REVA UNIVERSITY
Bengaluru, India

SCHOOL OF APPLIED SCIENCES

B.Sc.
(Bioinformatics, Statistics, Computer Science)

HANDBOOK: 2025-26

Rukmini Educational

CHANCELLOR'S MESSAGE

"Education is the most powerful weapon which you can use to change the world."

- Nelson Mandela.

There was a time when survival depended on just the realization of physiological needs. We are indeed privileged to exist in a time when 'intellectual gratification' has become indispensable. Information is easily attainable for the soul that is curious enough to go look for it.

Technological boons enable information availability anywhere anytime. The difference, however, lies between those who look for information and those who look for knowledge. It is deemed virtuous to serve seekers of knowledge and as educators it is in the ethos at REVA University to empower every learner who chooses to enter our portals. Driven by our founding philosophy of 'Knowledge is Power', we believe in building a community of perpetual learners by enabling them to look beyond their abilities and achieve what they assumed impossible.

India has always been beheld as a brewing pot of unbelievable talent, acute intellect and immense potential. All it takes to turn those qualities into power is a spark of opportunity. Being at a University is an exciting and rewarding experience with opportunities to nurture abilities, challenge cognizance and gain competence.

For any University, the structure of excellence lies in the transitional abilities of its faculty and its facility. I'm always in awe of the efforts that our academic board puts into develop the team of subject matter experts at REVA. My faculty colleagues understand our core vision of empowering our future generation to be ethically, morally and intellectually elite. They practice the art of teaching with a student-centered and transformational approach. The excellent infrastructure at the University, both educational and extra-curricular, magnificently demonstrates the importance of ambience in facilitating focused learning for our students.

A famous British politician and author from the 19th century - Benjamin Disraeli, once said 'A University should be a place of light, of liberty and of learning'. Centuries later this dictum still inspires me, and I believe it takes teamwork to build successful institutions. I welcome you to REVA University to join hands in laying the foundation of your future with values, wisdom and knowledge.

Dr. P. Shyama Raju

The Founder and Hon'ble Chancellor, REVA University

VICE CHANCELLOR'S MESSAGE

The last two decades have seen a remarkable growth in higher education in India and across the globe. The move towards inter-disciplinary studies and interactive learning have opened up several options as well as created multiple challenges. India is at a juncture where a huge population of young crowd is opting for higher education. With the tremendous growth of privatization of education in India, the major focus is on creating a platform for quality in knowledge enhancement and bridging the gap between academia and industry.

A strong believer and practitioner of the dictum "Knowledge is Power", REVA University has been on the path of delivering quality education by developing the young human resources on the foundation of ethical and moral values, while boosting their leadership qualities, research culture and innovative skills. Built on a sprawling 45 acres of green campus, this 'temple of learning' has excellent and state-of-the-art infrastructure facilities conducive to higher teaching-learning environment and research. The main objective of the University is to provide higher education of global standards and hence, all the programs are designed to meet international standards. Highly experienced and qualified faculty members, continuously engaged in the maintenance and enhancement of student-centric learning environment through innovative pedagogy, form the backbone of the University.

All the programs offered by REVA University follow the Choice Based Credit System (CBCS) with Outcome Based Approach. The flexibility in the curriculum has been designed with industry-specific goals in mind and the educator enjoys complete freedom to appropriate the syllabus by incorporating the latest knowledge and stimulating the creative minds of the students. Bench marked with the course of studies of various institutions of repute, our curriculum is extremely contemporary and is a culmination of efforts of great think-tanks - a large number of faculty members, experts from industries and research level organizations. The evaluation mechanism employs continuous assessment with grade point averages. We believe sincerely that it will meet the aspirations of all stakeholders – students, parents and the employers of the graduates and postgraduates of REVA University.

At REVA University, research, consultancy and innovation are regarded as our pillars of success. Most of the faculty members of the University are involved in research by attracting funded projects from various research level organizations like DST, VGST, DBT, DRDO, AICTE and industries. The outcome of the research is passed on to students through live projects from industries. The entrepreneurial zeal of the students is encouraged and nurtured through EDPs and EACs.

REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internships with industries have helped our students. REVA University has entered into collaboration with many prominent industries to bridge the gap between industry and University. Regular visits to industries and mandatory internship with industries have helped our students become skilled with relevant to industry requirements. Structured training programs on soft-skills and preparatory training for competitive exams are offered here to make students more employable. 100% of the placement of eligible students speaks about the effectiveness of these programs. The entrepreneurship development activities and establishment of "Technology Incubation Centers" in the University extend full support to the budding entrepreneurs to nurture their ideas and establish an enterprise. With firm faith in the saying, "**Intelligence plus character –that is the goal of education**" (Martin Luther King, Jr.), I strongly believe REVA University is marching ahead in the right direction, providing a holistic education to the future generation and playing a positive role in nation building. We reiterate our endeavor to provide premium quality education accessible to all and an environment for the growth of over-all personality development leading to generating "GLOBAL PROFESSIONALS".

