discuss the genetic basis of sex determination in different organisms
BT303.6	Demonstrate the principles of inheritance at the population level

PREREQUISITES:

Since the course comes under Basic sciences, school level knowledge of molecular biology and chemistry is required by the students to take up this course.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	History of Genetics	Historical views of heredity	2
	Mendelian Genetics	Mendel's experimental design. Mendelian laws and its application Punnett Square and forked line method. Probability Chi Square method.	7
2	Extension of Mendelian laws	Incomplete dominance and co-dominance. Multiple alleles. Gene Interactions that modifies Mendelian ratios: different type of epistasis, complementation analysis. Environmental effect on the expression of genes. Penetrance and expressivity, Pleiotropy. Position effect and genomic imprinting.	7
3	Non-Mendelian inheritance	Rules and examples of Non-Mendelian Inheritance: mitochondrial, chloroplast Maternal and uniparental inheritance. Infectious heredity Contrast to non-Mendelian inheritance o (Maternal Effect)	5
4	Chromosomal basis of inheritance	Evidences for chromosome theory of inheritance: Sex chromosomes, Sex linkage and non-disjunction of X chromosomes. Analysis of sex-linked and autosomal traits in humans. Mendelian inheritance in Human ; Pedigree analysis	7
	Cytogenetics and linkage mapping	Cytogenetic techniques. Variations in chromosome structure and number and associated disorders. Linkage and crossing over and gene mapping in eukaryotes.	6
5	Sex determination	Genotypic (Mammals, Drosophila, C. elegans), genic and environmental mechanisms. Mechanisms of dosage compensation in Mammals, Drosophila, C. elegans	6
6	Population genetics	Genetic structure of population: genotype and allele frequencies The Hardy-Weinberg Law. Genetic variation: mutation, migration, natural selection and random genetic drift.	5
Total Number of Lectures			**45**

METHODOLOGY: The course would be taught through lectures, demonstrations and practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. **Russell, P. J. (2006). Genetics A molecular approach, Pearson Benjamin Cummings, San Francisco Boston, New York.**
2. **Tamarin, R. H. (2002). Principles of Genetics 7th edition, The McGraw Hill Companies USA.**
3. **Klug, W. S., Cummings, M. R. (1999). Essentials of Genetics. Prentice-Hall Inc. USA.**

PRACTICAL IN GENETICS (2 Hs. Per Week) **MARKS: 50**

Sr. No.	Name of the experiment	Learning objective	Literature/ Web links for reference and videos
1	To study different model organisms (*Escherichia coli, Drosophila melanogaster, Caenorhabditis elegans, Mus musculus, Saccharomyces cerevisiae and Arabidopsis thaliana)*	To understand the importance of usage of model organisms systems in genetic studies	Genetics, A Conceptual Approach by B. A. Pierce, 5th edition, , W. H. Freeman & Company, 2013. Human Molecular Genetics by A. P. Read and T. Strachan, 4th edition, Taylor & Francis, 2011.
2	Estimation gene frequency in population / To study distribution of dominant and recessive traits in the population	To understand Mendelian inheritance patterns in Humans	

3	Mutants in *Drosophila*, monohybrid and dihybrid crosses in *Drosophila*,	To understand Mendelian inheritance patterns	
4	Preparation of ideogram of human chromosomes and its analysis	To identify chromosomal anomalies	
5	To study the effect of genetic drift on sample population (Founder effect)	Understanding genetic drift in populations	
6	Sex Linked lethal in Drosophila	To understand sex linked inheritance	
7	To identify auxotroph mutants in bacteria	To understand recombination in Bacteria	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT303.1	-	1	2	3	2	-	3	-	1	2	3	2	2	1	1
BT303.2	2	3	2	2	2	-	-	2	3	2	2	2	2	1	2
BT303.3	2	2	2	-	2	-	-	2	2	2	-	2	2	1	2
BT303.4	3	3	3	2	2	2	3	3	3	3	2	2	3	2	2
BT303.5	3	3	3	2	2	2	3	3	3	3	2	2	2	1	1
BT303.6	3	3	2	3	2	2	3	3	3	2	3	2	2	1	2

COURSE: CONCEPTS IN BIOINFORMATICS

COURSE CODE: BI301 **L T P H C**

MARKS: 150 **2 0 4 6 4**

OBJECTIVE:

The objective of the course is to familiarize the student with basic concepts in Bioinformatics

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BI301.1	Outline the scope of bioinformatics and use sequence and structural databases
BI301.2	Identify the data retrieval tools and illustrate respective biological file formats to solve a research problem
BI301.3	Analyse and interpret nucleotide and protein sequences based on biological tools such as BLAST, FASTA, CLUSTAL Omega

BI301.4	Predict structures and apply data from secondary databases to assess various biological questions such as evolutionary relationship, structural and functional annotations

PREREQUISITES

Students should be familiar with school level mathematics and Biology to take up this course. In case they do not have mathematics at the twelfth level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1	Overview of Bioinformatics.	Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology.	02
	Introduction to nucleic acid and protein databases.	NCBI, EMBL, DDBJ, UNIPROT, PDB, SCOP, CATH.	05
2	Data acquisition, Database content, structure and annotation.	File formats: GenBank, EMBL, PDB, PIR, ALN Types of database: flat file, relational, hierarchical, network, object-oriented. Annotated sequence databases, Genome and Organism specific databases.	03
	Retrieval of Biological Data.	Data retrieval tools: Entrez, SRS etc.	02
3	Pairwise sequence alignment.	Sequence comparisons & alignment concepts, Global Alignments – Needleman-Wunsch Algorithm Local Alignments – Smith-Waterman Algorithm Introduction to Homology, Analogy, Orthology Paralogy, Xenology.	04
	Multiple sequence alignment.	Methods of multiple sequence alignment, CLUSTALW & MUSCLE Algorithms, Applications of MSA.	03
	Database similarity searches.	FASTA, BLAST, PSI-BLAST algorithms.	02
	Patterns, Motifs, and Profiles.	Derivation and searching, Derived Databases of patterns, motifs and profiles Prosite, Blocks, Prints, Pfam etc.	03
4	Introduction to Phylogenetic analysis.	Methods of phylogenetic analysis, cladistics, Building phylogenetic trees, evolution of macromolecular sequences.	03
	Introduction to structural Bioinformatics.	Levels of protein structure, Analyzing secondary structure, Ramachandran Plot, Protein structure prediction, RNA structure prediction, visualization tools.	03
Total Number of Lectures			**30**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED

1. Ramsden, J. (2023). Bioinformatics: an introduction. Springer Nature.
2. Rastogi, S. C., Rastogi, P., & MENDIRATTA, N. (2022). Bioinformatics: Methods and Applications-Genomics, Proteomics and Drug Discovery. PHI Learning Pvt. Ltd.
3. Bioinformatics: Sequence and genome analysis by D. W. Mount, 2nd edition, CBS Publication, 2005.
4. Bioinformatics: Tools & Applications by D. Edward, J. Stajich and D. Hansen, Springer, 2009.
5. Bioinformatics: Databases, Tools & Algorithms by O. Bosu and S. K. Thurkral, Oxford University Press, 2007.
6. Bioinformatics: Methods and Applications - Genomics, Proteomics and Drug Discovery by S.C. Rastogi, N. Mendiratta, P. Rastogi, PHI Learning Pvt. Ltd., 2015.

PRACTICAL IN BIOINFORMATICS (4 Hs. Per Week) MARKS: 100

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Introduction to Nucleic Acid and Protein Sequence Data Banks.	Explore and Search Nucleic acid Sequence Database NCBI, EMBL, DDBJ.	www.ncbi.nlm.nih.gov/genbank/ https://www.ebi.ac.uk/embl/ www.ddbj.nig.ac.jp/
2.	Introduction to Protein Sequence Data Banks.	Explore and Search and use analysis tools at Protein Sequence Database: UNIPROT	http://web.expasy.org/docs/swiss-prot_guideline.html http://pir.georgetown.edu/
3.	Database Similarity Searches.	•BLAST •FASTA	https://blast.ncbi.nlm.nih.gov/ https://www.ebi.ac.uk/Tools/sss/fasta/
4	Database Similarity Searches.	PSI-BLAST,PHI-BLAST algorithms	https://blast.ncbi.nlm.nih.gov/
5	Multiple sequence alignments.	Clustering algorithm CLUSTALW, Tree View, MUSCLE	www.genome.jp/tools/clustalw/
6	Patterns, motifs and Profiles in sequences.	Study Derived Databases: PROSITE, BLOCKS, Prints Pfam etc.	https://prosite.expasy.org/prosite_link.html https://www.ncbi.nlm.nih.gov/pmc/articles/PMC102408/
7	Genome Databases.	Ensemble, TIGR, Flymine	http://plantta.jcvi.org/ www.flymine.org/
8	Protein Structure Databases.	PDB, SCOP, CATH	http://www.rcsb.org/pdb/home/home.do scop.mrc-lmb.cam.ac.uk/scop/
9.	Structure Visualization and Manipulation	Structure Visualization Tools: Pymol, RASMOL	https://pymol.org/
10	Data Structure Algorithms	Data Structure Algorithms for gene, protein sequence analysis.	https://www.perl.org/

BOOK RECOMMENDATION:

Bioinformatics: A practical guide to Analysis of Genes & Proteins by A. D. Baxevanis and B. F. Francis Ouellette, 3rd edition, John Willey and sons, 2005

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BI 301.1	3	3	3	-	3	3	-	-	2	2	-	3	1	1	-
BI 301.2	3	3	3	-	3	3	-	-	2	2	-		1	1	-
BI 301.3	3	3	3	3	3	3	-	-	2	2	1	2	3	2	2
BI 301.4	3	3	3	3	3	3	2	2	3	3	2	2	3	2	2

COURSE: BIOSAFETY, BIOETHICS AND INTELLECTUAL PROPERTY RIGHTS
COURSE CODE: BT304 **L T P H C**
MARKS: 50 **2 0 0 2 2**

OBJECTIVES:

The objective of the course is to make students learn about the legal, safety and public policy issues raised due to the rapid progress in Biotechnology and development of new products. The biotechnology students supposed to understand and follow the regulatory framework important for the product safety and benefit for the society. The students are given case history to discuss and express their views.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT304.1	Practice biological risk assessment in a laboratory and implement measures of protection though various levels of biosafety practices
BT304.2	Outline various national and international guidelines related to biosafety and its implementation in biotechnology
BT304.3	Comply with bioethical practices in biotechnological research
BT304.4	Categorize intellectual property into patents, copyrights, Trademarks, Industrial designs, Trade secrets and Geographical Indications

PREREQUISITES:

This is an advance level course. Students must have an understanding of introductory undergraduate level course such as chemistry, biology, microbiology.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Biosafety	Introduction and Development of Biosafety Practices and Principles General lab requirements Definitions and Biosafety levels: 1,2,3,4 & Summery Biological safety cabinets: centrifuges, Shipment of biological specimens, Biological waste management, Decontamination, Biosafety manuals, Medical surveillance, Emergency response Risks and Assessment of Risks Biosafety at small scale and large-scale processes Biosafety for genetically engineered microbes, plants and animals	9
2	Safety Guidlines	National biosafety committees Biosafety and environment protection International conventions	3

3	Bioethics	History and Introduction Ethics and genetic engineering Genetic Privacy Patent of genes Human races, Trading Human Life, Human Cloning Stem Cells, Eugenics, Christian faith, Human genome and religious considerations Case Studies and Final Considerations	6
4	Intellectual Property Rights	Introduction and Types of Intellectual Property Rights Patents Copyrights, Trademarks, Industrial designs, Trade secrets, Geographical Indications and Farmers rights & Plant variety Protection. IPR for Biotechnology, Patenting of transgenic organisms and isolated genes, microbes etc International conventions and cooperation Current status of IPR in India	12
Total Number of Lectures			**30**

METHODOLOGY

The course will be covered through lectures. The students will be given problems and case histories to discuss and clear their problems. The students will be evaluated based on two class tests, lecture and lab attendance, class participation, write up and quizzes.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Understanding Biotechnology by A. Borem, D. E. Bowen and F. R. Santos, 1st edition, Pearson Education Inc., 2003.
2. Biotechnology an Introduction by S. R. Barnum, Brooks/Cole; International Edition 2004
3. Biosafety and Bioethics by R. Joshi, Isha Books, Delhi, 2006.
4. Introduction to Bioethics by J. A. Bryant and L. B. la Velle Bryant, 1st edition, Wiley Blackwel Publishing, 2005.
5. Intellectual Property Rights by C.B. Raju, 1st edition, Serials Publications, 2007.
6. Law Relating to Intellectual Property by B. L. Wadehra, Universal Law Publishing CO., Fourth Edition, 2007.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 304.1	1	2	2	1	3	3	3	1	1	2	3	2	2	-	3
BT 304.2	1	2	3	2	2	2	3	1	1	2	3	2	2	-	3
BT 304.3	1	2	2	1	1	2	3	3	2	3	2	2	2	1	3
BT 304.4	1	2	2	2	2	2	2	1	2	3	3	1	2	1	3

COURSE: UNIVERSAL HUMAN VALUES 2: UNDERSTANDING HARMONY

COURSE CODE: HU301	**L**	**T**	**P**	**H**	**C**
MARKS: 100	**2**	**1**	**0**	**3**	**3**

HUMAN VALUES COURSES: During the Induction Program, students would get an initial exposure to human values through Universal Human Values – I. This exposure is to be augmented by this compulsory full semester foundation course.

OBJECTIVE: The objective of the course is four fold:

1. Development of a holistic perspective based on self- exploration about themselves (human being), family, society and nature/existence.
2. Understanding (or developing clarity) of the harmony in the human being, family, society and nature/existence
3. Strengthening of self-reflection.
4. Development of commitment and courage to act.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
HU301.1	Develop a holistic perspective based on self- exploration about themselves (human being), family, society, nature and existence
HU301.2	Acquire harmony in the self, family, society and nature
HU301.3	Strengthen self-reflection and develop commitment and courage to act responsibly
HU301.4	Utilize the professional competence for augmenting universal human values

PRE-REQUISITES: None. Universal Human Values 1 (Desirable)

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction	Purpose and motivation for the course, recapitulation from Universal Human Values-I. 2. Self-Exploration–what is it? - Its content and process; 'Natural Acceptance' and Experiential Validation- as the process for self-exploration. 3. Continuous Happiness and Prosperity- A look at basic Human Aspirations 4. Right understanding, Relationship and Physical Facility- the basic requirements for fulfilment of aspirations of every human being with their correct priority. 5. Understanding Happiness and Prosperity correctly- A critical	2

		appraisal of the current scenario 6. Method to fulfil the above human aspirations: understanding and living in harmony at various levels	
	Understanding Harmony in the Human Being - Harmony in Myself!	Understanding human being as a co-existence of the sentient 'I' and the material 'Body'. 2. Understanding the needs of Self ('I') and 'Body' - happiness and physical facility. 3. Understanding the Body as an instrument of 'I' (I being the doer, seer and enjoyer). 4. Understanding the characteristics and activities of 'I' and harmony in 'I'. 5. Understanding the harmony of I with the Body: Sanyam and Health; correct appraisal of Physical needs, meaning of Prosperity in detail. 6. Programs to ensure Sanyam and Health.	6
2	Understanding Harmony in the Family and Society- Harmony in Human-Human Relationship	Understanding values in human-human relationship; meaning of Justice (nine universal values in relationships) and program for its fulfilment to ensure mutual happiness; Trust and Respect as the foundational values of relationship 2. Understanding the meaning of Trust; Difference between intention and competence 3. Understanding the meaning of Respect, Difference between respect and differentiation; the other salient values in relationship 4. Understanding the harmony in the society (society being an extension of family): Resolution, Prosperity, fearlessness (trust) and co-existence as comprehensive Human Goals 5. Visualizing a universal harmonious order in society- Undivided Society, Universal Order- from family to world family.	6
3	Understanding Harmony in the Nature and Existence - Whole existence as Coexistence	1. Understanding the harmony in the Nature 2. Interconnectedness and mutual fulfilment among the four orders of nature- recyclability and self-regulation in nature. 3. Understanding Existence as Co-existence of mutually interacting Unit in all-pervasive space. 4. Holistic perception of harmony at all levels of existence.	7

4	Implications of the above Holistic Understanding of Harmony on Professional Ethics	1. Natural acceptance of human values 2. Definitiveness of Ethical Human Conduct 3. Basis for Humanistic Education, Humanistic Constitution and Humanistic Universal Order 4. Competence in professional ethics: a. Ability to utilize the professional competence for augmenting universal human order b. Ability to identify the scope and characteristics of people friendly and eco-friendly production systems, c. Ability to identify and develop appropriate technologies and management patterns for above production systems. 5. Case studies of typical holistic technologies, management models and production systems 6. Strategy for transition from the present state to Universal Human Order: a) At the level of individual: as socially and ecologically responsible engineers, technologists and managers b) At the level of society: as mutually enriching institutions and organizations	7
Total Number of Lectures			**30**

TUTORIAL SESSIONS

Unit	Detail Syllabus	No. of Lectures
1	Practice sessions to discuss natural acceptance in human being as the innate acceptance for living with responsibility (living in relationship, harmony and co-existence) rather than as arbitrariness in choice based on liking-disliking	2
	Practice sessions to discuss the role others have played in making material goods available to me. Identifying from one's own life. Differentiate between prosperity and accumulation. Discuss program for ensuring health vs dealing with disease.	3
2	Practice sessions to reflect on relationships in family, hostel and institute as extended family, real life examples, teacher-student relationship, goal of education etc. Gratitude as a universal value in relationships. Discuss with scenarios. Elicit examples from students' lives.	3
3	Practice sessions to discuss human being as cause of imbalance in nature (film "Home" can be used), pollution, depletion of resources and role of technology etc.	3
4	Practice Exercises and Case Studies will be taken up in Practice (tutorial) Sessions e.g. to discuss the conduct as an engineer or scientist etc	3

	Total	14

BOOKS RECOMMENDED:

1. Human Values and Professional Ethics by R R Gaur, R Sangal, G P Bagaria, Excel Books, New Delhi, 2010
2. Jeevan Vidya: EkParichaya, A Nagaraj, Jeevan Vidya Prakashan, Amarkantak, 1999.
3. Human Values, A.N. Tripathi, New Age Intl. Publishers, New Delhi, 2004.
4. The Story of Stuff (Book).
5. The Story of My Experiments with Truth - by Mohandas Karamchand Gandhi.
6. Small is Beautiful - E. F Schumacher.
7. Slow is Beautiful - Cecile Andrews
8. Economy of Permanence - J C Kumarappa
9. Bharat Mein Angreji Raj - PanditSunderlal
10. Rediscovering India - by Dharampal
11. Hind Swaraj or Indian Home Rule - by Mohandas K. Gandhi
12. India Wins Freedom - Maulana Abdul Kalam Azad
13. Vivekananda - Romain Rolland (English)
14. Gandhi - Romain Rolland (English)

MODE OF CONDUCT (L-T-P-C 2-1-0-3 or 2L:1T:0P 3 credits): Lectures hours are to be used for interactive discussion, placing the proposals about the topics at hand and motivating students to reflect, explore and verify them.

Tutorial hours are to be used for practice sessions.

While analysing and discussing the topic, the faculty mentor's role is in pointing to essential elements to help in sorting them out from the surface elements. In other words, help the students explore the important or critical elements.

In the discussions, particularly during practice sessions (tutorials), the mentor encourages the student to connect with one's own self and do self- observation, self-reflection and self-exploration.

Scenarios may be used to initiate discussion. The student is encouraged to take up "ordinary" situations rather than" extra-ordinary" situations.

Such observations and their analyses are shared and discussed with other students and faculty mentor, in a group sitting.

Tutorials (experiments or practical) are important for the course. The difference is that the laboratory is everyday life, and practical are how you behave and work in real life. Depending on the nature of topics, worksheets, home assignment and/or activity are included. The practice sessions (tutorials) would also provide support to a student in performing actions commensurate to his/her beliefs. It is intended that this would lead to development of commitment, namely behaving and working based on basic human values.

It is recommended that this content be placed before the student as it is, in the form of a basic foundation course, without including anything else or excluding any part of this content. Additional content may be offered in separate, higher courses.

This course is to be taught by faculty from every teaching department, including HSS faculty.

Teacher preparation with a minimum exposure to at least one 8- day FDP on Universal Human Values is deemed essential.

ASSESSMENT:

This is a compulsory credit course. The assessment is to provide a fair state of development of the student, so participation in classroom discussions, self-assessment, peer assessment etc. will be used in evaluation.

Example:

Assessment by faculty mentor: 10 marks

Self-assessment: 10 marks

Assessment by peers: 10 marks

Socially relevant project/Group Activities/Assignments: 20 marks

Semester End Examination: 50 marks

The overall pass percentage is 40%. In case the student fails, he/she must repeat the course.

This is only an introductory foundational input. It would be desirable to follow it up by

a) faculty-student or mentor-mentee programs throughout their time with the institution

b) Higher level courses on human values in every aspect of living. E.g. as a professional

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HU 301.1	-	-	-	-	-	2	3	3	3	3	-	2	-	-	1
HU 301.2	-	-	-	-	-	2	3	3	3	3	-	2	-	-	1
HU 301.3	-	-	-	-	-	3	2	3	3	2	-	2	-	-	1
HU 301.4	-	-	-	-	-	2	-	3	3	2	-	3	-	-	1

COURSE: NPTEL/SWAYAM/MOOC online course

COURSE CODE: BTSEC301	**L T P H C**
MARKS: 50	**2 0 0 2 2**

OBJECTIVE

Enhancement of student's skill by giving them the opportunity to gain insight on a topic of interest which is not a part of the syllabus.

DESCRIPTION:

The list of courses offered on the MOOCs platform during the third semester are provided to the students. The list includes core program specific courses, soft skill development courses and other additional skill development courses, the duration of which is 8 weeks. The students choose any one of the course which interests them the most. At the end of the semester the students need to earn a certificate on the basis of which they will be given credits out of two.

COURSE: APTITUDE BUILDING-III

COURSE CODE: BTAEC301 **L T P H C**

MARKS: 50 **0 0 2 2 1**

OBJECTIVE

1. To enhance the logical reasoning skills of the students and help them improve the problem-solving abilities
2. To acquire skills required to solve quantitative aptitude problems
3. To boost the verbal ability of the students for academic and professional purposes

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC301.1	Exhibit sound knowledge to solve problems of Quantitative Aptitude
BTAEC301.2	Demonstrate ability to solve problems of Logical Reasoning
BTAEC301.3	Display the ability to tackle questions of Verbal Ability
BTAEC301.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr no.	Practical/Training/Tests/Interviews	Contact Hours
1	Data arrangements and Blood relations	04
2	Ratio and Proportion	04
3	Percentages, Simple and Compound Interest	04
4	Number System	04
5	Essential grammar for placements	02
6	Electromagnetic Spectrum, Fluorescence and Bioluminescence	02
7	Instrumentation of Microscope	02
8	Morphometry	01
9	Data representation	02

10	Competitive Examination Preparation	02
11	Mock Interviews	01
12	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing

2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.