Welcome to the portals of REVA University!

Dr. Sanjay R. Chitnis
Vice Chancellor, REVA University.

DIRECTOR'S MESSAGE

The B.Sc. Bioinformatics, Statistics, and Computer Science (BStCs) program offered by REVA University is designed to equip students with the skills and knowledge required to excel in modern areas of computational biology, data science, and life sciences. The program aims to bridge the gap between biological data and computational solutions by integrating biological insight with analytical and programming skills.

This unique combination of BStCs provides a strong foundation in biological sciences along with the computational and mathematical tools needed to analyze and interpret vast amounts of biological data. The curriculum emphasizes practical and industry-relevant training to ensure students develop global competence and are prepared for a dynamic, data-driven world.

The program encourages students to develop critical thinking, creativity, and scientific curiosity. It aims to nurture future bioinformaticians, data analysts, computational biologists, software developers, research scientists, and academicians who can contribute meaningfully to sectors such as genomics, personalized medicine, drug discovery, healthcare analytics, and agricultural informatics. The outcome-based curriculum is aligned with national and international academic standards and integrates key cross-cutting themes like professional ethics, sustainability, human values, and gender sensitivity. It ensures students acquire the necessary theoretical concepts and practical competencies to meet both academic and industrial demands. The Choice Based Credit System (CBCS) and Continuous Assessment Grading Pattern (CAGP) further enhance the teaching-learning process through flexibility and continuous feedback.

Through this program, students will gain hands-on experience in programming, statistical data analysis, molecular modeling, machine learning, biological databases, and high-throughput data analysis. These competencies prepare graduates to transition smoothly into research, higher education, or industry roles. This handbook outlines the academic regulations, course structure, and detailed syllabus for the B.Sc. BStCs program. I am confident that students who choose B.Sc. BStCs at REVA University will benefit immensely from our vibrant curriculum, modern infrastructure, research-driven environment, and the mentorship of experienced faculty.

I warmly welcome you to be a part of this transformative academic experience at REVA University and wish you great success in all your endeavors.

Prof. Shilpa B. R.
Director (I/C), School of Applied Sciences
REVA University

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RUKMINI EDUCATIONAL CHARITABLE TRUST

It was the dream of late Smt. Rukmini Shyama Raju to impart education to millions of underprivileged children as she knew the importance of education in the contemporary society. The dream of Smt. Rukmini Shyama Raju came true with the establishment of **Rukmini Educational Charitable Trust (RECT)**, in the year 2002. Rukmini Educational Charitable Trust (RECT) is a Public Charitable Trust, set up in 2002 with the objective of promoting, establishing, and conducting academic activities in the fields of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology, among others. In furtherance of these objectives, the Trust has set up the REVA Group of Educational Institutions comprising of REVA Institute of Technology & Management (RITM), REVA Institute of Science and Management (RISM), REVA Institute of Management Studies (RIMS), REVA Institute of Education (RIE), REVA First Grade College (RFGC), REVA Independent PU College at Kattigenahalli, Ganganagar and Sanjaynagar and now REVA University. Through these institutions, the Trust seeks to fulfill its vision of providing world class education and create abundant opportunities for the youth of this nation to excel in the areas of Arts, Architecture, Commerce, Education, Engineering, Environmental Science, Legal Studies, Management and Science & Technology.

Every great human enterprise is powered by the vision of one or more extraordinary individuals and is sustained by the people who derive their motivation from the founders. The Chairman of the Trust is Dr. P. Shyama Raju, a developer and builder of repute, a captain of the industry in his own right and the Chairman and Managing Director of the DivyaSree Group of companies. The idea of creating these top notched educational institutions was born of the philanthropic instincts of Dr. P. Shyama Raju to do public good, quite in keeping with his support to other socially relevant charities such as maintaining the Richmond Road Park, building, and donating a police station, gifting assets to organizations providing accident and trauma care, to name a few.

The Rukmini Educational Charitable Trust drives with the main aim to help students who are in pursuit of quality education for life. REVA is today a family of ten institutions providing education from PU to Post Graduation and Research leading to PhD degrees. REVA has a well-qualified experienced teaching faculty of whom majority are doctorates. The faculty is supported by committed administrative and technical staff. Over 13,000 students study various courses across REVA's three campuses equipped with exemplary state-of-the-art infrastructure and connective environment for the knowledge driven community.