3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC301.1	-	2	2	-	2	-	-	-	-	-	-	2	2	-	-
BTAEC301.2	1	1	1	-	-	-	-	-	-	-	-	-	1	-	-
BTAEC301.3	1	1	1	-	2	-	-	-	-	2	-	-	1	-	-
BTAEC301.4	1	1	1	-	1	-	-	-	-	-	-	-	1	-	-

SEMESTER IV						
Course Code	**Course Name**	**L**	**T**	**P**	**H**	**Cr**
BT401	Molecular Biology	3	0	4	7	5
BT402	Stem cells & Animal Tissue culture	2	0	2	4	3
BT403	Plant Biotechnology	3	0	4	7	5
BT404	Immunology	3	0	2	5	4
BT405	Developmental Biology	2	0	2	4	3
BTIKS401	Indian Regional Biodiversity (Includes field trips and expeditions)	0	1	0	1	1
BTAEC401	Aptitude Building-IV (includes Competitive exam preparation, placement related sessions and alumni interactions and trainings)	0	0	2	2	1
BTOP401 Non-credit mandatory course	Social outreach program/ Science for Society	0	1	0	1	0
Total		**13**	**2**	**16**	**31**	**22**

COURSE: MOLECULAR BIOLOGY
COURSE CODE: BT401 **L T P H C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE :
The objective of the course is to familiarize the students with the basic concept in molecular biology.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT401.1	Outline the concept of molecular biology and genome organization
BT401.2	Illustrate the mechanism of DNA damage and repair, and recombination
BT401.3	Explain and analyse the mechanism of DNA replication
BT401.4	Summarize the mechanism of RNA transcription and its regulation with detailed understanding of post transcriptional processing
BT401.5	Apply the knowledge of protein translation and posttranslational modification for understanding cellular functions
BT401.6	Discuss the regulation of gene expression in prokaryotes and eukaryotes

PREREQUISITES:
Since the course is advance in nature, student must know about biochemistry of nucleic acids, chromosomes and gene structure. Student must have background with Genetics.

COURSE DESCRIPTION:

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction:	Concept of genes, Central dogma of Molecular Biology DNA as the genetic material Structure of DNA and RNA	2
	Genome and its organization:	• Genome, cot analysis, C value paradox, • Repetitive DNA, Satellite DNA, Gene families and gene clusters	3

		• Nuclear and organelle genome	
	Chromatin and Chromosome organization:	• Nucleosome structure, Higher order chromatin structure • Chromosome structure in prokaryotes & eukaryotes	3
2	DNA damage DNA Repair Recombination:	• Types of mutations. Replication errors and their repairs. • DNA damage • DNA repair – Single step and multistep • Models of homologous recombination in eukaryotes and prokaryotes • Non homologous and end joining (NHEJ) recombination • Genetic consequences of mechanism of recombination. • Site specific recombination and transposition of DNA: conservative site specific recombination, biological roles of sites recombination • Gene conversion.	10
3	Replication of DNA	• Models of DNA replication • Replication fork, continuous and discontinuous DNA synthesis. • Enzymes and proteins in replication • Replication of DNA and different models of replication • Telomeres. Inhibitors of DNA replication.	5
4	Transcription and mRNA processing, maturation	• Components of transcriptional machinery in prokaryotes and eukaryotes: Promoters and Enhancer sequences and transcription Unit • RNA polymerases - E. *coli* and eukaryotic RNA polymerases. • Transcription process: Chromatin remodeling, Initiation, elongation and termination of RNA synthesis. • Monocistronic and polycistronic RNAs • Posttranscriptional modifications/processing of eukaryotic RNA: • Capping and poly-adenylation, RNA splicing and splicing mechanisms. RNA editing • Inhibitors of transcription	8
5	Translation and post translational modifications:	• General features of genetic code • tRNA & aminoacyl tRNA synthetases, Ribosomes • Translation process- Initiation, Elongation & termination of translation in prokaryotes and eukaryotes, Translational factors • Inhibitors of protein synthesis – antibiotics and other inhibitors. • Post-translational modifications: Covalent and enzymatic modification of proteins • Protein folding, Proteolysis	8

6	Regulation of gene expression:	• Regulation of gene expression in prokaryotes: The operon model- lac, trp operons. Transcriptional control by attenuation in trp operon. • Regulation of gene expression in eukaryotes • Regulatory proteins (Transcription factors)- DNA-binding motif of regulatory proteins. Role of zinc fingers, leucine zippers, helix-turn-helix.	5
	Molecular evolution:	• DNA based phylogenetic trees and their applications.	1
Total Number of Lectures			**45**

METHODOLOGY

The course would be taught through lectures lectures supported by tutorials and assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Instant notes in Molecular Biology by Turner, Viva Publication, 1997.
2. Microbial Genetics by D. Freifelder, Jones & Bartlett, 2004.
3. Molecular Biology by D. Freifelder, Jones & Bartlett, 2008.
4. Molecular Biology of Gene Watson, by Baker et.al. 7th Edition, Pearsons Publication, 2013.
5. Molecular Biology of the Cell by B. Alberts, Talor & Francis, 2008.
6. Genes by Lewin and Benjamin, Editions IX, Jones & Bartlett, 2010

PRACTICAL IN MOLECULAR BIOLOGY (4 Hs. Per Week) MARKS 100

Sr no.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1	Preparation of glassware, plasticware, reagents and stock solutions for molecular biology	Special preparations for carrying out molecular biology experiments	Molecular cloning by J. Sambrook, F. Edward and T. Maniatis, 2nd edition, New York: Cold spring harbor laboratory press, 2012.
2	To isolate DNA from a) bacteria b) animal tissues/cells c) plant material using appropriate methods	To understand the critical requirement of specific methods depending on source of DNA	
3	Quantification of DNA by UV absorption and analysis by agarose gel electrophoresis	To understand the quality, and quantity of DNA present per cell	
4	To isolate plasmid DNA from bacteria, restriction analysis and agarose gel electrophoresis	To distinguish between plasmid and genomic DNA in terms of size and migration properties in gel	
5	To isolate RNA from eukaryotic cells and analyse by denaturing formaldehyde agarose gel electrophoresis	To understand various types of RNA/RNA profile and quality of RNA preparation	

6	To find the Melting temperature of DNA	Measure temperature and estimate T_m from your data	
7	Isolation of nuclei, calcium activation of endonuclease resulting DNA ladder including the mononucleosome formation	Hands-on verification of the concept of chromatin structure	
8	Extraction of histone from nuclei and analysis by SDS-PAGE	Understanding the contribution of histones in the formation of chromatin	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 401.1	3	2	1	1	1	-	1	1	-	1	-	3	2	1	1
BT 401.2	3	3	3	3	3	1	1	1	1	1	-	3	2	1	1
BT 401.3	3	3	3	3	3	1	1	1	1	2	-	3	2	1	1
BT 401.4	3	3	3	3	3	1	1	2	1	1	-	3	2	1	1
BT 401.5	3	3	3	3	3	1	1	2	2	1	-	3	3	3	2
BT 401.6	3	3	3	3	3	1	1	2	1	1	-	3	3	3	2

COURSE: STEM CELLS AND ANIMAL TISSUE CULTURE
COURSE CODE: BT402 **L T P H C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE :
Complete understanding of the science of Animal Tissue Culture and stem cells, with emphasis on Mammalian Cells.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT402.1	Outline the basics of animal tissue culture and its types, and methods of cell line development and preservation
BT402.2	Determine the characteristics of different cell lines and their applications
BT402.3	Apply the knowledge of cell culture and tissue engineering for industrial production of therapeutic molecules
BT402.4	Summarize the role of stem cells in tissue architecture development and cloning and comply with ethical issues

PREREQUISITES:
Students should have undertaken a course in Cell Biology before taking this course on Stem cells and Animal Tissue Culture. Students should be aware of good laboratory practices.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction:	History,	2
		Cell culture techniques,	
		Equipment and sterilization methodology.	
	Introduction to animal cell cultures:	Nutritional and physiological: Growth factors and growth Parameters	4
		General metabolism and Growth Kinetics	
	Primary cell cultures	Establishment and maintenance of primary cell cultures of adherent and non-adherent cell lines with examples.	3
	Secondary cell cultures	Establishment and maintenance of secondary and continuous cell cultures	2
2	Characterization of cell lines	Karyotyping, biochemical and genetic characterization of cell lines, Identification of cells, adventitious agents	2
3	Application of cell cultures	Vaccine production,e.g. Measles, Rabies	2
		Use of Hybridoma for production of monoclonal antibodies.	
		Therapeutic biological products, cytokines etc	
	Bioreactors in animal cells	Bioreactors for large-scale culture of animal cells	2
	Tissue engineering	Principle and theory of tissue engineering	3
		Applications of tissue engineering	
	Cryopreservation and tissue culture applications	Cryopreservation	1
		Tissue culture applications	
4	Stem Cells Introduction		1
	Stem Cells from Early Mammalian Embryos Adult stem cells, Mesenchymal stem cells		4
	Embryonic Stem cells		2
	Stem Cells to Functional Tissue Architecture		2
	Stem Cells and Cloning		3
	Future for stem cell		1

	research Ethics		
	Total		**34**

METHODOLOGY

The course would be taught tHough lectures, demonstrations and LCD powerpoint presentation

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1) Culture of Animal Cells – A manual of basic technique and specialized applications by R. I. Freshney, 6th edition, Wiley-Blackwell, 2010.
2) Animal Cell Technology: From Biopharmaceuticals to Gene Therapy. L. R. Castilho et. al. Taylor & Francis Group, 2008.
3) Animal Biotechnology, by A. Akbarsha et. al., 1st edition, Pearson Education 2012.
4) Basic Cell Culture by J. M. Davis, 2nd Edition, Oxford University Press, 2002.
5) Stem cell handbook, by Stewart Sell, Humuna Press. Inc. 2004.

PRACTICAL IN STEM CELLS AND ANIMAL TISSUE CULTURE (2 Hs. Per Week) MARKS 50

Sr. No.	**Name of the experiment**	**Learning objective**	**Literature/ Weblinks for reference**
1	Laboratory set-up and Equipment used in ATC	To understand the functions of ATC Laboratory and use of equipment in ATC	Culture of Animal Cells – A manual of basic technique and specialized applications by R. Ian Freshney, 6th edition, Wiley-Blackwell 2010 Development of 3D Alginate Encapsulation for Better Chondrogenic Differentiation Potential than the 2D Pellet System, T. Debnath et. al., J Stem Cell Res Ther 5:276. 2015 Apoptosis mediated cytotoxicity induced by isodeoxyelephantopin on nasopharyngeal carcinoma cells, A.K. Farha et. al., Asian J Pharm
2	Preparation of Ca^{++}-Mg^{++}-free phosphate buffered saline	The uses and method of preparation of PBS	
3	Preparation of cell culture medium	Composition and preparation of cell culture medium	
4	The practice of aseptic technique	Importance and practical knowledge of aseptic technique in ATC	
5	Subculturing of adherent cell line, with counting & viability staining of cells	Procedure, principle and nuances of passaging adherent cells, use of hemocytometer, Trypan Blue staining	

6	Cryopreservation and thawing of cells	Principle, procedure and critical steps in freezing and thawing cells	Clin Res, Vol 6, Suppl 2, 51-56, 2013.
7	Isolation of peripheral blood mononuclear cells	Method of density gradient centrifugation for PBMC isolation	
8	Isolation and culture of primary cells.	Technique and importance of primary cell culture	
9	Encapsulation of cells in alginate beads and MTT staining	Use and method for preparation of cell-laden alginate beads	
10	Cytotoxicity testing using cultured cells	Application of cultured cells for cytotoxicity testing	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 402.1	3	3	3	-	-	3	3	1	3	3	-	3	3	3	1
BT 402.2	3	3	3	-	3	2	-	-	2	2	-	3	3	3	3
BT 402.3	3	3	3	3	3	3	3	2	3	3	3	3	3	3	3
BT 402.4	3	3	3	3	3	3	3	1	2	1	2	3	3	3	3

COURSE: PLANT BIOTECHNOLOGY
COURSE CODE: BT403 **L T P H C**
MARKS: 200 **3 0 4 7 5**

OBJECTIVE :
The objective of the course is to familiarize the students with basic concepts and advanced research areas in plant biotechnology.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT403.1	Understand the fundamentals of plant biotechnology and plant development
BT403.2	Apply and evaluate the effect of plant growth regulators
BT403.3	Establish and maintain various *in vitro* plant cell cultures
BT403.4	Demonstrate plant micropropagation techniques and their applications
BT403.5	Illustrate various plant transformation methods
BT403.6	Explain plant secondary metabolites and their *in vitro* production

PREREQUISITES
Since the course is advance in nature, student must know about sterilization techniques and basic knowledge of plant sciences and molecular biology.

COURSE DESCRIPTION

Sr. No	Topic	Detail Syllabus	No. of Lectures
1	Introduction	Introduction to Plant Biotechnology	1
	Plant development	Embryo development, meristem development, differentiation and organ formation	3
2	Growth Hormones	Auxins, Cytokinins, Gibberellins, ABA and Ethylene as regulators of plant development	3
3	Plant Tissue culture Techniques	Totipotency, differentiation, redifferentiation, Techniques- explants, nutrient media, aseptic manipulations, incubation Callus culture, Suspension culture	6
4	Micropropagation	Pre-existing meristems Direct and indirect Organogenesis Somatic embryogenesis Different stages of micropropagation & Applications	2 2 2 4

		Germplasm conservation	2
5	Plant genetic engineering	Agrobacterium as a natural genetic engineer Agrobacterium based vectors (selectable and screenable markers) Transformation methods a) Agrobacterium b) Direct gene transfer Selective analysis of transgenics Applications	2 2 3 2 1
6	Plant Natural Products	Secondary Metabolites, Types, Pathways In vitro production of secondary metabolites Hairy root culture Elicitors & biotransformation Bioreactors.	2 4 2 2 2
Total Number of lectures			**45**

METHODOLOGY:

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Plant tissue Culture : Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, 1996.
2. An Introduction to Plant Biotechnology by H. C. Chawla, Oxford and IBH, 2002.
3. Gene Transfer to Plants by I.Potrykus and G. Spangenberg, Springer Lab Manual, Springer Verlag, 1997
4. Plant Biotechnology: New Products and Applications by J. Hammond, P. McGarvey, V. Yusibov, Springer Verlag, 1999.
5. Plant Biotechnology: The Genetic Manipulation of Plants by A. Slater, N. Scott and M. Fowler, Oxford University Press Inc. (2008)
6. Plant Physiology by Lincoln Taiz and Eduardo Zeiger. Panima Publishing Corporation, 2003
7. Plant Physiology by L. Taitz , 3rd edition & 5th edition, Sinauer Associates Inc., Publishers Sunderland, Massachusetts U.S.A. 2002 & 2014.

PRACTICALS IN PLANT BIOTECHNOLOGY (4 Hs. Per Week) MARKS 100

Sr. No	Name of the experiment	Learning objective	Literature/ Weblinks for reference
1	Aseptic culture techniques for establishment and maintenance of *in vitro* cultures	To learn the aseptic manipulation techniques for successful plant tissue culture experiments.	1) Plant Tissue Culture, K. K. Dey, New CentralBook Agency, 2007 2) Plant tissue Culture: Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier, Amsterdam, 1996. 3) Plant Biotechnology and its applications in Plant tissue culture by A. Kumar and S. Roy, I. K. International Publishing House, 2006. 4) Molecular cloning: a laboratory manual. J. Sambrook, D.W.Russell, 3rd edition, New York: Cold Spring Harbor Laboratory,. II, P 125 – 127, 2012.
2	Preparation of stock solutions of MS basal medium and plant growth regulators	To understand need of stock solution for media and growth regulators stock preparation and calculation of the same.	
3	Preparation of Nutrient media	Preparation of PTC media using media and growth regulators stock solutions	
4	Callus culture by using Carrot explant/ Leaf explants and somatic embryogenesis	To understand procedure of surface sterilization of explant and perform callus culture and embryogenesis	
5	Establishment of suspension culture by using callus/ isolated cells	Understand procedure and importance of suspension culture	
6	*In vitro* embryo culture	To learn embryo rescue through *in vitro* method	
7	Micropropagation by using axillary bud /apical meristem	To study micropropagation for regeneration of plants for various fields.	
8	Isolation and purification of active compounds from plants by column chromatography technique	Isolation and identification of plant secondary metabolites	
9	*Agrobacterium tumefaciens*-mediated plant transformation	To understand importance and process for *Agrobacterium* mediated plant transformation	

10	GUS staining of transformed plants	To learn the technique to identify the transformants.	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 403.1	3	3	1	2	1	1	1	1	1	2	1	3	3	3	2
BT 403.2	3	2	2	2	2	1	2	2	2	2	1	3	2	2	2
BT 403.3	3	2	2	2	3	2	3	1	3	2	2	3	2	3	3
BT 403.4	3	3	2	2	2	1	2	1	3	2	2	3	2	3	3
BT 403.5	3	3	2	2	3	1	3	1	3	3	2	3	2	3	3
BT 403.6	3	2	3	2	3	1	2	1	2	2	2	3	2	1	1

COURSE: IMMUNOLOGY
COURSE CODE: BT404 **L T P H C**
MARKS: 150 **3 0 2 5 4**

OBJECTIVE :
The objective of the course is to familiarize the students with the immune system and it's function and the advances in the immunology.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT404.1	Develop the basic understanding of immunology, mediators of immunity, and organs of the immune system
BT404.2	Explain various components involved in humoral and cell mediated immune responses
BT404.3	Explain the structure and functions of various immunoglobulins
BT404.4	Apply various techniques for determining antigen-antibody interactions
BT404.5	Outline the organization and inheritance of MHC and their role in antigen presentation
BT404.6	Apply the basic and advanced knowledge of immunology in understanding health and diseases, and to develop treatment measures

PREREQUISITES:
Student should have background of cell biology. They should know basic concept of molecular biology also to understand expression of immunoglobulin gene. They should know some basic assays.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Introduction to Immune System (i) The Cells and soluble mediators of the Immune system	1. Historical Perspective: Early vaccination studies, Early studies of Humoral and Cellular Immunity, Theoretical Challenges, Infection and Immunity (in brief) 2. The Cells and soluble mediators of the Immune system (i) Cells of the immune system : Phagocytes, B cells & T cells, Cytotoxic cells, and Auxillary cells	8

	(ii) Organs of the Immune system	(ii) Soluble mediators of immunity : Acute phase proteins, Complement proteins & Cytokines 3. Immune response to pathogens : Innate and Adaptive Immunity (i) Innate Immune response, Pathogen Associated Molecular Patterns (PAMPs), Phagocytes and Lymphocytes as a key mediators of Immunity (ii) Adaptive Immune Response : Features of the adaptive immune response: (Specificity and Memory), Humoral Immunity & Cell-mediated Immunity (Antigen recognition and Antigen eradication, B cell clonal selection, Concept of antigen processing & presentation on MHC molecules) 4. Principle of vaccination 5. Inflammation: Principle components, Chemotaxis 6. Consequences of Immune system failure : Autoimmunity, Immunodeficiency, & Hypersensitivity 1. Primary and Secondary lymphoid Organs 2. Primary lymphoid Organs (Thymus, Bone Marrow) 3. Secondary Lymphoid Organs (Lymph nodes, Spleen, and Mucosa associated Lymphoid tissue (MALT)	
2.	Generation of B cell & T cell response	1. Immunogenicity Versus Antigenicty 2. Haptens as valuable research and diagnostic tools 3. Properties of Immunogen Contributing to Immunogenicity 4. Biological System contribution in Immunogenicity 5. Adjuvants : Freund's incomplete and complete adjuvant 6. Epitopes : Characteristic Properties of B-cell epitope	4
3.	Immunoglobulins Structure and Function	1. Basic structure of antibodies, Chemical and enzymatic methods for basic antibody structure 2. Fine structure of antibodies 3. Antibody Classes and Biological activities 4. Antigen determinants on Immunoglobulins : Isotype, Allotype & Idiotype 5. Immunoglobulin Superfamily 6. Monoclonal Antibodies	6
4	Antibody-mediated effector functions	1. Opsonization 2. Activation of complement system : Classical and alternative pathway 3. Antibody-dependent cell mediated cytotoxicity (ADCC)	3
	Organization and Expression of Immunoglobulin genes	1. Immunoglobulin genes organization & Rearrangements 2. Generation of antibody diversity 3. Synthesis, assembly, and Secretion of Immunoglobulins 4. Antibody Engineering	4
	Antigen-Antibody Interactions	1. Strength of antigen and antibody interactions: Antibody affinity, antibody avidity, and Cross reactivity 2. Precipitation reactions (Immunodiffusion and Immunoelectrophoretic technique) 3. Agglutination reaction 4. Radioimmunoassay 5. Enzyme linked Immunosorbant Assay (ELISA) 6. Western blot 7. Immunoprecipitation	6

		8. Flow Cytometry	
5	The Major Histocompatibility Complex (MHC) and Antigen presentation	1. General Organization and Inheritance of the MHC, MHC molecules 2. Peptide binding by class I and class II MHC molecules 3. Experimental demonstration to prove processing of antigen is required for recognition by T cells 4. Antigen Presenting cells (APCs) 5. Antigen-Processing and Presentation Pathways (i) Endogenous Antigens: The Cytosolic Pathway (ii) Exogenous Antigens: The Endocytic Pathway	4
6.	Immune system in Health and Disease	1. Tolerance and Autoimmunity: Central and Peripheral Tolerance Establishment and Maintenance of Tolerance, Autoimmunity, Organ-Specific Autoimmune disease, Systemic Autoimmune Disease 2. Transplantation Immunology: Immunological basis of graft rejection, HLA typing, Mixed Lymphocyte Reaction, General Immunosuppressive Therapy 3. Immune Response to Infectious Diseases (Viral infections (Influenza virus) and bacterial infections (*Mycobacterium tuberculosis*), and Parasitic disease (*Plasmodium species*) 4. Vaccines: Active and Passive Immunization, Live, Attenuated vaccines, Inactivated or Killed Vaccines, Subunit and Conjugate Vaccines, DNA vaccines, Recombinant Vector Vaccines 5. AIDS: HIV infection of target cells and Activation of Provirus, Stages in viral replication cycle for therapeutic anti-retroviral drugs, Therapeutic agents inhibiting retrovirus replication 6. Cancer and the immune system: Origin and terminology, Malignant transformation of cells, Oncogenes and Cancer induction, Tumors of the immune system, Tumor antigens, Tumor evasion of the immune system, Cancer immunotherapy	6
Total Number of Lectures			**41**

METHODOLOGY:

The course would be taught through lectures, demonstrations and LCD powerpoint presentation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	60 minutes	20
II Internal	30 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

BOOKS RECOMMENDED:

1. Immunology by J, Kuby , 5th edition, W.H. Freeman and company, New York, 2002.
2. Essentials of Immunology by I. M. Roitt, 10th edition, MOSBY, Elsevier Ltd. (International Edition), 2002.
3. Cellular and Molecular Immunology by A. Abbas, 8th edition, Elsevier Ltd., 2014.

4. Molecular Biology of the Cell by B. Alberts, 5th edition, Garland Science, 2007.

PRACTICAL IN IMMUNOLOGY (2 Hs. Per Week) MARKS 50

Sr. No.	Name of the experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	To determine Blood Group antigens by hemagglutination assay	To understand about the various blood group antigens present in a population; principle of agglutination	Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper, Myrtek, USA, Elsevier, Academic Press; 2006
2.	Detection of syphilis using RPR card test	Immunological detection of specific bacterial infections by indirect agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
3.	Detection of typhoid infection by WIDAL test	Immunological detection of specific bacterial infections by direct agglutination	Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013
4.	Density gradient separation of PBMCs using Histopaque-1077	Principle of density gradient separation of immune cells	Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007. Immunology, The experimental Series – II by W. Luttmann, K. Bratke, M. Kupper,

			Myrtek, USA, Elsevier, Academic Press; 2006 Cell Separation Media Methodology and Applications 18111569, handbook GE Healthcare Isolation of mononuclear cells Methodology and Applications 18-1152-69, handbook GE Healthcare http://www.gelifesciences.com/handbooks/
5.	To study interaction of antigen and antibody by Ouchterlony double diffusion assay	To learn about precipitin phenomena at equimolar concentrations of antigen and antibody	□ A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 □ Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. □ Practical immunology by F. C. Hay, M. R. Olwyn, 4th edition, Westwood. Blackwell Publishing Company; 2002. □ Immunology by M. D, J. Brostoff, D. B. Roth, I. Roitt, 7th edition, Elsevier, 2007.
6.	Determination of antibody titre by ELISA	To learn about different types of ELISA method and their applications	□ A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006 □ Manual of clinical laboratory Immunology by N. R. Rose, R. G. Hamilton, B. Detrick, 6th edition, ASM Press, 2002. □ Immunology by J. A. Owen, J. Punt, S. A. Kuby, 7th edition, USA: Susan Winslow; 2013.
7.	Production of polyclonal antibodies in mouse	Principle of immunization, collection and analysis of serum for antibody	A handbook of practical and clinical immunology by G. P. Talwar, S. K. Gupta,. 2nd ed. Vol. I & II; 2006
8.	Purification of IgG from serum	Single step purification of IgG by affinity chromatography	Physical Biochemistry, D. Freifelder, 2nd ed. W.H. Freeman and Company, New York; 1982 Affinity Chromatography, Vol. 1: Antibodies, 18103746, handbook GE Healthcare http://www.gelifesciences.com/handbooks/

PRACTICAL EVALUATION SCHEME

Examination **Marks**

Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 404.1	3	3	2	-	-	2	-	-	2	3	-	3	2	1	-
BT 404.2	3	3	2	-	-	2	-	-	2	2	-	3	2	1	-
BT 404.3	3	2	2	-	-	2	-	-	2	3	-	3	2	1	-
BT 404.4	3	3	2	2	2	3	2	3	3	3	2	3	3	2	2
BT 404.5	3	2	2	1	-	1	-	-	2	2	-	2	3	2	2
BT 404.6	3	2	2	1	1	2	3	3	3	3	2	3	3	3	2

COURSE: DEVELOPMENTAL BIOLOGY
COURSE CODE: BT405 **L T P H C**
MARKS: 100 **2 0 2 4 3**

OBJECTIVE :
The objective of the course is to develop a basic understanding of animal development, emphasizing on various stages in embryonic development. The course would also give an insight on the influences of environment in animal development and applications of basic research in developmental biology.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT405.1	Elucidate the morphological operations that convert a fertilized egg into a multicellular organism
BT405.2	Describe the molecular, biochemical, and cellular processes that control the formation of specialized cells, tissues, and organs during embryonic development
BT405.3	Recognize the model organisms utilized in the study of developmental biology and contrast the developmental schemes of various organisms
BT405.4	Explain the genetic, molecular, and cellular methods, inclusive of genome editing, employed to study the processes of development in different organisms
BT405.5	Showcase the ability to observe and use technical skills to obtain and examine quantitative data, interpret results, and present experimental data
BT405.6	Discuss the importance of developmental biology in reproduction including assisted reproductive technologies

PREREQUISITES:
The course requires senior school (10+2 or equivalent) level knowledge of development in animals.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Introduction to Developmental Biology	• Early beliefs in organismal development • Discovery of primary embryonic organizer	• 1
2	Gametogenesis and Fertilization	• Spermatogenesis and Oogenesis in placental mammals (mouse/human) • Comparison of internal and external fertilization • Steps in the fertilization process in mouse/human: Capacitation of sperm, Acrosome Reaction, Sperm-egg fusion, Activation of the egg, Fusion of sperm	• 4

		and egg pro-nuclei, Prevention of polyspermy (with reference to placental mammals and sea urchin)	
	Embryonic Cleavage	• Cytoskeletal mechanisms in cleavage • Maternal-zygotic transition • Types of cleavage based on potentiality of blastomeres, position and amount of yolk, and position of mitotic spindles • Emphasis on cleavage in embryos of echinoderms (sea urchin), molluscs (snail), amphibians (frog) and placental mammals (mouse/human)	• 4
	Stages after embryonic cleavage and Gastrulation	• Pre-implantation and implantation of mouse/human embryos • Primary germ layers and their derivatives in placental mammals • Various types of morphogenetic movements during gastrulation • Gastrulation in mouse/human embryos with emphasis on primitive streak, differentiation of lateral mesoderm and somitogenesis	• 4
3	Genes and Development	• Origin of gene theories in development • Genomic equivalence: Evidences with emphasis on metaplasia and animal cloning, and exceptions to the rule • Differential gene expression: Regulation at the level of genome, transcription, translation and post-translation • Gene silencing: Antisense RNA and Gene knockouts • Cell fate specification based on position and lineage in early embryogenesis • Lateral inhibition in *Drosophila* neurogenesis	• 5
3	Axes formation and Organogenesis	• Axes formation and early embryonic patterning in *Drosophila* and vertebrates • Homeotic genes • Development of the germ layer derivatives with emphasis on the formation of central nervous system and epidermis, fore-limb and hind-limb in vertebrates	• 4
4	Metamorphosis and Regeneration	• Complete and incomplete metamorphosis, metamorphosis in insects and Anurans • Epimorphosis, Morphallaxis and Compensatory regeneration	• 3
5	Environmental influences in development	• Environmental disruption of normal development • Teratogens, with emphasis on alcohol, retinoic acid and pathogens • Endocrine disruptors	• 3
6	Translational developmental biology	• Biology of stem cells Applications of stem cells in regenerative medicine Assisted reproductive technology on *in vitro* fertilization (IVF) and intra-cytoplasmic sperm injection (ICSI) • Genetically modified organisms (GMOs) and their applications in biomedical research	• 2

Total Number of lectures	30

METHODOLOGY:

The course would be covered through lectures and group discussions using teaching aids.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS/JOURNALS RECOMMENDED:

1.
1. Gilbert, S. F., Barresi, M. J. F. (2016). Developmental Biology, Eleventh Edition, Sinauer Associates Inc.

2.Wolpert, L., Tickle, C., Arias A. M. (2015). Principles of Development, Fifth Edition, Oxford University.

3.Slack, J. M. W. (2012). Essential Developmental Biology, Third Edition, Wiley- Blackwell.

4. S. Sell (Ed.) (2013). Stem Cells Handbook, Second Edition, Humana Press, New York, USA.

2. Genes and Development, Cold Spring Harbor, New York, USA, Years: 1987–present.
3. Development, The Company of Biologists, United Kingdom, Years: 1953–present, **Journal ISSN**: 0950-1991 (print); 1477-9129 (web), (Former name: Journal of Embryology and Experimental Morphology).
4. Developmental Biology, Elsevier B.V., Amsterdam, Netherlands, Years: 1959–present, **Journal ISSN**: 0012-1606 (print); 1095-564X (web).

PRACTICAL IN DEVELOPMENTAL BIOLOGY (2 hours per week) MARKS: 50

Sr. No.	Name of the Experiment	Learning objective	Literature/ Weblinks for reference and videos
1.	Introduction to life cycle in animal development (eg: *Drosophila*).	Familiarization with various stages of life cycle in insects. Understanding the the phenomenon of metamorphosis, and differentiation of the sexes.	Fly Pushing: The theory and practice of *Drosophila* genetics, By R. J. Greenspan 2nd Edition The Neurosciences Institute, San Diego.
2.	Dissection and identification of imaginal discs in the third instar larval stages in *Drosophila*.	Familiarization with the location and types of the progenitors of various adult structures.	1) Dissection of imaginal discs from 3rd instar *Drosophila* Larvae, D. C. Purves and C. Brachmann. *J Vis Exp*; (2): 140. 2007. 2) The preparative isolation of imaginal discs from larvae of *Drosophila Melanogaster*, J. W. Fristrom and H. K. Mitchell, *J Cell Biol*; 27: 445–448, 1965. 3) Fly Pushing: The theory and practice of *Drosophila* genetics, By R. J. Greenspan 2nd Edition The Neurosciences Institute, San Diego.
3.	Preparation and mounting of *adult Drosophila structures* in Hoyer's medium or Canada balsam.	Familiarization with wings, legs and thorax in adult flies and understanding the patterning of these cuticular structures.	1) Preparation and mounting of adult *Drosophila* structures in Canada balsam, D. L. Stern and E. Sucena, *Cold Spring Harb Protoc*; 373-375, 2012. 2) Preparation and mounting of adult *Drosophila* structures in Hoyer's medium, D. L. Stern and E. Sucena, *Cold Spring Harb Protoc*, 107-109, 2012.
4.	Examination of external morphology of *Drosophila* eyes using nail polish imprint technique.	Understanding the patterning of compound eye in insects.	A simple nail polish imprint technique for examination of external morphology of *Drosophila* eyes, R. Arya and S. C. Lakhotia, *Curr Sci*; 90:1179-1180, 2006.

Sr. No.	Name of the Experiment	Learning objective	Literature/ Weblinks for reference and videos
5.	Preparation and identification of 48 hours and 96 hours chick whole-embryos using filter paper ring technique.	Familiarize with prominent structures formed during organogenesis in early chick embryos.	Improved method for chick whole-embryo culture using a filter paper carrier, S. C. Chapman et al, *Dev Dyn*; 220:284-289, 2001.
6.	Study of cell death during morphogenesis	Observation of cell death in chick embryos (5 days old) limd morphogenesis	
7.	Staining bone and cartilage in zebrafish (*Danio rerio*) embryos.	To study skeletogenesis using a unique model that is amenable to developmental analyses and genetic screening.	1) A two-color acid-free cartilage and bone stain for zebrafish larvae, M. B. Walker and C. B. Kimmel, *Biotechnic & Histochemistry*, 82: 23-28, 2006. 2) Zebrafish embryology and cartilage staining protocols for high school students, Emran F et al, *Zebrafish*; 6: 139-143, 2009.
8.	Study of regeneration in Hydra	Observation of regeneration process in Hydra	

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 405.1	1	2	1	-	-	1	-	1	1	1	-	2	2	1	-
BT 405.2	1	2	1	2	2	1	-	1	1	1	-	2	2	1	-
BT 405.3	1	1	1	1	1	1	1	1	1	1	1	3	2	1	1
BT 405.4	2	2	1	3	2	1	1	1	1	1	1	3	3	2	2
BT 405.5	2	3	1	3	2	1	1	1	1	1	1	2	3	2	2
BT 405.6	2	2	1	3	2	1	-	2	1	2	1	3	3	2	3

COURSE: INDIAN KNOWLEDGE SYSTEM: INDIAN REGIONAL BIODIVERSITY
COURSE CODE: BTIKS401 **L T P H C**

MARKS: 50 **0 1 0 1 1**

OBJECTIVE :

The objective of this course is to make students aware and familiarize them with the Indian Knowledge System to create a holistic and culturally sensitive learning environment. By incorporating elements of IKS into modern education, students can gain a deeper understanding of their cultural heritage, diverse perspectives, and alternative ways of knowing.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTIKS401.1	Understand a holistic understanding of India's traditional knowledge systems and their relationship with regional biodiversity
BTIKS401.2	Explore various biogeographical zones and their characteristics
BTIKS401.3	Analysis of India's various ecosystems, that include tropical rainforests, deserts, marshes, and mountain ranges, regional biodiversity influencing ecosystem processes and services.
BTIKS401.4	Assess the present conservation problems facing Indian regional biodiversity and evaluate viable methods and policies for the protection and sustainable management of these natural resources.

PREREQUISITES:

Open to new ideas and willingness to learn and contribute.

COURSE DESCRIPTION

Unit	Topic	Detailed syllabus	No. of Lectures
1.	Introduction to Indian Knowledge System (IKS),	• Overview of India's traditional knowledge systems (e.g., Ayurveda, Yoga, Vastu Shastra, etc.). • Understanding the integration of traditional knowledge with nature and biodiversity. • Role of traditional ecological knowledge in resource management.	**1**

2	Biogeographic Zones of India	• Overview of India's biogeographic zones and their characteristics. • • Study of the Himalayan region, Indo-Gangetic Plains, Western Ghats, Eastern Ghats, Deccan Plateau, and coastal areas.	**3**
2.	*Biodiversity of the Western Ghats, Coastal areas and marine ecosystems*	• Exploration of the Western Ghats biodiversity hotspot. • Tropical rainforests and endemic species. • Threats and conservation challenges. • Traditional ecological insights and conservation practices. • Coastal areas, mangroves, estuaries, and marine biodiversity. • Traditional knowledge related to coastal resource management. • Conservation policies and practices integrating traditional wisdom.	**4**
3.	Biodiversity of the Indo-Gangetic Plains, Forests, Desert ecosystems	• Flora and fauna of the Indo-Gangetic region. • Riverine ecosystems and their ecological importance • Tropical and sub-tropical evergreen and deciduous forests. • Protected areas and wildlife reserves. • Thar Desert ecosystems and adaptations	**4**
4.	*Conservation Strategies*	Habitat destruction and fragmentation • Pollution and its impact on biodiversity. • Climate change and its implications for Indian biodiversity. • Integration of traditional ecological knowledge with modern conservation strategies. • Collaborative conservation efforts with local communities. • • Ethical considerations and issues related to biodiversity research and conservation.	**4**
		TOTAL	**16**

METHODOLOGY

The course will be covered through lectures & assignments.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1. Introduction to Indian knowledge system: concepts and applications. ISBN: 9789391818203, authors: B. Mahadevan, Nagendra Pavana , Vinayak Rajat Bhat.
2. Living with others (Biodiversity around us). ISBN: 9788123017464. author: M.A. Haque
3. 3) Biodiversity and livelihood: lessons from community research in India. ISBN: 978-981-14-8307-3, authors: Oommen V., Oommen, Laladhas K, Erach Bharucha

4. 4) Biodiversity traditional knowledge and intellectual property rights, ISBN: 9788172339692, authors: s. Ram Reddy, M. Surekha, V. Krishna Reddy
6) Biodiversity hotspot of the western ghats and Sri Lanka. ISBN:9781774913758, author: T. Pullaiah
7) Ethnobotany of India, volume 2: western ghats and west coast of peninsular India, ISBN: 978-1771884044, authors: T. Pullaiah, K. V. Krishnamurth, Bir Bahadur
8) SAHYADRI : WESTERN GHATS BIODIVERSITY INFORMATION SYSTEM (http://ces.iisc.ernet.in/biodiversitsy)

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTIKS401.1	-	-	-	-	-	-	2	-	1	-	-	-	-	1	-
BTIKS401.2	-	1	-	-	-	1	2	-	1	-	-	1	-	1	-
BTIKS401.3	1	1	1	-	1	1	2	-	1	-	-	-	-	-	-
BTIKS401.4	1	1	1	-	1	1	2	1	1	-	-	1	1	1	-

COURSE: APTITUDE BUILDING-IV

COURSE CODE: BTAEC401 **L T P H C**

MARKS: 50 **0 0 2 2 1**

OBJECTIVE

- To enhance the logical reasoning skills of the students and help them improve the problem-solving abilities
- To acquire skills required to solve quantitative aptitude problems
- To boost the verbal ability of the students for academic and professional purposes

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC401.1	Apply critical thinking skills, such as problem solving related to their subject matter
BTAEC401.2	Demonstrate competency in verbal, quantitative and reasoning aptitude
BTAEC401.3	Display good written skills for use in academic and professional scenarios
BTAEC401.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr. No.	Practical/Training/Tests/Interviews	Contact Hours
1	Logical Reasoning	04
2	Data interpretation and Data sufficiency - Advanced	04
3	Time and work– Advanced	02
4	Time, Speed and Distance - Advanced	04
5	Profit and loss, Partnerships and averages - Advanced	02
6	Number system - Advanced	02

7	Choice and Instruments and protocols for solving biological problems	02
8	Establishment of stable trans-gene expression in unicellular and multicellular systems	02
9	Monoclonal antibodies, Biosimilars	02
10	Competitive Examination Preparation	02
11	Mock Interviews	02
12	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing

2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.

3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO
BTAEC401.1	-	2	2	1	2	-	-	-	-	1	-	2	2	-	-
BTAEC401.2	1	1	1	-	-	-	-	-	-	1	-	-	1	-	-
BTAEC401.3	1	1	1	-	2	-	-	-	-	2	-	-	1	-	-
BTAEC401.4	1	1	1	-	1	-	-	-	-	1	-	-	1	-	-

SEMESTER V						
Course Code	**Course Name**	**L**	**T**	**P**	**H**	**Cr**
BT501	Environmental Biotechnology	2	0	2	4	3
BT502	Recombinant DNA Technology	2	0	4	6	4
BT503	Biochemical Engineering & Bioprocess Technology	3	0	4	7	5
BT504	Enzymology & Enzyme Technology	2	0	2	4	3
BI501	R Programming	1	0	0	1	1
BT 505/BT506/ BT507	**Elective-I** BT505 Biopharmaceuticals BT506 Clinical Research BT507 Human Diseases and Pathobiology	3	0	2	5	4
BTSEC501	Science communication	0	0	2	2	1
BTAEC501	Aptitude Building-V	0	0	2	2	1
	Total	**13**	**0**	**18**	**31**	**22**

COURSE: ENVIRONMENTAL BIOTECHNOLOGY
COURSE CODE: BT501 **L T P H C**
MARKS: 100 (Theory 50 + Practical 50) **2 0 2 4 3**

OBJECTIVES OF THE COURSE:

The objective of the course is to familiarize the students with advanced research area and basic concept in Environmental Biotechnology.

COURSE OUTCOMES:

CO No.	At the end of the course, the learner should be able to:
BT501.1	Classify types of pollution and illustrate application of biotechnology for a pollution-free environment
BT501.2	Discuss different waste water treatment systems and analyse the decay behaviour of xenobiotic compounds
BT501.3	Demonstrate the process of bioremediation and illustrate the management of hazardous waste
BT501.4	Describe the role of biofuels in environmental sustainability and explore advanced systems for environmental management

PREREQUISITES

Since the course is very important in science, student must know about the new biotechnological methods which to apply in environment. Student must have background with Biotechnological aspects and molecular genetics.

COURSE DESCRIPTION

Sr. No.	Topic	Detail Syllabus	No. of Lectures
1	Environmental Biotechnology	Role of Biotechnology in protection and conservation of Environment	02
	Environmental Pollution	Types of Pollution and their sources (Water pollution, Soil Pollution, Air Pollution, Noise Pollution) Case studies and Innovative technologies for preventing pollution	04
2	Microbiology of waste water treatment	Aerobic System Biological processes for domestic and industrial waste water treatments; Aerobic systems - activated sludge process, trickling filters, biological filters, rotating biological contractors (RBC), Fluidized bed reactor (FBR), expanded bed reactor, Inverse fluidized bed biofilm reactor (IFBBR) packed bed reactors air- sparged reactors. Anaerobic System Anaerobic biological treatment - contact digesters, packed column reactors, UASB. Biofilms and its relevance in microbial survival	06
2	Microbiology of degradation of xenobiotics	Xenobiotics in environment Decay behavior of xenobiotics	03
3	Bioremediation	Bioremediation I & II Solid phase bioremediation - land farming, prepared beds, Phytoremediation, Composting, Vermicomposting technology	05
	Hazardous Waste Management & safety guidelines for disposed	Biotechnology application to hazardous waste Management Detoxification of chemical waste	03
4	Bio Fuels	Microorganisms and energy requirements of mankind, Production of nonconventional fuels - Methane (Biogas), Hydrogen, Alcohols and algal hydrocarbons, Use of microorganisms in augmentation of petroleum recovery. Bioplastic-biopol, microbial rubber & adhesive polymers	05

	Advances in Environmental Biotechnology	GIS in Environmental Management Computer based Environmental modeling Design of ETPs	02
	Total number of Lectures		**30**

METHODOLOGY

The course would be taught through lectures, demonstrations and practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

BOOKS RECOMMENDED:

1. Stanier R. Y., Ingram J.L., Wheelis M.L., Painter R.R., General Microbiology, McMillan Publications, 1989.
2. Foster C.F., John Ware D.A., Environmental Biotechnology, Ellis Horwood Ltd.,1987.
3. Karrely D., Chakrabarty K., Omen G.S., Biotechnology and Biodegradation, Advances in Applied Biotechnology Series, Vol.4, Gulf Publications Co. London,1989.
4. Bioremediation engineering; design and application 1995 John. T. cookson, Jr. Mc Graw Hill, Inc.

PRACTICAL IN ENVIRONMENTAL BIOTECHNOLOGY 2 Hs per week Marks:50

1) Methods of sampling for pollution measurement
   a) Statistical design for collection of samples from site
   b) Air sampling (Impaction)
   c) Soil sampling (soil probes/auger)
   d) Water sampling (Niskin type or equivalent depth sampling)

2) Methods of Pollution Measurement (as per Indian and global recommendations)

   a) Air pollution by measurement of SOX (sulphur oxides-di), NOX (nitrous oxide-di) and suspended particulate matter.

   b) Water pollution by measurement of water conductivity, pH, dissolved oxygen, and turbidity.

   c) Soil pollution by measurement of metals and organic compounds.

   d) At least one representative biological indicator for each of air (lichens), water (Macroinvertebrate) and soil (Moss) pollution.

   e) Graphical representation of the data collected after analysis of samples and comparison of values with Indian and Global standards.

3) (Please delete this practical) Community analysis of polluted and non-polluted sites by PCR based methods (eukaryotic and prokaryotic domain primers). Comparison of polluted versus non-polluted sites to ascertain the possible alteration in community structure introduced due to pollutant.

4) Microbial biodegradation (aerobic and anaerobic) of any one pollutant (e.g. hydrocarbon) or any xenobiotic and study of its decay behaviour.

5) Bioremediation – Monitoring uptake of heavy metals using biological methods- organisms.

6) Demonstration for biogas production/Agro-waste composting/visit to wastewater plant/ biogas plant.

Note: Wherever it is not possible to perform the experiment due to limitation of equipment or other reasons, a demonstration will be arranged, however no more than 10% practical's will be demonstrations.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO
BT 501.1	2	2	3	2	-	3	3	3	3	1	2	3	2	-	-
BT 501.2	3	3	3	3	3	3	3	2	1	2	2	3	2	1	-
BT 501.3	2	2	3	3	2	2	3	2	2	1	2	3	2	1	-
BT 501.4	3	2	2	2	3	3	3	3	2	2	2	3	2	1	1

COURSE: RECOMBINANT DNA TECHNOLOGY

COURSE CODE: BT502 **L T P H C**

MARKS:150(Theory 50+Practical 100) **2 0 4 6 4**

OBJECTIVES: To familiarize the student with emerging field of biotechnology i.e. Recombinant DNA Technology, as well as to create understanding and expertise in wet lab techniques in genetic engineering.

COURSE OUTCOME:

CO No.	**At the end of the course, the learner should be able to:**
BT502.1	Apply the knowledge of molecular biology for genetic engineering using various gene manipulation tools
BT502.2	Demonstrate different recombinant DNA techniques for manipulation of DNA, RNA and protein
BT502.3	Employ different gene cloning strategies to optimize various applications in genetic engineering

BT502.4	Plan and employ different recombinant DNA techniques in healthcare and agricultural sector
BT502.5	Apply genetic engineering techniques in diagnosis of human disorders and employ suitable therapies
BT502.6	Outline cross disciplinary genetic engineering approaches along with ethical issues for commercialization of genetically modified products

Prerequisites: Knowledge of molecular biology is sufficient.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1	Introduction	Landmarks in Molecular biology and Biotechnology What is genetic engineering and recombinant DNA technology? Advantages of using microorganisms in Genetic Engineering Genetic engineering in *E. coli* and other prokaryotes, yeast, fungi and mammalian cells.	2
	Tools in genetic engineering	Enzymes: DNA polymerases, ligases, reverse transcriptases, nucleases restriction endonucleases (Restriction modification system, Restriction mapping) and terminal transferases, phosphatases, polynucleotide Kinase etc. Cloning vectors: plasmids, bacteriophage vectors, cosmids, phagemids BAC,YAC vectors, Shuttle vectors, expression vectors etc.	5
2	Recombinant DNA techniques	Polymerase chain reaction (PCR) and its types Molecular Probes and Nucleic acid labeling Blotting Techniques (Northern, Southern and Western) Autoradiography, Hybridization, DNA footprinting, Electrophoretic mobility gel shift assay (EMSA) DNA sequencing, site directed mutagenesis and its applications DNA fingerprinting, RAPD, RFLP, AFLP. Different methods for analysis of gene expression	6
3	Gene cloning	Isolation and purification of DNA (genomic, plasmid) and RNA. Isolation of gene of interest- restriction digestion, electrophoresis, Cutting and joining of DNA Methods of gene transfer in prokaryotic and eukaryotic cells. Methods for Recombinant selection and screening: genetic, immunochemical, South-western analysis, nucleic acid hybridization, HART, HRT Expression of cloned DNA molecules and maximization of gene expression Cloning strategies- genomic DNA libraries, cDNA libraries, subtractive hybridization, chromosome walking and jumping.	7
4	Applications of Recombinant	Gene therapy, medicine, crop improvement, disease resistance: In vivo approach, ex-vivo approach of gene therapy, Antisense therapy,	5

	DNA technology	Interference technology (siRNA, shRNA, miRNA) CRISPAR Cas 9 mediated gene therapy, Transgenics	
5	Genetic disorders, Diagnosis and screening	Prenatal diagnosis, Single nucleotide polymorphisms, DNA microarrays, Future strategies.	2
6	Protein interaction technology	Two-hybrid and other two component systems Detection using GST fusion protein, co-immunoprecipitation, FRET, BRET, Phage display assays, Surface plasmon resonance (SPR) etc	2
	The Human Genome Project	The Human Genome Project Objectives and its outcome.	1
Total no. of Lectures			**30**

METHODOLOGY : The course will be covered through lectures supported by PowerPoint presentations, research articles and practical teaching.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal*	45 min.	15
Teachers assessment		05
End Semester Examination	1 Hrs 15 min.	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICAL IN RECOMBINANT DNA TECHNOLOGY (4 hours per week) Marks: 100

LIST OF PRACTICALS:

1. Requirement of a genetic engineering lab including physical containment facilities and other biosafety procedures
2. Culturing Escherichia coli K12 and making competent cells for transformation
3. Preparation of the vector DNA and target DNA, ligation and transformation
4. Elution of DNA from Agarose gel

5. Selection of transformants by

a) Antibiotic resistance

b) Blue-white screening

c) Restriction analysis

6. Preservation and storage of clones

7. Cloning in expression vectors for expression of specific genes

8. Target DNA amplification by polymerase chain reaction

9. DNA finger printing technique RFLP/RAPD

10. Bioinformatics tools in Genetic engineering

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Practical Internal (Continuous) assessment:	40
End semester examination:	60
Total:	**100**

REFERENCES:

1. Primrose, S. B. and Twyman, R. M. , Principles of Gene Manipulation and Genomics, eighth edition, John Wiley and Sons Ltd, June 2016
2. Reece, R. J., Analysis of gene and Genome, Wiley, 2004
3. Brown, T. A, Gene Cloning and DNA Analysis: An Introduction, Eighth edition, Wiley-Blackwell, 2020
4. Michael R.G, Sambrook J, Molecular Cloning A Laboratory Manual (Vol 1,2,3) , Fourth edition, Cold Spring Harbor Laboratory Press, 2013

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 502.1	3	1	1	1	3	1	1	1	1	1	1	3	3	2	1
BT 502.2	3	3	3	3	3	1	2	2	2	3	1	3	1	3	1
BT 502.3	3	3	3	3	3	2	2	2	3	2	2	3	3	1	1

BT 502.4	3	3	3	3	3	3	3	3	3	2	2	3	3	1	1
BT 502.5	3	3	3	3	3	3	2	3	3	2	3	3	3	1	1
BT 502.6	3	3	3	3	3	3	3	3	3	3	3	3	2	2	3

COURSE: BIOCHEMICAL ENGINEERING AND BIOPROCESS TECHNOLOGY
COURSE CODE: BT503 **L T P H C**
MARKS: 200 (Theory 100+Practical 100) **3 0 4 7 5**

OBJECTIVE

The objective of the course is to create general understanding amongst the students in the subject of Biochemical Engineering and fermentation technology through in-depth lectures. The objective of the

course is creating an understanding of concepts of and basic principles in the subject with emphasis on how to apply the knowledge in industrial processes involving Biochemical Engineering. The students would learn industrial techniques as: Isolation, improvement, maintenance and preservation of microbial cultures, Design of media, bioreactors and downstream processes along with production studies during the tenure of their study.

COURSE OUTCOMES

CO No.	At the end of the course, the learner should be able to:
BT503.1	Explain the basic concepts in biochemical engineering and bioprocess technology
BT503.2	Demonstrate various techniques for isolation, preservation, and strain improvement of industrially important microbes
BT503.3	Design a fermentation process by manipulating the media, inoculum, sterilization techniques and bioreactors
BT503.4	Demonstrate different downstream processing methods employed to purify the desired products
BT503.5	Determine the bioprocess kinetics of different cultures and understand fluid rheology, product formation and mass transfer
BT503.6	Plan and design bioprocess scale up methods to produce useful metabolites

PREREQUISITES

This is an introductory level course. Students are expected to have an understanding of introductory knowledge in Physics, Chemistry and Biology.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Introduction to Biochemical Engineering and Bioprocess Technology	Historical background of Biochemical engineering, Introduction of industrially important biotechnologically products	2
2.	Isolation of microbes and Strain improvement	Isolation and preservation of industrially important microbes and introduction of strain improvement	3
3	Design of fermentation media and inoculum development	Nutritional media components essential for growth of microorganisms and product formation, Media optimization using conventional and statistical designs, Inoculum development for bacterial, fungal and yeast strains	4
	Design of Fermenter, types of Bioreactors, Instrumentation and control	Design of fermenter and its important parts, Bioreactor types for products of microbial, plant and animal origin, Sensors for measurement of different bioprocess parameters, process control, Data analysis during process	7

3	Sterilization	Sterilization of Fermenter (batch and continuous processes), Feed sterilization, filter sterilization and sterilization of liquid waste	3
4	Downstream Processing	Cell separation techniques, Concentration of metabolites, Purification of metabolites	6
5	Bioprocess Kinetics	Introduction of Stoichiometric analysis and yield concept with examples, ideal and nonideal bioreactors, Kinetics of microbial growth, Batch, continuous, fed-batch culture, Plug flow bioreactor, Product formation kinetics, Substrate utilization kinetics and Cell death kinetics	10
	Fluid flow and Mass Transfer	Introduction to Newtonian and Non-Newtonian fluids and rheology, Mass transfer concepts in different phase systems, K_La and oxygen transfer rate	4
6	Scale up, Bioprocess Economics	Concept of scale up and scale down and consideration of important parameters for scale up, Introduction to Bioprocess Economics	2
	Biosynthesis of Metabolites	Examples of Industrial Production of few metabolites starting from inoculum development to downstream procesing	4
Total Number of Lectures			**45**

METHODOLOGY

The course will be covered through lectures supported by tutorials and laboratory practical's. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCES:

1. P. F. Stanbury, A. Whitaker and S. J. Hall. 'Principles of Fermentation Technology', Pergamon Press, Oxford and revised editions 1995.
2. J. E. Bailey, D. F. Ollis Biochemical Engineering Fundamentals, 2nd edition, McGraw-Hill, New. York) and revised editions 1986.
3. Pauline Doran, Bioprocess Engineering Principles, Academic Press (1995) and revised editions.
4. Shuler, ML and F. Kargi. Bioprocess. Engineering: Basic Concepts (Second Ed.). Prentice Hall, Englewood Cliffs, NJ. 2002.
5. A.H. Patel. Industrial Microbiology. MacMillan 2000.
6. Casida, L E JR Industrial Microbiology, Wiley Eastern (revised editions) 1984.

PRACTICALS IN BIOCHEMICAL ENGINEERING AND BIOPROCESS TECHNOLOGY
(4 Hrs. Per Week) MARKS : 100

LIST OF PRACTICALS

1. Isolation of industrially important microorganisms by screening methods such as enzyme producer, antibiotic producer etc.
2. Introduction of different Preservation techniques of industrially important microorganisms.
3. Demostration of various parts of lab scale fermenter and study of bioreactor design.
4. Study of microbial growth kinetics and growth curve. Determination of growth rate constant, generation time, specific growth rate and saturation constant.
5. Production of alpha amylase by solid state fermentation and downstream processing for recovery of enzyme and determination of enzyme activity.
6. Production of streptomycin/penicillin antibiotic by fed batch fermentation and determination of antibiotic activity.
7. Production of bioethanol from sugarcane juice and molasses. Downstream processing for recovery of bioethanol by simple distillation and chemical estimation of bioethanol.
8. Production of citric acid using *Aspergillus niger* by surface and submerged fermentation and study of rheological parameters. Recovery of citric acid by precipitation method and chemical estimation of citric acid.
9. Determination of K_La by sulphite oxidation method.
10. Determination of thermal death point and thermal death time of different microorganisms.
11. Immobilization of whole cells for demonstration of its biological activity.
12. Industrial visit to fermentation industry.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) Assessment	40
End semester Exam	60
Total	**100**

References:

1. Manual of Industrial Microbiology and Biotechnology, (2nd Edition by Arnold L. Demain and Julian E. Davies, Ronald M. Atlas, Gerald Cohen, Charles L. Hershberger, Wei-Shou Hu, David H. Sherman, Richard C. Willson and J. H. David Wu)
2. Industrial Microbiology-An introduction (By Michael J. Waites, Neil L. Morgan, John S. Rockey and Gary Higton)
3. Principles of Fermentation Technology (2nd edition, by Peter F. Stanbury, Allan Whitaker and Stephen J. Hall, Butterworth-Heinemann, An imprint of Elsevier Science
4. Fermentation and Enzyme Technology By D.I.C. Wang, C.L. Cooney, A.L. Demain, P. Dunnill, A.E. Humphrey & M.D. Lilly John Wiley and sons, New York

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 502.1	2	-	1	3	-	2	-	-	3	3	-	3	3	2	1
BT 502.2	1	2	3	2	3	2	3	2	2	2	2	3	3	2	1
BT 502.3	2	2	3	3	3	2	3	3	2	1	3	2	3	2	2
BT 502.4	1	3	3	3	2	1	2	2	3	2	3	3	3	2	2
BT 502.5	2	2	3	3	2	1	2	2	2	3	2	3	3	2	2
BT 502.6	3	2	3	3	3	2	3	2	3	2	3	3	3	2	3

COURSE: ENZYMOLOGY AND ENZYME TECHNOLOGY

COURSE CODE:BT504 **L**
T P H C
MARKS: 100 (Theory 50+Practical 50) **2 0 2 4 3**

OBJECTIVE

- To familiarize the student with enzyme classification, enzyme-substrate interactions as well as mechanism of enzyme action
- To create thorough understanding regarding kinetics of allosteric and non allosteric enzymes.
- To impart knowledge about modeling of enzyme systems and structure-function relations in enzymes.
- To familiarize the student with Immobilization techniques and applications.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT504.1	Classify enzymes on the basis of their attributes, naming conventions, features, and mechanism of action
BT504.2	Apply biochemical computations for determining the kinetics of enzymes
BT504.3	Compare and contrast the techniques for production, purification, identification, and immobilization of enzymes
BT504.4	Comprehend advances in enzyme technology and enzyme engineering

PREREQUISITES

This is an advanced course. The student should be aware of basics in enzymology as well as some fundamental aspects of biomolecules and chemistry.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1	Enzymes	Classification: Trivial and Enzyme Commisions System of nomencleature EC system, Properties of enzymes. Enzyme substrate interactions, enzyme substrate complex, concept of active site, transition state theory. Factors affecting enzyme activity: Effect of pH, temperature and substrate concentration on reaction rate	06
	Mechanism of enzymatic Reactions	Enzyme Catalysis: Factors affecting catalytic efficiency - proximity and orientation effects. Bisubstrate reactions: single and double displacement reactions. Enzyme catalysis: acid-base, covalent and metal ion. Chemical modification of enzymes. Isoenzymes and multiple forms of enzymes.	05
2	Enzyme Kinetics	Enzyme activity, international Unit, specific activity, turnover number.	8

		Michaelis Menten equation, Significance of Km and Vmax, Enzyme inhibition and kinetics: competitive, non competitive, uncompetitive and mixed. Structure-Function Relations: chymotrypsin, lysozyme, metalloenzyme .	
	Allosteric interactions and Enzyme Regulations	Allosteric enzymes :Types, positive and negative cooperativity, theory of concerted and sequential models, kinetics of Allosteric enzymes. Enzyme Regulation: Feedback inhibition, covalent modification and Zymogen activation.	5
3	Enzyme Immobilization and applications	Methods of immobilization: ionic binding, adsorption, covalent binding (based on R groups of amino acids), microencapsulation and gel entrapment. Applications of enzymes: Food processing, medicine, diagnostics, leather industry, textile industry.	4
4	Enzyme Technology	Recent advances in enzyme technology, enzyme engineering, artificial enzymes**.**	2
Total Number of Lectures			**30**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICAL IN ENZYMOLOGY AND ENZYME TECHNOLOGY (2 Hrs. Per Week) MARKS: 50

List of Practicals:

1. Handling of enzymes and estimation of specific activity of an enzyme (e.g. amylase, phosphatase, protease)
2. Isolation of β-amylase from sweet potato (Ipomoea batatas)/ barley (Hordeum vulgare) and determination of enzyme activity using specific substrate
3. Purification of enzyme by ammonium sulphate precipitation
4. Effect of physicochemical parameters (pH, temperature) on the activity of enzyme
5. In situ enzyme activity staining on SDS-Polyacrylamide gel.

(Amylase, Lactate dehydrogenase)

6. Immobilization of enzyme by gel entrapment and cross linking method
7.* Study on enzyme inhibition.

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

REFERENCES:

1. Fundamentals of Enzymology: The Cell and Molecular Biology of Catalytic proteins by Nicholas C. Price and Lewis Stevens; 3rd edition, 2010
2. Enzymes: Biochemistry, Biotechnology, Clinical Chemistry by Trevor Palmer; 2nd edition, 2008
3. Enzyme Technology by Ashok Pandey, Colin Webb, Carlos Ricardo Soccol, Christian Larroche, 2005
4. Principles of Biochemistry by Lehninger, Nelson Cox, 4th edition, 2017
5. Biochemistry by Lubert Stryer, 4th edition,1995

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 504.1	2	3	3	3	-	1	-	-	2	2	2	3	2	2	-
BT 504.2	3	3	2	2	2	1	-	-	2	2	3	3	2	2	1
BT 504.3	3	3	3	2	1	1	2	2	2	1	2	3	2	1	1
BT 504.4	2	2	1	2	2	3	2	2	2	3	3	3	3	2	1

COURSE: R PROGRAMMING
COURSE CODE: BI501 L T P H C
MARKS: 50 (Theory 50) 1 0 0 1 1
Course Outcomes

CO No.	At the end of the course, the learner should be able to:
BI501.1	Apply the essential concepts of R programming
BI501.2	Use various data structures for writing programs
BI501.3	Apply data and file handling features in writing a program
BI501.4	Implement statistical packages in R programming for analyses of biological data

Prerequisite –

- In depth knowledge of C programming is required
- Basic understanding of Statistics & Data Structure
- Basic knowledge of Molecular Biology, Genetics, Biochemistry and Computer aided drug designing.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction and basics of R	What is R? History of R Features of R Uses of R Applications of R Data types Escape Sequences Variables Keywords Operators Control statements and loops	2
	Data Structures	Vectors Lists Arrays Matrix Data Frames	2

		Factors	
2	Data and File Handling	Reading and writing data R CSV file R Excel file R XML file R Database	2
3	R Statistics	R Mean, Median & Mode R Linear Regression R Normal Distribution R Binomial Distribution R Time Series Analysis R Random Forest R Chi Square Test Support with the machine Neural network Nearest neighbor	5
	R Graphics	R Plot, R Line, R Pie Chart, R Bars	2
4	R applications in Biotechnology	Use various R functions to solve biological problems	2
Total Number of Lectures			**15**

METHODOLOGY:

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EXAMINATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal*		**20**
End Semester Exam		**30**
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

REFERENCES:

1. Thulin, M. (2024). Modern Statistics with R: From wrangling and exploring data to inference and predictive modelling. CRC Press
2. Wickham, H., Çetinkaya-Rundel, M., & Grolemund, G. (2023). R for data science. " O'Reilly Media, Inc.".
3. Weinberg, S. L., Harel, D., & Abramowitz, S. K. (2023). Statistics using R: an integrative approach. Cambridge University Press.

4. Kabacoff, R. (2022). R in action: data analysis and graphics with R and Tidyverse. Simon and Schuster
5. Wimberly, M. C. (2023). Geographic Data Science with R: Visualizing and Analyzing Environmental Change. Chapman and Hall/CRC.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BI501.1	3	2	2	-	-	2	-	-	2	2	-	3	2	1	-
BI501.2	3	2	2	-	-	2	-	-	2	2	-	3	2	2	1
BI501.3	3	3	3	-	-	3	-	-	3	3	-	3	2	2	2
BI501.4	2	2	2	1	3	2	-	1	2	2	2	2	2	2	3

Elective I
COURSE: BIOPHARMACEUTICALS
COURSE CODE: BT505 **L T P H C**
MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVE :

To create general understanding regarding basic knowledge of Biopharmaceuticals
to familiarize the student with the production techniques, mode of action and therapeutic uses of Biopharmaceuticals.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT505.1	Explain the scientific methods and protocols used for the discovery and development of biopharmaceuticals
BT505.2	Acquire knowledge of good manufacturing practices and recognise their importance in the formulation of biopharmaceutical products
BT505.3	Explain the uses of recombinant DNA and hybridoma technology in the discovery and development of biopharmaceuticals
BT505.4	Demonstrate the significance of blood products and enzymes in biopharmaceuticals
BT505.5	Explain the wound healing process and significance of various growth factors in the process
BT505.6	Apply the knowledge of gene therapy and antisense technology in the production of biopharmaceuticals, and explain the production of monoclonal antibodies, vaccines and biosimilars

PREREQUISITES
Students should know the basics of Microbiology, Biochemistry

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1	Overview	Introduction and current status of Biopharmaceuticals in the pharmaceutical industry. How are Biopharmaceuticals different from Pharmaceutical products	03
2	The drug manufacturing process	Good Manufacturing Practices: Cleanroom, cleaning, documentation and sanitation (CDS), preparation of purified water and water for injection for the biopharmaceutical processing, Source of Biopharmaceuticals: *E.coli* as a source of recombinant, transgenic animals, and transgenic plants Analysis of final biopharmaceutical products: Detection of protein based product impurities, pyrogen detection, endotoxin assay, and immunological approaches	09
3	Hormones of therapeutically interest	Insulin, Insulin receptors, production of human insulin by rDNA technology, insulin formulation, and Glucagon	07

4	Blood products and therapeutic enzymes	Anticoagulants: Hirudin, Vitamin K, and Antimetabolites, Oxygen carrying blood substitutes: Albumin, Dextran, and Gelatin	06
5	Growth factors and wound healing	Insulin growth factor (IGF), Epidermal growth factor (EGF), and Platelet derived growth factor (PDGF), Wound healing process	07
6	Vaccines and Nucleic acids therapeutics	Vaccines: Types of vaccines, peptide vaccine, and vaccine vectors Basic approach to gene therapy: Types of gene therapy vectors Antisense technology: Uses, advantages, and limitations	09
Total Number of Lectures			**40**

METHODOLOGY

The course would be taught through lectures, demonstrations and practicals.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

PRACTICALS IN BIOPHARMACEUTICALS (2 Hrs. Per Week) MARKS: 50

List of Practicals:

1. Chemical assay for estimation of penicillin /streptomycin/tetracycline Antibiotics
2. Bioassay to determine the antifungal activity of standard Aureofungin/ clotrimazole/ fluconazole/
3. Bioassay to determine the antibacterial activity of standard penicillin,streptomycin, tetracycline antibiotics by standard disc/well method
4. Sterility testing of commercial injectable such as saline water, eye drops or ear drops
5. Extraction and detection of antimicrobial compounds from plant origin
6. Determination of glucose in serum/plasma by GOD/POD method
7. Determination of endotoxin in the therapeutic formulation (WFI, gentamycin injection ampicillin injections) by using LAL test reagent
8. Determination of SGPT/SGOT activity in serum / plasma sample by chemical method
9. LIMIT test for chloride, sulphates, iron and heavy metals in pharmaceutical products.
10. One day industrial visit to a pharmaceutical company

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment	20
End semester examination:	30
Total:	50

REFERENCES:

1. Biopharmaceuticals- Biochemistry and Biotechnology. Second Ed. Garry Walsh. John Wiley and Sons. 2003

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 505.1	2	1	1	-	-	1	1	1	1	2	1	1	2	1	1
BT 505.2	2	2	2	1	1	2	3	3	1	2	2	3	2	2	3
BT 505.3	3	2	3	2	2	2	1	1	1	3	3	3	3	2	3
BT 505.4	3	3	3	1	1	2	1	2	1	3	2	3	3	2	3
BT 505.5	3	2	1	1	1	2	1	2	1	3	2	3	3	2	3
BT 505.6	3	3	3	3	3	3	3	3	2	3	3	3	3	3	3

Elective I

COURSE: CLINICAL RESEARCH

COURSE CODE: BT506 **L T P H C**

MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVE

The objective of the course is to familiarize the students about higher educational areas after their graduation. At the end of the course students should be able to understand various disciplines in the field of clinical research which will also help them in selecting their dissertation topics in final year of their course.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT506.1	Outline the importance of various clinical research phases and ethical guidelines related to clinical trials
BT506.2	Explain the different steps involved in clinical trials
BT506.3	Perform unbiased data monitoring and analysis as per good clinical practice
BT506.4	Assess adverse events and health-related quality of life in clinical trials
BT506.5	Determine the trial completion, implication, follow-up, reporting, and new drug application procedures
BT506.6	Acquire awareness about the current situation of clinical research including updated regulations in India and the future of clinical research

PREREQUISITE:

Students should be familiar with biology and basic statistics to take up this course.

COURSE DESCRIPTION

Unit	Topic	Detailed syllabus	No. of Lectures
1	Introduction to clinical trials	History & background of origin of clinical research; Drug development process and phases of clinical trials (CT); Terminology in clinical research	3
	Introduction to different clinical guidelines and ethics	Ethics in clinical research; Introduction to different clinical guidelines (Schedule Y, DGCI,ICMR, ICH-GCP); Principles of ICH-GCP, US Food and Drug Administration (USFDA); Medicines and Healthcare Products Regulatory Agency (MHRA): Overview, European Agency for Evaluation of Medicinal Products (EMEA), Ethical guidelines for biomedical research on human participants (as given in ICMR); Indian Good Clinical Practices; Clinical trial application requirements (IND,NDA,ANDA, orphan drugs);	5

		Informed consent; Ethical committee (EC)-constitution; Roles & responsibilities; Communication with EC	
2	Design of the study	Planning a protocol: an overview; Selection of questions, Defining the study population; Types of study design; Response variables and measurement; Bias and elimination of bias - Types and mechanics of randomization; Types of blinding in trials and methods of protecting blind design	8
	Initiation of recruitment	Sample size calculation; Recruiting participants; Baseline assessment	3
3.	Clinical data monitoring and analysis	Case report form (CRF); CRF Tracking, Data entry processing; Data validation and discrepancy management; Quality monitoring of the data; Minimizing poor quality data; Data analysis; Competing events; Co-variance adjustment; Subgroup analysis; Cut-points; Meta-analysis	7
4.	Impact analysis	Adverse effect; Health related quality of life; adherence and survival analysis	5
5.	Termination and reporting	Closeout- Termination of the trial; Procedure of termination; Post study follow up; Evaluation of the trial; Reporting a trial; Interpretation and publication bias; Comparing results between studies, clinical implication of the findings, Multicenter trials, Globalization of trials, Drug approval- Indian scenario and US FDA, EU	9
6.	Other components of clinical research	Medical writing; Pharmacoepidemiology; Pharmacovigilance; B.A./B.E. Studies; Overview of the on-going clinical trials in India	5
Total no. of Lectures			**45**

METHODOLOGY

The course will be covered through lectures and demonstrations.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

PRACTICAL IN CLINICAL RESEARCH (2 Hrs. Per Week) MARKS: 50
List of Practicals:

1. Drafting of Informed Consent Form/Assent Form-
2. Drafting of CRF
3. Visit to clinical research setting (Industrial/Hospital based)

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

REFERENCES:

1. Dyer, R. K. R., & McFarlane, B. E. K. (2022). *Clinical research: A textbook for health professionals*. Wiley-Blackwell.

2. Fundamentals of clinical trials, by Friedman, LM; Furberg, CD; Demets, DL; 2015. ISBN 978-1-4419-1585-6, Publisher Springer

3. Bellary S, Krishnankutty B, Latha MS. Basics of case report form designing in clinical research. *Perspect Clin Res*. 2014;5(4):159-166. doi:10.4103/2229-3485.140555

4. Clinical Trials Handbook: Design and Conduct, Cutis L. Meinert, ISBN 978-1-1182-1846-4, Publisher Wiley

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 506.1	3	3	3	-	-	3	3	3	2	1	1	3	1	1	3
BT 506.2	3	3	3	-	-	3	3	3	3	3	3	3	3	3	3
BT 506.3	3	3	3	3	3	3	1	3	2	3	3	3	3	3	2
BT 506.4	3	3	3	3	3	3	3	3	3	3	2	3	3	3	3
BT 506.5	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
BT 506.6	2	3	3	2	2	3	3	3	3	3	3	3	3	3	3

Elective I

COURSE: HUMAN DISEASES AND PATHOBIOLOGY

COURSE CODE: BT507 **L T P H C**

MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVE

The objective of the course is to develop an understanding regarding various human diseases. The course covers details of various infectious and non-infectious diseases.

COURSE OUTCOME:

On completion of the course would enable the student to understand various human diseases.

CO No.	At the end of the course, the learner should be able to:
BT507.1	Outline the characteristics of diseases and identify types of laboratories for disease investigation
BT507.2	Illustrate various human pathogens and explain the effect of microbial virulence factors
BT507.3	Describe the prevention and treatment of infectious diseases
BT507.4	Discuss the disorders of endocrine and immune systems including autoimmune disorders
BT507.5	Comprehend signs, symptoms, diagnosis, and treatment of digestive and cardiovascular disorders
BT507.6	Identify diseases associated with aging, and examine the importance of disease management

PREREQUISITES

Since the course is advance in nature knowledge in microbiology, human anatomy and physiology is required.

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1.	Introduction to nature and investigation of diseases	Introduction to health and disease Characteristics and features of diseases Classification of disease Epidemiology Investigating diseases: Types of pathology laboratories, role and evaluation of hospital laboratory tests.	7
2.	Pathogens and virulence	Introduction to pathogens, parasites and types of infection Types of pathogens : Bacteria, Fungi, Helminths, Prions, Protozoans and Viruses Types and effects of microbial virulence factors (offensive and defensive).	6

3.	Infectious disease and treatments	Bacterial infections of skin, eye, ear, central nervous system, respiratory system urogenital system and gastrointestinal system Viral infections of central nervous system, respiratory system, urogenital system and gastrointestinal system Fungal infections of skin and respiratory system Systemic infections, Sepsis, Prevention and treatment of infections (with antibiotics, antiviral combination therapy and surgery)	6
4	Disorders of immune system	Introduction to the defense system and types of immunodeficiency diseases Signs, symptoms, diagnosis and treatments of i) Primary immunodeficiency diseases : SCID, CVID, Transient hypogammaglobulinemia, DiGeorge Anomaly and Wiskott-Aldrich Syndrome ii) Autoimmune Disorders: Rheumatoid Arthritis, Systemic Lupus Erythematosus and Myasthenia Gravis iii) Immunological Hypersentivities: Type I to IV	6
	Disorders of the endocrine system	Introduction to endocrine system and its disorders. Signs, symptoms, diagnosis and treatments of disorders linked to a) Growth hormones : Acromegaly, Gigantism b) Thyroid Glands: Hypothyroidism and Hyperthyroidism c) Adrenal Glands: Addison disorder and Cushing syndrome d) Pancreas: Diabetes Mellitus e) Reproductive hormones : i) Male: Hypogonadism, Gynecomastia ii) Female: Amenorrhea and PCOS Causes and treatment of infertility in men and women	6
5	Disorders of digestive system	Introduction to GIT and common disorders eg: Gastritis, Ulcers Signs, symptoms, diagnosis and treatments of Cholelithiasis, Hepatitis , Hernia, and Crohn disease	5
	Disorders of the cardiovascular system	Introduction to the circulatory system and common disorders eg: hypertension, cardiac failure and angina Signs, symptoms, diagnosis and treatments of dilated congestive cardiomyopathies, endocarditis and atherosclerosis	5
6	Disorders linked to aging	Introduction to causes of aging, age-related disorders eg: Parkinson disorder, Alzheimer disorder and Progeria	3
	Disease surveillance	History and importance of surveillance in disease management	2
Total No. of Lectures			**46**

METHODOLOGY

The course would be covered through lectures, group discussions, teaching aids and would be supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
I Internal	60 mins	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

PRACTICAL IN HUMAN DISEASES AND PATHOBIOLOGY (2 Hrs. Per Week) MARKS: 50

List of Practicals:

1. Introduction to pathogens/parasites (e.g., bacteria, protozoans, arthropods etc.) including disease causing stages in their life cycle using permanent slide preparations/images.

2. Identification of microbes$ using indicator media (e.g., Blood Agar).

3. Common and rare skin diseases/disorders in a population (based on the cases in the outpatient unit of Department of Dermatology, DPU Medical College and Hospital)#.

4. Metabolic and immune disorders in a population (based on the cases in the outpatient unit of Departments of Pathology and General Medicine, DPU Medical College and Hospital)#.

5. Sexually transmitted diseases in a population (based on the cases in the outpatient unit of Department of Venereology, DPU Medical College and Hospital)#.

6. Clinical methods (eg: X-ray, CT scan etc.) used in diagnosis of common diseases (at the Departments of Radio-diagnosis, Pathology and Microbiology, DPU Medical College and Hospital)#.

7. Study the implications of viral infections in the context of biomedical research (by visiting a research organization) #.

$ Non-pathogenic strains would be used for the experiment.

Students are to take note on the practical carried out and the observations made during visit to the Medical College and Hospital or other research institutes/centers. Practical examination would involve questions based on what has been studied/demonstrated in these visits.

PRACTICAL EVALUATION SCHEME

Examination	Marks
Internal (Continuous) assessment	20
End semester examination:	30
Total:	**50**

REFERENCES:

1. Biology of Disease, by Nessar Ahmed, Maureen Dawson, Chris Smith, Ed Wood, **Publisher:** Taylor & Francis; **ISBN-13:** 978-0748772100

2. Gordis, L. (2004). *Epidemiology.* Third edition. Philadelphia: Elsevier Saunders. (The second edition is also acceptable.)

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 507.1	2	2	2	-	1	1	1	-	1	-	1	1	2	-	-
BT 507.2	2	2	2	-	-	1	-	-	-	-	1	1	2	-	-
BT 507.3	2	2	2	1	1	1	-	-	-	-	1	1	2	-	-
BT 507.4	2	2	2	1	1	1	-	-	-	-	1	1	2	2	-
BT 507.5	2	2	2	1	1	1	-	-	-	-	1	1	2	2	-
BT 507.6	2	2	2	2	1	1	-	1	-	-	1	1	2	2	-

COURSE: SCIENCE COMMUNICATION
COURSE CODE: BTSEC501 **L T P H C**
MARKS: 50 (Theory 50) **0 0 2 2 1**

OBJECTIVES OF THE COURSE:

- To train the students for communicating science in simple language
- To understand and present a particular topic, published research work in front of an audience
- To develop capability and potential to discuss, delineate a topic precisely, professionally in an interactive manner
- To prepare science columns, science videos, science animations for effective public outreach
- To prepare science blogs

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTSEC501.1	Comprehend scientific articles and communications
BTSEC501.2	Communicate science to public in simple ways through articles, cartoons, blogs
BTSEC501.3	Communicate science to public in simple ways through animations, videos,
BTSEC501.4	Relate ethics in Science communication

PRACTICAL IN SCIENCE COMMUNICATION (2 Hrs. Per Week) MARKS: 50

List of Practicals:

1. Modes of Professional Scientific Communication
2. Structure of research article
3. Interpreting the scientific data and writing a popular science article
4. Interpreting the scientific data and writing a blog
5. Interpreting the scientific data and making a science animation
6. Interpreting the scientific data and making a science video
7. Ethical practices in science communication

Sr no.	Practical / Workshop	Hrs
1	Modes of Professional Scientific Communication	02
2	Structure of research article	02
3	Interpreting the scientific data and writing a popular science article	04
4	Interpreting the scientific data and writing a blog	04
5	Interpreting the scientific data and making a science animation	08
6	Interpreting the scientific data and making a science video	08
7	Ethical practices in science communication	02
	Total	**30**

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		
Attendance		20
Presentations/Report/Video/Blog/Article/Animation		30
Total		**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTSEC501.1	1	1	-	-	-	2	-	-	1	3	-	1	1	-	-
BTSEC501.2	1	1	-	-	2	2	-	1	2	3	-	1	1	-	-
BTSEC501.3	1	1	-	-	2	2	-	1	2	3	-	1	1	-	-
BTSEC501.4	1	1	-	-	-	2	-	3	1	1	-	1	1	-	-

COURSE: APTITUDE BUILDING-V

COURSE CODE: BTAEC501 **L T P H C**

MARKS: 50 (Theory 50) **0 0 2 2 1**

OBJECTIVE

1. To enhance the logical reasoning skills of the students and help them improve the problem-solving abilities
2. To acquire skills required to solve quantitative aptitude problems
3. To boost the verbal ability of the students for academic and professional purposes

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC501.1	Apply critical thinking skills, such as problem solving related to their subject matter
BTAEC501.2	Demonstrate competency in verbal, quantitative and reasoning aptitude
BTAEC501.3	Display good written skills for use in academic and professional scenarios
BTAEC501.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

PRACTICAL IN APTITUDE BUILDING-V (2 Hrs. Per Week) MARKS: 50

Sr no.	Practical/Training/Tests/Interviews	Hrs
1	Essential Grammar	02
2	Vocabulary for placements	04
3	Verbal Ability	08
4	Presentation & Writing skills for placements	04
5	Quality and regulatory documentation	02
6	Bioreactor design and process optimization	02

7	Enzyme-based sensors	02
8	Competitive Examination Preparation	02
9	Mock Interviews	02
10	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing

2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.

3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC501.1	-	2	2	1	2	-	-	-	-	1	-	2	2	-	-
BTAEC501.2	1	1	1	-	-	-	-	-	-	1	-	1	1	-	-
BTAEC501.3	1	1	1	-	2	-	-	-	-	2	-	1	1	-	-
BTAEC501.4	1	1	1	-	1	-	-	-	-	1	-	1	1	-	-

SEMESTER VI						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BT601	Food Biotechnology	2	0	2	4	3
BT602	Marine Biotechnology	2	0	0	2	2
BT603	Basic Pharmacology & Toxicology	2	0	0	2	2
BT604	Genomics, Transcriptomics and Proteomics	3	0	4	7	5
BI601	Artificial Intelligence	1	0	2	3	2
BT605/BT606	**Elective II** BT605 Perl & Bioperl BT606 Structural Biology	3	0	2	5	4
BTIKS601	Indian Constitution and Law	1	0	0	1	1
BTSEC 601	Foreign Language Course German/French/Japanese/Korean/Spanish/ any other (online MOOCs/offline)	2	0	0	2	2
BTAEC 601	Aptitude Building-VI	0	0	2	2	1
Total		**16**	**0**	**12**	**28**	**22**

COURSE: FOOD BIOTECHNOLOGY

COURSE CODE: BT601 **L T P H C**
MARKS: 100 (Theory 50+Practical 50) **2 0 2 4 3**

OBJECTIVE:

The objective of the course is to familiarize the students with quality process used in food industry and basic concept in Food Biotechnology

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT601.1	Comprehend the technical terms and skills involved in food science
BT601.2	Classify and categorize various biomolecules present in food
BT601.3	Demonstrate various processing methods in food industry
BT601.4	Demonstrate the role of microbes in fermented food products
BT601.5	Describe various approaches including cloning and genetic engineering for the production of genetically modified and superior quality foods
BT601.6	Analyse and evaluate food products in terms of nutrition, adulteration, and overall quality as per the National and International standards

PREREQUISITES:

Since the course is application oriented, student must know about the basics of Biomolecules, Microbiology and Fermentation technology.

COURSE DESCRIPTION

Sr No	Topic	Detail Syllabus	No. of Lectures
1	Introduction to Food Biotechnology	Activities of Food Biotechnologist, Career in Food Biotechnology.	1
2	Nutritive aspects of Food Constituents	Food and Energy, Role of Carbohydrate, Proteins, and Fats in Nutrition. Bioavailability of Nutrients, Role of Vitamins, Minerals, Fiber and Water. Stability of Nutrients	3
3	Biotechnology in Food Processing	Unit Operation in Food Processing Quality Factors in Food Food deterioration Food Preservation and its Principle Rheology of Food in general.	6

4	Role of Microbes in Food and Food Products	Fermentation and other uses of Microorganism, Single Cell Proteins. Production of Pickle, Kefir, Wine, Beer, Bread, Monosodium Glutamate (MSG). Production of Cheese and Types of Cheese. Use of enzymes in food industry - Proteases, Glucose oxidase, Amylase.	10
5	Molecular cloning in Food Industry and Other technique to develop new plant varieties	Antisense RNA technology (Flavr Savr Tomatoes), Enviro Pig, Daisy Cow, Golden Rice, BT Brinjal. Agrobacterium mediated gene transformation, Somaclonal Variation, Gametoclonal Variation. Ethical Issues related to use of Genetically modified foods.	8
6	Food Laws and Standards	Prevention of Food Adulteration Act, FSSAI and its function, International Food Standards- FAO, WHO and CODEX Alimentarius. Hazard Analysis Critical Control Point (HACCP). Food Labeling and Nutrition Labeling. Quality Control in Food.	2
Total Number of Lectures			**30**

METHODOLOGY

The course would be taught through lectures, demonstrations and practical.

Evaluation Scheme (Theory)

Examination	**Duration**	**Marks**
Internal*	45Mins	15
Teachers assessment	-	05
End Semester Exam	1 hrs 15 mins	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICAL IN FOOD BIOTECHNOLOGY (2 Hrs. per Week) MARKS: 50

List of Practicals:

1. Determination of quality of milk by MBRT test.
2. To Detect the number of bacteria in milk or any given sample by Breed Count or Direct Microscopic Count (DMC).
3. To check the efficiency of food preservatives.
4. Estimation of Percentage of lactic acid (Titrable acidity) in given milk and milk product sample using titration method.
5. Detection of pathogenic bacteria from food sample using selective media.
6. To Detect the number of bacteria in food sample by Standard Plate Count (SPC) Method.
7. To make/bake bread using Saccharomyces cerevisiae (Baker's yeast).
8. To make Cheese in Laboratory

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Internal (Continuous) Assessment	20
End semester Exam Viva & Spotting	30
Total	**50**

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 601.1	1	1	1	1	-	-	1	-	1	2	-	1	1	3	1
BT 601.2	3	1	2	1	-	3	1	2	1	2	-	3	2	3	2
BT 601.3	3	3	3	2	2	3	2	2	2	2	3	3	2	3	2
BT 601.4	3	3	3	3	2	3	2	2	2	2	3	3	2	3	2
BT 601.5	3	3	3	3	3	3	2	3	2	2	2	3	3	3	3
BT 601.6	2	1	3	1	1	3	3	3	2	2	3	3	3	3	3

COURSE: MARINE BIOTECHNOLOGY L T P Hr C
COURSE CODE: BT602 2 0 0 2 2
MARKS: 50(Theory 50)

OBJECTIVE:

The objective of the course is to give an overview of marine environment and its living and nonliving resources. Further the utility of the resources for overall benefit of humans and other biota is also covered.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT602.1	Outline marine ecosystems and their biodiversity to isolate and identify potential marine organisms of biotechnological importance
BT602.2	Demonstrate various marine culture techniques to produce aquatic food, and maintenance of aquatic animal health and broodstock
BT602.3	Practice genetic improvement of fish stocks, develop probing technologies and biosensors
BT602.4	Devise marine models for regenerative medicine and strategies for the conservation of marine resources

PRE-REQUISITES:

Students are expected to have a basic understanding in Biology.

COURSE DESCRIPTION:

Unit	Topics	Detail Syllabus	No. of Lectures
1	Marine Science Fundamentals	• Bathymetry: Ocean basins, tectonics and sediments • Marine biology and ecology: Biodiversity, benthos, food chain, non-cultivable life forms	3
	Marine Microbiology	• Methods for assessment of microbial life forms: sampling, identification, community structure analysis • Role of Microbes in marine ecosystem: beneficial and harmful effects, interactions with other flora and fauna	4

	Marine resources-Bioprospecting	• Marine Natural Products: screening using advanced high- throughput systems, isolation and identification techniques using genomics, proteomics or transcriptomics approaches • Bioactive compounds and Biomaterials: antibiotics, enzymes, alkaloids, biominerals, biocomposites, • Biopolymers	6
2	Marine culture	• Aquaculture: Methods, ponds, cultivation systems, examples- Gastropod, Bivalve and Crustacean production • Marine life poisoning: marine toxins • Aquatic animal health management: diseases of commercial fishes, spoilage, control methods • Broodstock development: Maintenance of important broodstock	7
3	Advanced technologies and products	• Transgenic fish: development and applications • Probing technologies: biochemical, molecular, bioindicators • Biosensors: role in marine environment	5
4	Marine models of regenerative medicine	• Principles of organ regeneration: Xenopus and Zebrafish as models for regeneration • Examples of marine biomaterials in regeneration	3
	Marine Conservation	• Pollution in the marine environment: Causes • Marine protection acts and laws: for conservation	2
	Total		**30**

METHODOLOGY:

The course will be covered through lectures and laboratory practicals. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hours 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

REFERENCES:

1. Marine Biotechnology I, Le Gal, Yves, Ulber, Roland (Eds.), Springer (2005).
2. Marine Biotechnology II, Le Gal, Yves, Ulber, Roland (Eds.), Springer (2005).
3. Handbook of Marine Biotechnology, Kim, Se-Kwon (Ed.), Springer (2015).
4. Micro Algae: Biotechnology & Microbiology, E. W. Becker Cambridge University Press.
5. Aqua Culture – An Introduction, Lee & Newman, Interstate Publishers Biotechnology an Introduction, Susan R. Barnum, Vikas Publishing House

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 602.1	2	3	3	2	3	3	2	1	2	2	3	2	3	2	3
BT 602.2	3	3	2	2	3	3	2	2	2	1	2	3	3	3	3
BT 602.3	2	2	3	3	2	3	3	2	2	3	2	2	3	2	3
BT 602.4	3	3	3	3	2	2	3	3	2	3	3	2	2	3	3

COURSE: BASIC PHARMACOLOGY & TOXICOLOGY
COURSE CODE: BT603 **L T P H C**
MARKS: 50 (Theory 50) **2 0 0 2 2**

OBJECTIVE :
The objective of the course is to familiarize the students with basic aspects of Pharmacology and toxicology.

COURSE OUTCOMES:

CO No.	At the end of the course, the learner should be able to:
BT603.1	Comprehend the importance of dose-effect relationship in pharmacology and toxicology
BT603.2	Explain the pharmacokinetics of xenobiotics with special reference to metabolism
BT603.3	Analyse various chemical interactions and their importance in toxicity testing
BT603.4	Illustrate molecular basis of interactions of various receptors with their chemical ligands

PREREQUISITES:
Students should studied chemistry and cell biology

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction to pharmacology and toxicology	1. History and scope 2. Definitions and terms	3
	Dose-effect relationships	1. Assumptions in deriving the Dose: Response relationship 2. Individual, graded and quantal Dose: Response relationship 3. Evaluating Dose: Response relationship: Therapeutic, Lethal effective dosage. 4. Dose–Response Assessment: NOAEL	6
2	Pharmacokinetic	1. Route and site of exposure: oral, dermal, inhalation and injection 2. Absorption 3. Distribution	4

		4. Metabolism 5. Excretion	
	Biotransformation of Xenobiotics	1. Biotransformation versus metabolism 2. Phase I and Phase II enzymes and reactions	6
3	Interaction of chemicals	1. Potentiation, 2. Agonism and Antagonism, 3. Synergistic	3
	Toxicity testing	1. *In vitro* and *in vivo* tests Acute, sub-chronic, chronic, Mutagenicity and carcinogenicity 2. Special Tests	7
4	Response to different chemicals	1. Receptor classification 2. Drug receptor interaction Ligand-gated ion channel, G-protein coupled receptors, Kinase and enzyme linked and nuclear receptors.	6
Total Number of lectures			32

METHODOLOGY: The course will be covered through lectures and laboratory practical's. Students will be evaluated based on two class tests, lecture and laboratory attendance, class participation.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	----	20
II Internal		
End Semester Exam	1 hour 15 minutes	30
Total		**50**

BOOKS RECOMMENDED:

1) Toxicology: The Basic Science of Poisons, Casarett and Doull's:Amdur, Mary O. PhD; Doull, John PhD, MD; Klaassen, Curtis D. PhD MC Graw Hill Publisher 7th Edition.
2) A text book of toxicology Ernest Hodgson A JOHN WILEY & SONS, INC., PUBLICATION, 4th edition
3) Lippincott's Illustrated Reviews: Pharmacology, 5th edition, Richard A. Harvey. Publisher- Lippincott Williams & Wilkins, a Wolters Kluwer Business.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 603.1	2	2	1	-	-	1	-	-	2	1	-	2	2	2	-
BT 603.2	1	1	1	-	-	2	1	-	2	2	-	2	2	2	-
BT 603.3	2	2	1	1	2	2	1	2	2	1	2	3	3	3	-
BT 603.4	2	3	3	3	-	2	2	2	2	2	2	3	3	3	2

COURSE: GENOMICS TRANSCRIPTOMICS & PROTEOMICS
COURSE CODE: BT604 **L T P H C**
Total marks: 200 (Theory 100+Practical 100) **3 0 4 7 5**

OBJECTIVES:

The recent proliferation of genomic data has transformed biology, making previously laborious and expensive experiments easier and cheaper, enabling new avenues of inquiry, andfundamentally altering our understanding of biology and medicine. This course will introduce to the questions that can be asked and answered with genomic data, and to the computational tools available to analyze that data.

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BT604.1	Outline the genome organization and various tools used for genome analysis
BT604.2	Demonstrate the concept of transcriptome and the tools involved in its analysis
BT604.3	Employ microarray and various sequencing techniques including NGS for genomic and trancriptomic studies
BT604.4	Illustrate the concept and tools for analysing proteome of organisms
BT604.5	Elucidate the principles and usage of tools for studies in metabolomics
BT604.6	Planning and implementation of advanced techniques including mass spectrometry, GCMS etc. for protein and metabolite identification

PREREQUISITE
Basic knowledge of molecular biology, Recombinant DNA technology and Bioinformatics is required.

COURSE DESCRIPTION

Unit	Topics	Detail Syllabus	No. of Lectures
1.	Genomics	Structure and organization of prokaryotic and eukaryotic genomes- nuclear, mitochondrial and chloroplast genomes.	4

		Databases different types DNA databases, Tools for finding genes and regulatory regions.	
2.	Transcriptomics	Concepts of transcriptomics and its scope.	2
		Micro (mi) RNA biogenesis and its role in regulation of gene expression.	1
		Tools for analyzing gene expression: Serial Analysis of gene expression (SAGE), massively parallel signature sequencing (MPSS).	4
3	Microarray technique in Genomics and Transcriptomics	Basic principles and design of cDNA and oligonucleotide arrays, DNA microarray. Basic steps involved in designing a microarray experiment.	3
		Types of microarray based on its applications:- Expression arrays, Comparative Genomic Hybridization (CGH) arrays, Re-sequencing arrays.	3
		Different microarray platforms (Affymetrix, Agilent etc.); Tools used to normalize microarray Data.	1
		Microarray databases – NCBI; GEO (Gene Expression Omnibus), Array Express (EBI);	2
		Functional Analysis: Gene Ontology functional enrichment tools, Pathway analysis (KEGG Database)	3
	Sequencing technology in Genomics and transcriptomics	**Next Generation sequencing (NGS)**: Introduction to NGS, overview and comparison of different Sequencing Platform (Illumina, 454 (Roche), SOLiD (Life technology), Specific Biosciences, Ion Torrent, Nanopore, PacBio.	4
	Types of NGS	DNA-sequencing (Whole genome sequencing), exome sequencing, Deep sequencing, ChIP sequencing, RNA-sequencing (**Whole transcriptome sequencing, WTS)**.	2
4	Proteomics:	What is proteomics?; proteome complexity; Overview of protein structure-primary, secondary, tertiary and quaternary structure. , Clinical and biomedical applications of proteomics.	2
		Post translational Modifications (PTMs): Different type of PTMs, Quantitative proteomics, clinical proteomics and disease biomarkers, mass spectral tissue imaging and profiling	3
		Bioinformatics tools in Proteomics: Protein database, Relationship between protein structure and function.Track emrging diseases and design new drugs	4
5	Metabolomics	An overview, basic sample preparation strategies-extraction, derivatization. Workflow for lipidomics;	4

		Targeted Vs Untargeted metabolomics; development of targeted assays for small molecules, Metabolomic Data Analysis:Peak detection, retention time alignment; identification of molecular features and metabolites; Structural confirmation of metabolites. Software- Multiquant, MZmine, XCMS, MarkerView,	
6.	Techniques in Protein and Metabolite Identification	Identification and analysis of proteins by 2D PAGE, Mass spectrometry: ion source (MALDI, spray sources), analyzer (ToF, quadrupole, quadruple ion trap) and detector for protein and metabolite analysis	3
Total no. of Lectures			**45**

METHODOLOGY:

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 mins	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

PRACTICAL IN GENEOMICS, TRANSCRIPTOMICS & PROTEOMICS (4 HRS) 100 MARKS

List of Practicals:

1. To determine genome size & genome complexity by Cot curve analysis
2. To perform zoo blotting.
3. Analyze microarray & RNA seq data
4. To carry out quantitative real time PCR (qRT-PCR)
5. To Isolate and analyse microRNA using polyacrylamide gel or PCR
6. To predict possible microRNAs targeting the gene of interest.
7. To Perform DNA sequencing
8. To Perform 2D gel electrophoresis & identification of the protein/peptide by MALDI
9. To carry out DNA sequence analysis from the available profile.
10. Genome Databases.

PRACTICAL EVALUATION SCHEME

Examination **Marks**

Practical Internal (Continuous) assessment: 40
End semester examination: 60
Total: 100

REFERENCES:

1.Principles of gene manipulation and Genomics Primrose S.B. and RM Twyman R.M.edi VII, 2006
2. Introduction to Genomics, Arthur M Lesk IInd edition Oxford University Press.2012
3. Introduction to Proteomics: Tools for New Biology Daniel C Liebler 1st Edition New York Humana Press,2001
4. Bioinformatics Sequence and Genome Analysis D.WMount Cold Spring Harbour Laboratories (CSHL) 2004
5. Discovering Genomics, Proteomics and Bioinformatic A. Malcolm Campbell , Laurie J. Heyer Benjamin Cummings; 2 edition (2006)
6.http://www.targetscan.org/vert_71
7.http://mirdb.org
8.http://www.exiqon.com/micrrna-target- prediction.
9.www.nanopore technologies.com
10.http://plantta.jcvi.org/
11.www.flymine.org/
12.www.ncbi.nlm.nih.gov/genbank/
13.https://www.ebi.ac.uk/embl/
14.www.ddbj.nig.ac.jp/

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 604.1	1	3	3	3	3	2	1	-	1	2	-	3	2	2	-
BT 604.2	1	3	3	3	3	2	1	-	1	2	-	3	2	2	-
BT 604.3	1	3	3	3	3	2	1	1	2	2	2	3	2	2	-
BT 604.4	1	3	3	3	3	2	1	-	1	2	-	3	2	2	-
BT 604.5	1	3	3	3	3	2	1	-	1	2	2	3	2	2	-
BT 604.6	1	3	3	3	3	2	1	1	2	2	2	3	2	2	3

COURSE: ARTIFICIAL INTELLIGENCE
COURSE CODE: BI601 **L T P H C**
MARKS: 100 (Theory 50+Practical 50) **1 0 2 3 2**

COURSE OBJECTIVE:

- This course introduces the concepts and state-of-the-art research in bioinformatics, data mining and AI especially for medical application
- To understand the various characteristics of Intelligent agents
- To learn the different search strategies in AI
- To learn to represent knowledge in solving AI problems
- To understand the different ways of designing software agents
- To know about the various applications of AI

COURSE OUTCOME

CO No.	At the end of the course, the learner should be able to:
BI601.1	Identify and analyse the application areas using AI
BI6012	Select search algorithms in AI based applications
BI601.3	Employ probabilistic reasoning in AI based applications
BI601.4	Create biological applications using Machine Learning and Deep learning methods

COURSE DESCRIPTION:

Unit	Topics	Detail Syllabus	No. of Lectures

1	Introduction to AI	Introduction to AI, history and scope, Application areas, Heuristic search, Algorithms	2
2	Search Algorithms	Random search, Search with closed and open list, Depth and Breadth first search	2
3	Probabilistic Reasoning	Probability, conditional probability, Bayes Rule, Bayesian Networks	1
4	Introduction to Machine Learning	Supervised & Unsupervised Learning	4
	Introduction to Deep Learning	Neural networks, Computer Vision, Natural Language Processing	3
	Application of AI in Biological Sciences	Case Study	4
Total no. of Lectures			**16**

METHODOLOGY:

The course will be covered through lectures supported by tutorials and practicals. In tutorials, apart from the discussion on the topics covered in lectures, assignments in the form of questions will be given. Normally a students is expected to complete the assignment by himself, however if needed, difficulties will be discussed in the tutorial classes. There will be two class tests/ and surprise test conducted during the tutorial classes.

EXAMINATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Internal*	45 mins	20
End Semester Exam	1hr and 15 mins	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICALS IN ARTIFICIAL INTELLIGENCE (2 HRS. PER WEEK) 50 MARKS

List of Practicals:

1. Basic foundation of Python and acquainted with IDE such Jupyter Notebook
2 . Practical implementation of python libraries such as NumPy, Pandas, and Matplotlib for data manipulation and visualization
3. Basic understating Libraries such as Scikit-learn, TensorFlow and Dataset such as Kaggle.
4. Implementation of Linear Regression, K-Means, SVM, Naïve Bayes classifier and Random Forest algorithm (at least two) by using Scikit-learn libraries

Miniproject

5. To build an AI system using convolution neural networks (CNNs) and Python that can detect pneumonia from a patient's X-ray images

6. To build a chatbot using Python
7. To build a recommendation system for customers for products with the help of ANN, data mining, machine learning, and programming

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

BOOKS RECOMMENDED:

1) Géron, A. (2022). *Hands-on machine learning with Scikit-Learn, Keras, and TensorFlow*. " O'Reilly Media, Inc."
2) Boden, M. A. (2018). Artificial intelligence: A very short introduction. Oxford University Press.
3) Russell, S. J., & Norvig, P. (2016). Artificial intelligence: a modern approach. Pearson
4) Poole, D. L., & Mackworth, A. K. (2010). *Artificial Intelligence: foundations of computational agents*. Cambridge University Press.
5) Russell, Stuart. "Human-Compatible Artificial Intelligence." (2022): 3-23

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BI 601.1	2	1	1	-	1	1	-	-	2	1	-	2	2	1	-
BI 6012	2	2	1	1	3	1	-	-	2	1	-	2	2	2	-
BI 601.3	2	2	2	2	3	2	-	-	2	2	-	3	2	2	1
BI 601.4	2	2	2	2	3	3	3	3	2	2	3	3	2	2	2

Elective II

COURSE: PERL & BIOPERL

COURSE CODE: BT605 **L T P H C**

MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVE

The objective of the course is to familiarize the Perl programming concepts

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT605.1	Illustrate the application of Perl in bioinformatics and the use of datatypes, arrays and data lists
BT605.2	Perform repetitive tasks using control structures such as if-else, switch, loops etc.
BT605.3	Apply Hash codes to enhance the program output and learn the syntax for basic input output operations
BT605.4	Illustrate various regular expressions for mining and cleaning biological data
BT605.5	Acquire the skills to write scripts and programs to generate functions using subroutines

BT605.6	Apply various Bioperl modules to perform specific biological tasks like sequence similarity search and sequence alignment

PREREQUISITES

Students should be familiar with basic concepts of programming.

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1	**Introduction and Installation**	Introduction to Perl, Use of Perl in Bioinformatics , History, Availability, Support and Basic Concepts	03
	Scalar Data	Data types, variables, scalars, Number, String, String functions, Comments, Escape sequences, Operators and operator types	04
	Arrays and List Data	Introduction, Literal Representation, Variables Array Operators and Functions, Scalar and List context	04
2	**Control Structure**	If-else, switch, last, next, for loop, while loop and do-while loop	05
3	**Hashes**	Hash variables, Literal Representation of hashes, Hash function	05
	Basic I/O	Opening & closing file, reading & writing file, different modes of file.	05
4	**Regular Expressions**	Use of regular expression, Patterns, Matching operators, Substitution, Split and join functions	05
5	**Subroutines**	System and user function, The local Operator, Variable length parameter list	03
6	**Advanced features in Perl**.	Object oriented programming in Perl, Perl DBI, Advanced features in Perl, Advanced functions, operators files and directories System Interaction, Using Perl‟s command line tool, References and Structures, Perl CGI, BioPerl Modules	08
Total Number of Lectures			**42**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	Duration	Marks
First Internal	60 minutes	20
Second Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

PRACTICALS IN PERL & BIOPERL (2 Hrs. Per Week) 50 MARKS

List of Practicals:

1. Installation of Perl and BioPerl.
2. Scripting to understand the scalar data representation.
3. To write scripts using control structures.
4. Write scripts using arrays and lists with
5. Write scripts using hashes with biological example.
6. Write scripts for Basic I/O with biological
7. Writing regular expressions for motifs and
8. Write scripts using subroutines with biological example.
9. Scripting to create and delete directories and

PRACTICAL EVALUATION SCHEME

Examination	Marks
Internal (Continuous) assessment:	20
End semester examination:	30
Total:	**50**

REFERENCES:

1. Bioinformatics – A Practical Guide to the Analysis of Genes and Proteins by Andreas Baxevanis, Francis Ouellette, Wiley-Interscience, 2005.
2. Introduction to Bioinformatics by T. K. Attawood & D.J. Parry-smith, 8th reprint, Pearson education, 2004
3. Bioinformatics: Sequence and genome analysis by D. W. Mount, 2nd edition, CBS Publication, 2005.
4. Fundamental Concepts of Bioinformatics by D. E. Krane and M. L. Raymer, Pearson Publication, 2006.
5. Bioinformatics: Tools & Applications by D. Edward, J. Stajich and D. Hansen, Springer, 2009.
6. Bioinformatics: Databases, Tools & Algorithms by O. Bosu and S. K. Thurkral, Oxford University Press, 2007.

7. Bioinformatics: Methods and Applications - Genomics, Proteomics and Drug Discovery by S.C. Rastogi, N. Mendiratta, P. Rastogi, PHI Learning Pvt. Ltd., 2015.

Matrix for Program Outcome and Program Specific Outcome

	PO 1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 605.1	3	2	1	-	-	1	-	-	1	1	-	1	1	1	1
BT 605.2	3	3	2	-	-	1	-	-	1	1	-	1	2	2	1
BT 605.3	3	3	2	1	-	-	-	-	1	1	-	1	2	2	1
BT 605.4	3	3	2	2	-	1	-	-	3	2	-	2	1	1	1
BT 605.5	3	3	3	2	-	2	-	-	2	2	2	2	3	2	3
BT 605.6	3	3	3	3	3	2	1	2	3	2	2	1	2	2	2

Elective II

COURSE: STRUCTURAL BIOLOGY

COURSE CODE: BT606 **L T P H C**

MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVE

The objective of the course is to familiarize the student with Structural Biology.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT606.1	Outline the potential of bioinformatics in solving biological problems and discuss the hierarchy of secondary and tertiary structures of proteins with various structure prediction and validation techniques
BT606.2	Illustrate RNA secondary structure prediction and determination using various tools and methods
BT606.3	Discuss protein-RNA interactions and illustrate genome annotation and functional genomics
BT606.4	Demonstrate various differential gene expression tools for functional analysis
BT606.5	Explain protein dynamics using various computational methods and algorithms

BT606.6	Explore the secondary structural databases and tools for explaining the functionality of the molecules

PREREQUISITES

Students should be familiar with school level mathematics and Biology to take up this course. In case they do not have mathematics at the twelfth level they should have cleared the core mathematics in the first semester.

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1	Protein sequences, sequence alignment; Basic polypeptide stereochemistry	Overview and scope of Bioinformatics, Computers in biology, medicine & different problems in biology.	02
	Hierarchy in protein folds:.	Secondary structure, tertiary structure; Protein structure determination by X-ray crystallography	05
	Principles of protein purification, crystallization, structure determination; Structure validation and best practices on the use of protein structures from the protein data bank; Protein fold-function relationships; structure and annotation.	protein purification, crystallization, structure determination Methods, Structure function relationship.	03
2	Tools and methods for structure prediction	Homology Modeling, Fold (Threading) prediction, Ab-initio method of structure prediction, Deep learning methods.	02
3	Protein ~~R~~NA interaction and functional Analysis	Understanding Protein-~~R~~**Nucleic Acid** complexes; Specific and non-specific interaction DNA-Protein and DNA-drug interaction	04
4	Gene to structure functional analysis	Conformation of DNA and RNA	03
5	Protein Dynamics	Protein functional dynamics, Protein dynamics studies by MD simulations;	02
	Protein dynamics by NMR;	Basic NMR techniques	03
	Protein dynamics studies by other biophysical techniques.	Computational Methods and Algorithms	03

6	Introduction to structural Bioinformatics.	Structure database and tools	03
Total Number of Lectures			**45**

METHODOLOGY

The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
First Internal	60 minutes	20
Second Internal	45 minutes	15
Attendance		5
End Semester Exam	2 hours 30 minutes	60
Total		**100**

REFERENCE BOOKS

1. Biophysics – An Introduction by Cotterill, Wiley Student Edition.
2. Foundations of Biophysics by A.L. Stanford, Academic Press.
3. Principles of protein structure by G Schulz and R H Schrimer, Springer Verlag.
4. Principles of nucleic acid structure by Sanger, Springer Verlag.
5. Introduction to Protein Science by Arthur M Lesk, Oxford University Press.
6. Biological Spectroscopy by J. D. Campbell and R. A.Dwek, Plenum Press.
7. A Textbook of Biochemistry and Biophysics by S.M Gopinath, Archers & Elevators International Publishing House, India. 1st Edition, 2014.

PRACTICAL IN STRUCTURAL BIOLOGY (2 Hrs. Per Week) MARKS: 50

List of Practicals:

1. Understanding Protein structures and Visualization
2. Drawing helical wheel for alpha helix
3. Using Rasmol and PyMOL for 3-D visualization
4. Analysis of protein-protein interaction and protein-DNA interaction
5. Advanced PyMOL usage
6. Use of PDBsum for structural analysis

7. Protein-Ligand interactions: LIGPLOT
8. Secondary structure prediction methods
9. PROSITE - Protein signature patterns
10. RNA secondary structure visualization

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Internal (Continuous) assessment	20
End semester examination:	30
Total:	**50**

References:

1) Introduction to Protein Structure, Carl Branden and John Tooze, Garland Publishing Inc., New York 29.
2) Bioinformatics: sequence and Genome Analysis, DW Mount, Cold Spring Harbor Laboratory Press, 200 30. Creighton T.E. ed.
3) Protein structure. A practical approach. (2004) Oxford University Press

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 606.1	2	2	2	1	2	-	-	-	1	2	-	1	2	2	1
BT 606.2	2	2	3	2	1	-	-	-	2	2	-	1	2	2	1
BT 606.3	3	2	3	2	2	2	1	1	2	1	2	1	2	2	2
BT 606.4	3	3	3	2	2	2	1	2	2	2	2	2	2	2	3
BT 606.5	2	3	3	3	3	1	1	1	2	2	1	2	2	2	2
BT 606.6	3	3	3	3	2	2	1	2	2	3	2	2	1	1	1

COURSE: INDIAN KNOWLEDGE SYSTEM: INDIAN CONSTITUTION AND LAW
COURSE CODE: BTIKS601 **L T P H C**
MARKS: 50 (Theory 50) **1 0 0 0 1**

OBJECTIVE

The objective of the course is to provide the students an introduction of Indian Constitution, its basic constituents and overview on the legal system in this country

COURSE OUTCOME:

CO No.	**At the end of the course, the learner should be able to:**
BTIKS601.1	Recognize the importance, sources, structure and principles of Constitution of India

BTIKS601.2	Comprehend the composition and powers of Parliament and State Legislatures
BTIKS601.3	Know the significance of local governance.
BTIKS601.4	Appreciate the structure and roles of judiciary in India

PREREQUISITES

Any student who has passed the Intermediate/ISC Class-XII/AISSE of CBSE or equivalent examinations in India or abroad.

COURSE DESCRIPTION

Unit	Topics	Detailed syllabus	No. of Lectures
1	**Introduction to the Constitution of India**	The Constitution of India and the Preamble. Sources and features of Indian Constitution. Citizenship, Fundamental Rights and Duties Directive Principles of State policy. Concept of Federalism, Federalism in India: Relationship between Central and State Governance. The three pillars of Indian Governance: Parliament, Executive and Judiciary. Roles of Election Commission in India.	3
2	**Union Government and it administration**	Legislature: Lok Sabha, Rajya Sabha, and their powers and roles. Executive: Appointments, powers and roles of President, Vice-President, Prime Minister and Council of Ministers. Introduction to civil services in India. Judiciary: Authorities and roles of the Supreme Court and the High Court.	3
3	**State Government and it administration**	Legislative Assembly, Legislative Council, their control and functions. Appointments, powers and roles of Governor, Chief Minister and Council of Ministers of the State.	3
4	**Local Governance in India**	Evolution of Local Governance in India. Composition of District Administration, their authorities and roles. Importance of Municipalities. Panchayati Raj: Composition and their functions, 73rd and 74th Amendments in the Constitution of India, importance of Zilla Parishad, Panchayat Samiti and Gram Panchayat.	3
5	**Indian Legal System**	Jurisprudence, its evolution and types (in brief). History and significance of legal systems in India. Basics of Indian laws and their types. Enactment of laws, Law commission in India Alternate Dispute Redressal. Personal and International laws in India.	3
Total Number of Lectures			**15**

METHODOLOGY

The course will involve the conduct of a series of lectures to understand the various aspects of Constitution of India and an overview on the laws of the land.

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hour 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

REFERENCES:

1) Durga Das Basu, Introduction to the Constitution of India, Gurgaon; LexisNexis, 2022 (26th edn.).

2) M.V.Pylee, India's Constitution, New Delhi; S. Chand Pub., 2017 (16th edn.).

3) J.C Johari, Indian Government and Politics, Shaban Lal & Co., 2012.

4) R. Bhargava, (2009) 'Introduction: Outline of a Political Theory of the Indian Constitution', in R. Bhargava (ed.) Politics and Ethics of the Indian Constitution, New Delhi: Oxford University Press.

5) Bidyut Chakrabarty & Rajendra Kumar Pandey, Indian Government and Politics, SAGE, New Delhi, 2008.

6) G. Austin, The Indian Constitution (OIP): Cornerstone of a Nation, Oxford, Oxford University Press, 1999.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTIKS601.1	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BTIKS601.2	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BTIKS601.3	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-
BTIKS601.4	-	-	-	-	-	1	-	-	-	-	-	1	-	-	-

COURSE: FOREIGN LANGUAGE

COURSE CODE: BTSEC601 **L T P H C**

MARKS: 50 (Theory 50) **2 0 0 2 2**

OBJECTIVE

To develop students' proficiency in speaking, reading and writing in foreign language. Additionally to help promote communication across linguistic barriers, enhance cultural awareness and widen the horizon for future endeavors.

DESCRIPTION

The students are given an option to choose any one from the languages - German/ French/ Japanese/ Korean/ Spanish for the offline course. Two of the most favored languages among these are considered for the offline course, while the students are free to opt for any other language through the online MOOCs, provided it fits in the semester tenure.

At the end of the semester the students need to earn a certificate on the basis of which they will be given credits out of two.

COURSE: APTITUDE BUILDING-VI

COURSE CODE: BTAEC601	**L**	**T**	**P**	**H**	**C**
MARKS: 50 (Theory 50)	**0**	**0**	**2**	**2**	**1**

OBJECTIVE

1. Help to trigger the students' logical thinking skills and apply it in the real-life scenarios
2. Learn to deploy the strategies of solving quantitative ability problems
3. To expand the verbal ability of the students
4. Assist to run the gamut of employability skills

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC601.1	Proficiency development in interacting and using decision making models effectively
BTAEC601.2	Comprehend the given concepts expressly to deliver an impactful presentation
BTAEC601.3	Acquire a knowledge of solving quantitative aptitude and verbal ability questions effortlessly
BTAEC601.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr no.	Practical/Training/Tests/Interviews	Contact Hours
1	Logical Reasoning puzzles - Advanced	02
2	Logical connectives, Syllogism and Venn diagrams	02
3	Permutation, Combination and Probability - Advanced	04
4	Quantitative Aptitude	06
5	Image interpretation	02
6	Critical Reasoning - Advanced	02
7	Genome, transcriptome and proteome analysis	02
8	Market Survey/Market Intelligence	02
9	Bioindicators	02
10	Competitive Examination Preparation	02
11	Mock Interviews	02
12	Discussion session-Industry Experts/Academia Experts/Alumni	02
	TOTAL	**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Marks**
Internal (Continuous) Assessment	20
Assignments/Practical/Training/Tests/Interviews	30
Total	**50**

REFERENCES:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing

2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.

3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC601.1	-	2	2	1	2	-	-	-	-	1	1	2	2	-	-
BTAEC601.2	1	1	1	-	-	-	-	-	-	1	-	1	1	-	-
BTAEC601.3	1	1	1	-	2	-	-	-	-	2	-	1	1	-	-
BTAEC601.4	1	1	1	-	1	-	-	-	-	1	-	1	1	1	-

SEMESTER VII						
Course Code	**Course Name**	**L**	**T**	**P**	**Hr**	**Cr**
BI701	Molecular Modeling	2	0	4	6	4
BT701	Nanobiotechnology and Biosensors	2	0	2	4	3
HU701	Principles of Management & Entrepreneurial Development	2	0	0	2	2
HU702	Quality Control Management in Biotechnology	2	0	0	2	2
BT702	Seminars in Biotechnology	2	0	0	2	2
BT 703/BT704/ BT705	**Elective-III** BT703 Metabolic Engineering BT704 Agriculture Biotechnology BT705 Cancer Biology	3	0	2	5	4
BTAEC701	Aptitude Building-VII	0	0	2	2	1
Total		**13**	**0**	**10**	**23**	**18**

COURSE: MOLECULAR MODELING
COURSE CODE: BI701 **L T P H C**
MARKS: 150 (Theory 50+Practical 100) **2 0 4 6 4**

OBJECTIVES:

This course gives detailed information on the basics, recent advances, and various applications of molecular modeling and drug designing.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BI701.1	Explain molecular modelling and relate the concepts of mathematics such as matrices and coordinates in computational representation and calculation of molecular properties
BI701.2	Illustrate various molecular file formats
BI701.3	Acquire the concepts of molecular and quantum mechanics including dynamics, and discuss energy minimization algorithms
BI701.4	Design novel lead molecules and optimize existing drugs using structure and ligand based drug designing approaches

PREREQUISITES:

This is an introductory course for the students who want to understand the concepts in molecular modeling and drug designing and should make a compulsory subject.

COURSE DESCRIPTION

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction to Molecular modeling and chemoinformatics	History, importance and application	01
	Molecular Graphics Representation	Representation of molecules using co-ordinates, Matrices and tables	06
	Building of molecules	Building of small molecules, Building of Biopolymers DNA & oligopeptides in different secondary structure	02
2	File Formats	SMILES, mol, mol2, sdf, pdb etc.	04
3	Energy Calculation (Molecular Mechanics and Quantum Mechanics)	Energy calculation using force fields and Schrodinger equations	04
	Geometry Optimization	Energy minimization by systematic search Method, Gradient based Energy minimization, Monte Carlo method, Genetic algorithm and simulated annealing. Molecular Dynamics	04
4	Ligand based drug design techniques	2D and 3D QSAR, Pharmacophore	06
	Structure based drug design techniques	Docking and Pharmacophore	03
Total Number of lectures			**30**

METHODOLOGY:

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hour 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICAL IN MOLECULAR MODELING & DRUG DESIGNING (4 Hrs. Per Week)
Marks: 100
List of Practicals:

1. Generating Rastor and Vector Graphics file and its importance
2. Extraction and Visualization of Macromolecules from database (Proteins & DNA) using Pymol
3. Extraction and Visualization of Macromolecules from database (Proteins & DNA) using Discovery Studio.
4. Extracting Small molecular structures from Databases by similarity Searching
5. Generating small Molecules using Fragment Library
6. Generating small molecules using drawing tools available in the software
7. Studying the protein databank file format
8. Preparation and study of different small molecular file formats
9. Studying the 2D and 3D file formats.
10. Calculation of total energy of the molecules
11. Generation of molecular conformations: Energy Minimization
12. Comparison of energies of a molecule obtained from various sources.
13. Calculation of Molecular Properties.
14. Protein and Ligand Preparation for Docking
15. Studying Protein-ligand interaction through Docking

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Continuous assessment	40
End semester examination	60
Total:	**100**

REFERENCES:

1. Engel, T. & Gasteiger, J. (2018). Applied Chemoinformatics: Achievements and Future Opportunities. Wiley,.
2. Engel, T. & Gasteiger, J. (2018). Chemoinformatics: Basic Concepts and Methods. Wiley .
3. Brown, N. (2016).In Silico Medicinal Chemistry, . RSC Publishing.
4. Wild, D. (2013),Introducing Cheminformatics. LuLu.
5. Faulon, J. L. & Bender, A. (2010).Handbook of Chemoinformatics Algorithms. CRC.
6. Leach, A.R. & Gillet, V. J. (2003), An Introduction to Chemoinformatics. Springer.
7. Engel, T. & Gasteiger, J. (2003). Chemoinformatics: A Textbook. Wiley.
8. https://www.youtube.com/watch?v=tFHBQJFic9Q
9. http://www.mrc-lmb.cam.ac.uk/rlw/text/MacPyMOL_tutorial.html
10. Chemoffice Tutorial 2004
11. https://sites.ualberta.ca/~pwinter/Molecular_Docking_Tutorial.pdf
12. Practical Chemoinformatics, Karthikeyan Muthukumarasamy, Vyas Renu, Springer 2014

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BI 701.1	3	3	1	-	1	-	-	-	2	2	-	2	3	1	1
BI 701.2	1	2	-	-	2	1	-	-	1	1	-	2	1	1	1

BI 701.3	3	1	3	2	3	1	3	2	1	3	1	3	2	2	2
BI 701.4	2	2	2	2	2	2	1	1	1	2	2	3	1	1	1

COURSE: NANOBIOTECHNOLOGY & BIOSENSORS

COURSE CODE: BT701 **L T P H C**

MARKS: 100 (Theory 50+Practical 50) **2 0 2 4 3**

OBJECTIVES:

The objective of the course is to familiarize the students with advanced research area and basic concept in Nanobiotechnology and Biosensors

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT701.1	Comprehend the basics of nanobiotechnology, nanomaterials and nanoparticles
BT701.2	Demonstrate the knowledge of nanobiotechnology in various fields such as medicine, drug encapsulation, drug delivery and other applications
BT701.3	Explain the construction and designing of various types of biosensors
BT701.4	Describe the different applications of biosensors in various fields such as health care, agriculture and environment

PREREQUISITES:

Since it is advance course, student should be familiar with basic knowledge of physics, chemistry, and biology.

COURSE DESCRIPTION*:*

Unit	Topic	Detail Syllabus	No. of Lectures
1	Introduction to Nanobiotechnology	-Nanotechnology and nanobiotechnology, History, -Broad perspective, and Today's World, -Significance of Nanoscale materials.	03
	Nanomaterials and nanoparticles	-Different classes of nanomaterials - Synthesis and characterization of nanomaterials - One, two, and three dimensional structure of nanomaterials - Bio-mimetics	06
2	Application of Nanomaterials in medicine	-Drug delivery -Drug encapsulation -Tissue repair and implantation -Nanocoatings - Miniaturized devices/ Lab on a chip Toxic effects of nanomaterials	05
3	Biosensors: General Concepts	-Introduction to biosensors -History of biosensors discovery	02
	Construction and designing of biosensors	- Components of a typical biosensor - Types of biosensors (Calorimetric, Potentiometric, amperometric, optical, Piezo-electric, Immuno based sensors)	05
4	Applications of biosensors	-Associated electronics with each category of biosensor - Applications related to healthcare, bio-defense, food and water safety, agriculture and environment	06

4	Case studies	-Success and failure of Nanodevices and biosensors with suitable examples -Multidisciplinary interactions for biosensor development	03
Total Number of Lectures			**30**

METHODOLOGY:

The course would be taught through lectures and practical.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
Internal*	45 minutes	15
Attendance		5
End Semester Exam	1 hour 15 minutes	30
Total		**50**

*Average of Internal I (15 marks) and Internal II (15 marks)

PRACTICAL IN NANOBIOTECHNOLOGY AND BIOSENSORS: 2 hours per week Marks: 50

List of Practicals:

1. Preparation of silver nanoparticles using sodium borohydride
2. Green synthesis of silver nanoparticles using bacteria/plant/fungi
3. Characterization of nanomaterials using Scanning Electron Microscopy.
4. Evaluation of antimicrobial activity of silver nanoparticles against Gram Positive and Gram negative microorganisms
5. Increasing bioavailability of drugs using nanostructured Beta-cyclodextrin
6. Entrapment of silver nanoparticles in alginate beads for remediation of water.
7. Study of principle and working of glucose biosensor
8. Study of conductivity of DNA for use in biosensor
9. Internalization of drug conjugated nanoparticles in mammalian cells
10. Study of nano-structured materials used for tissue engineering

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Internal (Continuous) assessment:	20
End semester examination:	30

Total: **50**

REFERENCES:

1. Biosensors and Nanotechnology, (Editors; Zeynep Altintas) John Wiley & Sons Inc, 2017, ISBN: 9781119065159, 9781119065159
2. Biosensors and Bioelectronics: D. Dharaneeshwara Reddy, O.M Hussain, DVR. Sai Gopal, Muralidhara Rao, and K.S Sastry. I. K International Publishing House Pvt. Ltd, New Delhi. ISBN 978-93-82332-19-0, Year?
3. C. M. Niemeyer, "Nanobiotechnology: Concepts, Applications and Perspectives", Wiley – VCH, 2006
4. David S Goodsell, "Bionanotechnology", John Wiley & Sons, 2004
5. Understanding Nanomedicine: An Introductory Textbook, Rob Burgess, Publisher: Pan Stanford Publishing; ISBN-13: 978-9814316385, year?
6. Introduction to Nanoscience, S.M. Lindsay, Oxford universal Press, First Edition, 2010 Nanotechnology: Understanding small system, Ben Rogers, SumitaPennathur and Jesse Adams, CRC Press, Second edition, 2011
7. Nanobiotechnology: Bioinspired Devices and Material of Future by Oded Shoseyov and Ilan levy, Human Press, First edition, 2007. The Nanobiotechnology Handbook (Editor; Yubing Xie) CRC press.

8. *Journal of Radiation Research and Applied Sciences*. 2016 9 (1):1-7

9. *Journal of Radiation Research and Applied Sciences.2016,9(3):217-227*

10. Bridging the Gap. *Current Drug Discovery Technologies*, 2014, *11,* 197-213

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 701.1	2	1	-	-	-	-	1	3	2	1	-	3	2	-	-
BT 701.2	3	3	3	3	-	3	2	3	2	-	3	3	2	2	-
BT 701.3	3	3	3	2	3	2	3	3	3	1	2	3	2	2	2
BT 701.4	3	3	2	3	3	3	3	2	2	1	2	3	2	2	3

COURSE: PRINCIPLES OF MANAGEMENT AND ENTREPRENEURIAL DEVELOPMENT
COURSE CODE: HU701 **L T P H C**
MARKS:50 (Theory 50) **2 0 0 2 2**

OBJECTIVES:

- Make students understand the work culture in an organization
- Preparing them to be competent in the corporate world
- Motivate students to critically analyse the problem and solve it
- Apply the knowledge of management in their future endeavour

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
HU701.1	Comprehend basic principles of management, including planning, organizing, leading, and controlling
HU701.2	Develop leadership, problem-solving, and decision-making skills that are valuable in various aspects of business
HU701.3	Develop an entrepreneurial mindset, innovation, and a willingness to take calculated risks, which are crucial for aspiring entrepreneurs
HU701.4	Demonstrate versatile abilities such as understanding financial concepts, business ethics, and social responsibility

PREREQUISITE:
This is an application based and management learning course, so students must have an understanding of the application oriented subject such as Food Biotechnology, rDNA Technology, Plant Biotechnology, Cancer Biology, Pharmaceuticals and Drugs research.

COURSE DESCRIPTION*:*

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Principles of Management	Introduction to Management- Management and Manager Definition, Purpose of Management, Management function, Manager Role in Management, Levels of Management	4
		Planning - Nature of planning, Importance of Planning Planning Process, Barriers to effective planning	5

		Forecasting - Importance of Forecasting, Limitations of forecasting, Techniques of Forecasting	
		Organising - Concept of Organising, Advantages of Organising, Need for organising structure Directing - Concept of Directing, Principles of Directing Leadership - Importance of Leaders, Leadership theories (Trait, Behavioural, Situational) Controlling - Importance of controlling, Controlling Process.	6
2.	Entrepreneurial Development	Preparation of Business plan for Biotech Start-up Importance of Licensing Technology/Research Raising money from Venture Capitalists Government Grants	4
		Human Resources management - Definition, Functions and Objectives, Image and qualities of HR Manager Customers and Competitors Marketing - Introduction to Marketing Management, Role and Function of Marketing Manager.	6
		Current challenges in an Organization Diverse and Global work force Partnerships and Strategic Alliances	5
Total Number of Lectures			**30**

METHODOLOGY:

The course would be covered through lectures, supported by quizzes and case history discussion.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
I Internal	45mins	15
Teachers assessment		05
End Semester Exam	1hr 15mins	30
Total		**50**

REFERENCES:

1) Principles and Practice of Management - by L M Prasad, 9th Edition, 2016
2) Principles of Management - by P C Tripathi and P N Reddy, 6th Edition, 2017.
3) A Handbook on Marketing Management - by Dr V O Varkey, 4th Edition, 2000.
4) Human Resource and Personnel Management- by K Aswathappa, 4th Edition, 2007

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HU 701.1	-	-	-	-	-	2	-	-	2	1	2	2	2	1	-
HU 701.2	-	-	-	-	-	2	-	-	3	1	1	1	1	2	-
HU 701.3	-	2	2	2	1	2	-	2	2	1	2	2	2	1	-

HU 701.4	-	-	-	-	-	2	2	3	1	1	2	2	2	2	2

COURSE: QUALITY CONTROL MANAGEMENT IN BIOTECHNOLOGY
COURSE CODE: HU702 **L T P H C**
MARKS: 50 (Theory 50) **2 0 0 2 2**

OBJECTIVES:

- Make students realise the importance of Quality control in Pharma and biotech industry
- Prepare students competent in the field of quality control management of drugs and biopharmaceutical
- Create a general motivation amongst students to critically analyse the problem and to apply the knowledge of quality management in their future endeavour.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
HU702.1	Comprehend and apply various quality management systems of national and international importance.
HU702.2	Manage comprehensive records and documentation to track and verify the quality of products as per the principles of various Quality Management systems including GMP, GLP and NABL
HU702.3	Develop awareness of ethical considerations as defined by various national and international bodies to be able to comply and ensure the safety & efficacy of biotechnological products in research and industry
HU702.4	Acquire capability to formulate and implement quality assurance systems and processes, ensuring that products meet regulatory and industry standards as per the governing body of biotechnology industry

PREREQUISITE:
This is a unique course comprising the combination of research, industry and management, so students should have understanding of all the basic concepts in biotechnology and should be well aware with the working and functioning of the biotech and pharma based industries.

COURSE DESCRIPTION:

Unit	Topic	Detail Syllabus	No. of Lectures

1	Quality Management	Introduction, Definition of Quality, Evolution of Quality, Dimension of Quality, Factors affecting Quality, Definition of QA/QC.	2
	TQM	Definition of TQM, History of TQM, Concept, Principles of TQM, TQM Framework, Barriers in TQM implementation, Benefits of TQM, Statistical tools to measure quality, Demings Cycle/PDCA cycle, Quality Movement in India.	4
2	Pharmacopoeias	Overview of the latest Indian Pharmacopoeias.	1
	Standards Institutions	ISO 9000 Series, ISO 14000 Series, ISO 22000 Series, ISO 13485 Series, Bureau of Indian Standards (BIS).	6
	Good Manufacturing Practice (GMP) for pharmaceutical Products (API)	Pharmaceutical Manufacturing Flow Chart study, GMP Implementation at - Personnel, Building and Facility, Process Equipment, Material management, Production and in-process control, Packaging and labelling, Storage and Distribution, Laboratory control, Validation of analytical procedure, Rejection and Reuse of material, Complaints and recalls, Agents, Brokers, Distributors and Re-labellers, Documentation and Records.	8
	Good Laboratory Practices(GLP) and SOP	GLP - History, GLP implementation and organization, GLP status in India. Standard Operating Procedure - Introduction, Need and Implementation.	3
3	ICH	Introduction and ICH Process for Harmonization.	3
4	Indian Regulatory Agencies and Accreditation	Central Drug Standard Control Organization (CDSCO) for Drugs. Food Safety and Standards Authority of India (FSSAI) for Food. National Accreditation Board for Testing and Calibration Laboratories (NABL).	3
Total Number of Lectures			**30**

METHODOLOGY:

The course would be covered through lectures, supported by quizzes and case history discussion.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**

I Internal	45mins	15
Teachers assessment		05
End Semester Exam	1hr 15mins	30
Total		**50**

BOOKS RECOMMENDED

1. Quality control assurance by T. Anjaneyulu, First Edition(Fifth Reprint) - 2017
2. Pharmaceutical management by Sachin Itkar, Second Edition - 2007
3. Pharmaceutical Master Validation Plan by Syed Imtiaz Haider, First Indian Edition - 2001
4. Biopharmaceuticals Second Edition by Gary Walsh, Second Edition -2011

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
HU 702.1	1	1	-	-	1	-	1	2	2	1	1	1	2	1	-
HU 702.2	2	2	-	-	1	-	2	3	2	1	2	2	2	2	-
HU 702.3	1	1	-	-	-	2	1	3	1	1	1	2	2	2	-
HU 702.4	2	2	2	2	2	3	2	2	1	2	2	2	2	2	1

COURSE: SEMINARS IN BIOTECHNOLOGY

COURSE CODE: BT702 **L T P H C**

MARKS: 50 **2 0 0 2 2**

OBJECTIVES OF THE COURSE:

- To train the students for literature survey
- To understand and present a particular topic, published research work in front of an audience
- To develop capability and potential to discuss, delineate a topic precisely, professionally in an interactive manner

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT702.1	Examine specific topics that can provide insights into the most recent developments in medicine, food, agriculture and different areas of biotechnology
BT702.2	Evaluate research information and appreciate how strategies are developed to address specific scientific questions
BT702.3	Develop critical thinking and scientific temper
BT702.4	Demonstrate presentation skills, communication abilities, and confidence in sharing their work with a broader audience
BT702.5	Examine different viewpoints and approaches in biotechnology to broaden knowledge horizons
BT702.6	Acquire knowledge in developing ideas, projects and their own research questions

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT 702.1	2	1	-	-	-	-	-	2	2	1	-	2	2	1	-
BT 702.2	2	1	-	-	-	-	-	2	2	2	-	2	2	2	-
BT 702.3	2	2	1	-	-	-	-	2	2	2	-	3	2	2	-
BT 702.4	2	2	-	-	-	1	-	2	2	3	2	3	2	2	-
BT 702.5	2	2	-	-	-	-	-	-	2	1	-	2	2	2	2
BT 702.6	2	2	2	2	3	2	2	1	2	2	2	3	3	3	2

Elective III
COURSE: METABOLIC ENGINEERING

COURSE CODE: BT703 **L T P H C**

MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVES:

- The course will provide an overview of the basic concepts and experimental techniques used in metabolic engineering and its applications in production of useful compounds of industrial importance.
- The students will also learn that how complex regulatory mechanisms at multiple levels control the dynamics of the cellular metabolism.
- The course will also cover examples of successful engineering strategies used for the production of commercially important primary and secondary metabolites or recombinant proteins.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT703.1	Explain the basic concepts of metabolic engineering, cellular reactions, enzyme kinetics and their regulation
BT703.2	Discuss strain-engineering strategies to alter cellular behaviour, metabolic flux and product formation
BT703.3	Analyse the methods for metabolic flux determination
BT703.4	Illustrate different pathways for the production and regulation of metabolites, and techniques for strain improvement
BT703.5	Plan the application of pathway databases in metabolic engineering
BT703.6	Comprehend various industrial applications of metabolic engineering in the fields of medicine, energy, and environment

PREREQUISITES:

Students should be familiar with basic concepts of biochemistry, metabolism and bioinformatics.

COURSE DESCRIPTION:

Unit	Topics	Detailed syllabus	No. of Lectures
1	Introduction to metabolic engineering and its importance	Introduction to metabolism, catabolism, anabolism. Basic concepts of metabolic engineering. Key differences between metabolic controls of prokaryotes and eukaryotes. Stoichiometry of cellular reactions, enzyme kinetics, reaction rates, dynamic mass balance, yield coefficients and linear rate equations, different models for cellular Reactions, Induction, Jacob Monod Model and its regulation, differential regulation by isoenzymes, concerted or cumulative	12

		feedback regulation. Regulation in branched pathways, permeability and transport of metabolites.	
2	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.	08
3	Experimental determination of metabolic fluxes.	C13 labeling, NMR and GC-MS based methods for flux determination.	04
4	Computational study of metabolic engineering.	Understanding and exploring various metabolic pathways such as KEGG, BRENDA, Reactome, DAVID, STRING.	05
5	Metabolic pathway models	Network pharmacology and its application in finding important targets in a pathway.	05
6	Industrial applications of metabolic engineering.	Pathway engineering strategies for overproduction of some commercially important primary and secondary metabolites (e.g. amino acids, organic acids, alcohols and therapeutic compounds) 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.	08
Total Number of Lectures			**42**

METHODOLOGY:
The course will be covered through lectures and supported by practical.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 minutes	15
Attendance		05
End Semester Exam	02 hours 30 minutes	60
Total		**100**

PRACTICAL IN METABOLIC ENGINEERING: 2 Hrs. Per Week MARKS: 50

List of Practicals:

1. Expression of metabolic enzymes in bacterial systems for metabolite engineering.
2. Effect of different parameters such as substrate concentration on metabolite expression.
3. Isolation and purification of industrially relevant metabolic enzymes.
4. Validation of enzyme expression and its effect on metabolic changes.

5. Extraction of Genes from KEGG
6. Screening of pathways getting affected by administration of drugs
7. Generate interaction map using list of genes
8. Exploring Cytoscape for representing a network.
9. Finding Hub Genes

PRACTICAL EVALUATION SCHEME

Examination	**Marks**
Continuous assessment:	20
End semester examination:	30
Total:	**50**

REFERENCES:

1. Metabolic Engineering: Principles and Methodologies by Gregory N. Stephanopoulus, Aristos A. Aristidou, and Jens Nielsen, Academic Press, 1998.
2. Pathway Analysis and Optimization in Metabolic Engineering by Néstor V. Torres and Eberhard O. Voit, Cambridge University Press, 2002.
3. The Metabolic Pathway Engineering Handbook: Fundamentals by Christina D. Smolke, CRC Press, 2009.
4. The Metabolic Pathway Engineering Handbook: Tools and Applications by Christina D. Smolke, CRC Press, 2009.
5. Biochemical Engineering by Harvey W. Blanch and Douglas S. Clark, Marcel Dekker, 1995.
6. Synthetic Biology – Metabolic Engineering by Huimin Zhao, An-Ping Zeng, Springer 2018.
7. Metabolic Engineering for Bioactive Compounds: Strategies and Processes by Vipin Chandra Kalia, Adesh Kumar Saini, Springer 2017.
8. Metabolic Engineering by Sang Yup Lee and Eleftherios T. Papoutsakis, Marcel Decker 1999.
9. The Metabolic Pathway Engineering Handbook: Tools and Applications by Christina D. Smolke, CRC Press, 2009.
10. https://www.kegg.jp/
11. http://mousecyc.jax.org/
12. https://reactome.org/

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT703.1	3	2	3	-	-	-	-	-	2	3	-	2	1	1	1
BT703.2	1	2	3	3	3	2	2	2	2	1	-	3	1	1	1
BT703.3	2	2	3	3	3	2	2	2	2	2	-	3	1	1	1

BT703.4	1	2	3	3	3	2	2	3	3	2	2	3	1	3	2
BT703.5	3	3	3	3	3	2	1	1	2	2	1	2	3	3	3
BT703.6	2	2	2	2	2	1	2	2	2	2	1	2	3	3	3

Elective III
COURSE: AGRICULTURE BIOTECHNOLOGY
COURSE CODE: BT704 **L T P H C**
MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVES:

- To familiarize the students with basic concepts of Agriculture Biotechnology
- To clarify major scientific, ecological and sociological aspects of biotechnology in agriculture and food production.
- To familiarize advanced molecular biology applications in Agriculture Biotechnology

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT704.1	Comprehend aspects of biotechnology in agriculture and its application in *in vitro* plant production
BT704.2	Apply different techniques for crop improvement using genetic engineering
BT704.3	Apply recent techniques for plant genotyping
BT704.4	Discuss various methods for production of secondary metabolites, pharmaceutically and commercially important proteins, edible vaccines and therapeutics
BT704.5	Devise strategies for manufacturing of biofertilizers, biopesticides and other plant products
BT704.6	Explain the significance of biotechnology in hydroponics and animal farming; ethical considerations in the development of genetically and its application to develop genetically modified products

PREREQUISITES:
The course is an application science, hence the student must have a background with knowledge in the basics of Plant Physiology, Plant Tissue culture and Molecular Biology.

COURSE DESCRIPTION:

Unit	Topics	Particulars	No. of Lectures
1	Introduction	Introduction: Agriculture and Agricultural Biotechnology	2
	Aspects of Plant production	*In vitro* Germplasm Conservation Micro propagation *In vitro* production of pathogen and/or disease-free plants	2 2 2

2	Techniques for Crop Improvement	Biotechnology- Methods of Crop Improvement Genetic Engineering for Crop Plants Improvement. Methods of gene transfer in plants, Transgenic Plants for biotic and abiotic stress resistance, *In vitro* induced mutagenesis Role of antisense and RNAi in crop improvement, Regulated and tissue specific expression of transgenes for crop improvement, Terminator gene technology	3 3 5
3	Techniques for Plant Genotyping	Recent advances – Non gel based techniques for plant genotyping – Homogenous assays – Qualitative/Real Time assays; DNA Chip and its technology. Molecular breeding (MAS) Transgenic Plants, Molecular Markers, QTL Mapping	3 3 3
4	Methods for production of plant metabolities	*In vitro* Production of Secondary Metabolites Production of foreign compounds in transgenic plants Molecular Pharming, Production of Edible vaccines and other therapeutics, Biotransformation	5
5	Strategies for manufacturing plant products	Biofertilizers and Phyto-remediation Biopesticides, Agricultural antibiotics	5
6	Modern techniques and it ethical aspects	Biotechnology in Agriculture, Hydroponics, Biosafety regulations, Ethical Aspects and Public Acceptance (Case studies)	3
		Animal farming, Animal farming with organic concept, Animal Breeding & Genetically modified animal products.	5
Total Number of Lectures			**45**

METHODOLOGY:

The entire course is covered through lectures, group discussions and with the help of ICT enabled teaching aids including PPTs, visits, E-learning resources etc.

EVALUATION SCHEME (THEORY):

Examination	**Duration**	**Marks**
I Internal	1 hour	20
II Internal	45 minutes	15
Attendance	----	5
End Semester Exam	2 hours 30 mins	60
Total		**100**

PRACTICAL IN AGRICULTURE BIOTECHNOLOGY: 2 hrs. per week Marks:50

List of Practicals:

1. Use of bioreactors in plant secondary metabolite production
2. Application of Polymerase Chain reaction – Marker based selection by using PCR
3. Agro-bacterium-mediated transformation protocol and selection of transformed regenerated plants (Laboratory visit)

4. DNA finger printing methods, RAPD, SSR.

5. Micropropagation, Visit to micro-propagation and Molecular Biology laboratory - a laboratory with automated Genotyping/sequencing facility.

6. Green house technology: Visit to functional green house. Climate: Measurement of temperature, humidity, air velocity, CO2, inside the green house. Calculation of environment indices inside green house. Fertigation, Post-harvest

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Internal (Continuous) Assessment:	20
End semester Examination:	30
Total:	**50**

BOOKS RECOMENDED:

1. Singh, B.D. and Shekhawat N.S. (2017). Molecular Plant Breeding. "Scientific Publishers."
2. Kumar, H. D. (2005). Agricultural Biotechnology "Daya Publishing House."
3. Wang, K. (2010). Agrobacterium Protocols, Volume 1. "Humana Press."
4. Gelvin, S. B. (2018). Agrobacterium Biology- From Basic Science to Biotechnology. "Springer International Publishing."
5. Altman, A. and Hasegawa, P. M. (2012). Plant Biotechnology and Agriculture-Prospects for the 21st Century. "Elsevier Science"
6. Singh, B. D. (2010). Biotechnology. "Kalyani Publishers."
7. Noureddine Benkeblia. (2014). Omics Technologies and Crop Improvement. "CRC Press."
8. Jebaraj G.S. and Pandiyarajan P. (2012). Agricultural Biotechnology. "Agro-Bios 2008, Reprint 2012."
9. Muhammad Abubakar, M., Saeed, A. and Kul,O. (2015). The Role of Biotechnology in Improvement of Livestock: Animal Health and Biotechnology. "Springer."
10. Secondary Metabolism of Hairy Root Cultures in Bioreactors In Vitro Cellular & Developmental Biology. Plant Vol. 38, No. 1 (Jan. - Feb., 2002), pp. 1-10 (10 pages)
11. Polymerase Chain Reaction Technology as Analytical Tool in Agricultural Biotechnology Journal of AOAC International vol. 88, no. 1, 2005
12. *Agrobacterium*- Mediated Plant Transformation: Biology and Applications *bioone.org/journals/the-arabidopsis-book/volume-2017/issue-15*
13. DNA finger printing in plants www.nbpgr.ernet.in Divisions_and_Unit Downloadfile.aspx? EntryId=7432
14. Micropropagation, Genetic Engineering and Molecular Biology of Populas .
15. USDA Forest Service Gen. Tech. Rep. RM-GTR-297. 1997
16. Advances in greenhouse automation and controlled environment agriculture International Journal of Agricultural and Biological Engineering 11(1) January 2018.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT704.1	3	2	3	3	-	-	3	3	3	2	-	3	1	1	1

BT704.2	3	3	3	3	3	3	3	3	3	2	3	3	1	1	1
BT704.3	2	2	3	2	3	2	3	3	3	2	2	3	1	1	1
BT704.4	3	2	3	-	-	-	3	3	3	2	-	3	1	3	2
BT704.5	2	3	3	3	3	3	3	3	3	2	3	3	3	3	3
BT704.6	3	3	3	3	3	3	3	3	3	2	3	2	3	3	3

Elective III
COURSE: CANCER BIOLOGY
COURSE CODE: BT705 **L T P H C**
MARKS: 150 (Theory 100+Practical 50) **3 0 2 5 4**

OBJECTIVES:

- The objective of the course is to develop understanding of the biology of cancer
- The course will elaborate understanding of tumor hallmarks, carcinogens, diagnostic and therapeutic options to cancer patients

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BT705.1	Outline the basic principles of cancer biology, origin and development of cancer
BT705.2	Explain the causes of cancer and its classification based on stages and grades
BT705.3	Analyse molecular drivers like proto-oncogenes, oncogenes and tumor suppressor genes for their roles in cancer development
BT705.4	Evaluate the molecular and cellular mechanisms underlying cancer progression and metastasis
BT705.5	Examine different cancer biomarkers and their diagnostic roles
BT705.6	Discuss different treatment modalities including chemotherapy, immunotherapy and targeted therapies

PREREQUISITES:

Since the course is advance in nature, basic knowledge in biochemistry, cell biology, genetics, and molecular biology is essential.

COURSE DESCRIPTION:

Unit	Topic	Detail Syllabus	No. of Lectures
1.	Introduction to	Cancer statistics and problems at National and International	5

	cancer	perspectives. Origin of cancer cell, Genetic, molecular and epigenetic changes in cancer cells, Tumor hallmarks, Tumor microenvironment.	
2	Cancer progression	Basis of tumour progression, Steps in tumor progression, Cancer stem cell theory for origin of cancer, Classifications, stages and grades of tumors.	6
	Causes of cancer	Chemical carcinogenesis Endogenous & exogenous mutagens, Identification of carcinogens, Tumour initiators & tumour promoters	6
3	Molecular basis of cancer	Aberrant signaling in cancer, Cellular and viral oncogenes (Gain of Function), Deregulated apoptotic genes (Loss of functions), Genomic landscape of cancers, DNA repair response in cancer, Dysregulation of cell cycle and cell growth, mutation in apoptosis genes, The role of viral genes in cancer progression (DNA tumour virus (SV 40) and human papilloma virus (E6 and E7).	5
3	Proto-Oncogenes and Oncogenes	Introduction to Oncogenes families Cell transforming ability of oncogene Retrovirus as a source of cancer Oncogenes: Ras, Myc, Src, Jun and Fos, Controlling factors of oncogene expressions	5
	Tumour suppressor genes	Molecular basis of tumor suppressor genes including Retinoblastoma (Rb), p53, Adenomatous polyposis coli (APC) in the development and progression of tumor.	4
4.	Metastasis	Molecular basis of metastasis, steps in cell invasion, intravasation,	4
		transport, colonization, angiogenesis.	
5.	Cancer biomarkers and diagnostic options	Expanded diagnostic technique, Tumour markers, Nucleic acid based markers and mitochondrial DNA mutation markers, Epigenetic markers including DNA methylation pattern and chromatin remodeling, mitochondrial DNA	4
6.	Cancer therapy	Contemporary chemotherapy, radiotherapy Emerging therapies (Targeted delivery & Synthetic lethal approaches) Inhibitors of oncogenic protein, tumour blood vessels as target for cancer therapy Tumor immunology and cancer immunotherapies	6
Total Number of Lectures			**45**

METHODOLOGY

The entire course is covered through lectures, group discussions and with the help of ICT enabled teaching aids including PPTs, Image, Videos, E-learning resources etc.

EXAMINATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
I Internal	45 minutes	15
II Internal	45 minutes	15
Teachers assessment		10
End Semester Exam	2 hours 30 minutes	60
Total		**100**

PRACTICAL IN CANCER BIOLOGY: 2 hrs. per week Marks:50

List of Practicals:

1. To perform MTT assay for the assessment and understanding of anti-proliferative and cytotoxicity effects using suitable drugs.

2. To study the effects serum starvation in cancer growth and its secreted microenvironment.

3. To observe migration and invasion ~~metastasis and angiogenesis~~ (One of hallmarks of cancer) using Boyden chamber assay.

4. To perform clonogenic assay to understand clonal concept and growth characteristics of cancer cells.

5. To study angiogenesis using chick embryo model.

6. To perform wound healing assay.

7. To study spheroid culture as a preferred model for cancer stem cell ~~angiogenesis~~ study

PRACTICAL EVALUATION SCHEME:

Examination	**Marks**
Internal (Continuous) Assessment:	20
End semester Examination:	30
Total:	**50**

REFERENCES:

1. The Biology of Cancer, 2nd Edition; Author(s): Robert A. Weinberg; Garland Science; 2nd edition (14 May 2013). ISBN: 9780815342205.
2. Molecular biology of the cell, Garland Science; 5th edition (November 16, 2007), By Bruce Alberts (Author), Alexander Johnson (Author), Julian Lewis (Author), Martin Raff (Author), Keith Roberts. ISBN-10: 0815341059, ISBN-13: 978-0815341055.
3. Cancer Biology, 4 edition (10 May 2007) By Raymond W. Ruddon, Oxford University press,

ISBN-10: 0195096908
4. Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
5. Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
6. Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
7. Weinberg, R.A. The Biology of Cancer. Second Edition. 2013. Garland Science.
Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
8. Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.
9. Dai Y, Grant S. 2011. Methods to study cancer therapeutic drugs that target cell cycle checkpoints. Methods Mol Biol. 2011;782:257-304. doi: 10.1007/978-1-61779-273-1_19.
10. Pecorino L. Molecular Biology of Cancer: Mechanisms, Targets, and Therapeutics. Third Edition. 2012. Oxford University Press.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BT705.1	1	3	2	-	-	-	-	-	1	1	-	3	1	1	1
BT705.2	1	3	2	2	-	1	-	-	1	2	1	2	1	1	1
BT705.3	1	2	2	3	2	1	2	1	1	1	2	2	1	1	1
BT705.4	1	2	2	2	3	1	1	1	1	1	2	3	1	3	2
BT705.5	1	3	3	3	3	1	1	1	1	2	2	3	3	3	3
BT705.6	1	2	3	3	3	3	1	2	1	1	2	3	3	3	3

COURSE: APTITUDE BUILDING-VII

COURSE CODE: BTAEC701 **L T P H C**

MARKS: 50 (Theory 50) **0 0 2 2 1**

OBJECTIVE

- Brush up of all the concepts of Aptitude & Life Skills
- Give students the confidence for their placements & future career opportunities

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTAEC701.1	Acquire a knowledge of solving quantitative aptitude, reasoning and verbal ability questions effortlessly.
BTAEC701.2	Develop demonstrable hard skills
BTAEC701.3	Perceive noticeable soft skills
BTAEC701.4	Develop technical skills

PREREQUISITE:

Students should be familiar with basic scientific concepts to take up this course.

COURSE DESCRIPTION

Sr no.	Practical/Training/Tests/Interviews	Contact Hours
1	Industry specific-Aptitude and Life Skills	18
2	Biosensors	02

3	Practice Tests	04
4	Competitive Examination Preparation	02
5	Mock Interviews	02
6	Discussion session-Industry Experts/Academia Experts/Alumni	02
Total Number of Lectures		**30**

METHODOLOGY

The course will be covered through Lectures/Assignments/Practical/Training/Tests/Interviews

EVALUATION SCHEME (THEORY)

Examination	**Duration**	**Marks**
Continuous Internal Assessment		20
Attendance		
Assignments/Practical/Training/Tests/Interviews		30
Total		**50**

BOOKS RECOMMENDED:

1. R. S. Aggarwal, (2017). Quantitative Aptitude for Competitive Examinations, 3rd (Ed.). New Delhi: S. Chand Publishing
2. ETHNUS, (2016). Aptimithra, 1st (Ed.). Bangalore: McGraw-Hill Education Pvt. Ltd.
3. Arun Sharma, (2016). Quantitative Aptitude, 7th (Ed.). Noida: McGraw Hill Education Pvt. Ltd.

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTAEC701.1	-	3	3	2	3	1	-	1	-	2	2	3	3	-	-
BTAEC701.2	2	2	2	-	-	1	-	1	-	2	-	2	2	-	1
BTAEC701.3	2	2	2	-	3	1	-	1	-	3	-	2	2	-	-
BTAEC701.4	2	2	2	-	2	1	-	1	-	2	-	2	2	2	-

Semester VIII		
BTMP801	**Research Project/Industrial Training/ Review writing/Entrepreneurship Start-up (5 months)**	**22 Credits**

OBJECTIVES:

The objectives of this course are to:

- Train the students to understand the research environment in a laboratory/ Industrial training and culture
- Enable students to learn practical aspects of research
- Impart training to the students for Literature review, Review writing, data analysis and thesis writing.

COURSE OUTCOME:

CO No.	At the end of the course, the learner should be able to:
BTMP801.1	Acquire in-depth knowledge of the chosen area of research
BTMP801.2	Develop competence in research design and planning
BTMP801.3	Perform analytical techniques/experimental methods to obtain objective-oriented results
BTMP801.4	Acquire research report writing skills

Matrix for Program Outcome and Program Specific Outcome

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PO12	PSO1	PSO2	PSO3
BTMP801.1	3	3	3	3	1	2	2	2	3	3	2	3	3	3	3
BTMP801.2	3	3	3	3	2	2	2	2	3	3	3	3	2	3	2
BTMP801.3	3	3	3	3	3	3	2	3	3	3	3	3	2	2	3
BTMP801.4	2	2	2	2	2	2	2	3	3	3	3	3	3	2	2

1: As regards the assessment of the students with exceptional achievements/performance in games and sports, performing/ fine arts, Social Work, NCC, or other similar subjects/ category is concerned, the same can be defined/prescribed based on their level of competition (State level/ National level/International level/ Commonwealth/ Olympics/ World Championships etc), the level of representation (District/ State/ National/ International), medal/distinction achieved in team/ individual events, and such exceptional performance shall be treated equivalent to an assessment.

Note 2: Following approved Value-added courses will be offered besides the above for 1 credit. Courses will be offered as per the approved eligibility. Evaluation will be for 50 marks.

- Essentials of research concept and practices
- Art of Hydroponics
- Organic Farming