ABOUT REVA UNIVERSITY

REVA University has been established under the REVA University Act, 2012 of the Government of Karnataka and notified in Karnataka State Gazette No. 80 dated 27th February 2013. The University is empowered by UGC to award degrees any branch of knowledge under Sec.22 of the UGC Act. The University is a Member of Association of Indian Universities, New Delhi. The main objective of the University is to prepare students with knowledge, wisdom, and patriotism to face the global challenges and become the top leaders of the country and the globe in different fields.

REVA University located in between Kempegowda International Airport and Bangalore city, has a sprawling green campus spread over 45 acres of land and equipped with state-of-the-art infrastructure that provide conducive environment for higher learning and research. The REVA campus has well equipped laboratories, custom-built teaching facilities, fully air-conditioned library and central computer center, the well-planned sports facility with cricket ground, running track & variety of indoor and outdoor sports activities, facilities for cultural programs. The unique feature of REVA campus is the largest residential facility for students, faculty members and supportive staff.

REVA consistently ranked as one of the top universities in various categories because of the diverse community of international students and its teaching excellence in both theoretical and technical education in the fields of Engineering, Management, Law, Science, Commerce, Arts, Performing Arts, and Research Studies. REVA offers 28 Undergraduate Programs, 22 Full-time and 2 Part-time Postgraduate Programs, 18 Ph. D Programs, and other Certificate/ Diploma/Postgraduate Programs in various disciplines. The curriculum of each Program is designed with a keen eye for detail by giving emphasis on hands-on training, industry relevance, social significance, and practical applications. The University offers world-class facilities and education that meets global standards.

The programs being offered by the REVA University are well planned and designed after detailed study with emphasis with knowledge assimilation, applications, global job market and their social relevance. Highly qualified, experienced faculty and scholars from reputed universities/institutions, experts from industries and business sectors have contributed in preparing the scheme of instruction and detailed curricula for this program. Greater emphasis on practice in respective areas and skill development to suit to respective job environment has been given while designing the curricula. The Choice Based Credit System and Continuous Assessment Graded Pattern (CBCS – CAGP) of education has been introduced in all programs to facilitate students to opt for subjects of their choice in addition to the core subjects of the study and prepare them with needed skills. The system also allows students to move forward under the fast track for those who have the

capabilities to surpass others. These programs are taught by well experienced qualified faculty supported by the experts from industries, business sectors and such other organizations. REVA University has also initiated many supportive measures such as bridge courses, special coaching, remedial classes, etc., for slow learners to give them the needed input and build in them confidence and courage to move forward and accomplish success in their career. The University has also entered MOUs with many industries, business firms and other institutions seeking their help in imparting quality education through practice, internship and assisting students' placements.

REVA University recognizes the fact that research, development, and innovation are the important functions of any university that has established an independent Research and Innovation division headed by a senior professor as Dean of Research and Innovation. This division facilitates all faculty members and research scholars to undertake innovative research projects in engineering, science & technology, and other areas of study. Interdisciplinary-multidisciplinary research is given the topmost priority. The division continuously liaises between various funding agencies, R&D Institutions, Industries, and faculty members of REVA University to facilitate undertaking innovative projects. It encourages student research projects by forming different research groups under the guidance of senior faculty members. Some of the core areas of research wherein our young faculty members are working include Bioinformatics, Genomics, Proteomics, Drug Discovery, Pharmacogenomics, Genetics, Molecular Biology, Biotechnology, Biochemistry, Chemical Sciences, Synthetic chemistry, Nano chemistry, Nanotechnology, Plant and Agricultural Research, Data Mining, Cloud Computing, Image Processing, Network Security, VLSI and Embedded Systems, Wireless Censor Networks, Computer Networks, IOT, MEMS, Nano- Electronics, Wireless Communications, Bio-fuels, Nano-technology for coatings, Composites, Vibration Energies, Electric Vehicles, Multilevel Inverter Application, Battery Management System, LED Lightings, Renewable Energy Sources and Active Filter, Innovative Concrete Reinforcement, Electro Chemical Synthesis, Energy Conversion Devices, Nano-structural Materials, Photo-electrochemical Hydrogen generation, Pesticide Residue Analysis, Nano materials, Photonics, Nana Tribology, Fuel Mechanics, Operation Research, Graph theory, Strategic Leadership and Innovative Entrepreneurship, Functional Development Management, Resource Management and Sustainable Development, Cyber Security, General Studies, Feminism, Computer Assisted Language Teaching, Culture Studies etc.

The REVA University has also given utmost importance to developing the much-required skills through a variety of training programs, industrial practice, case studies and such other activities that induce the said skills among all students. A full-fledged Career Development and Placement (CDC) department with world class infrastructure, headed by a dynamic experienced Professor& Dean, and supported by well experienced Trainers, Counselors and Placement Officers. The University also has University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director facilitating skill related training to REVA students and other unemployed students. The University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana. The Centre conducts several add-on courses in challenging areas of development. It is always active in facilitating a student's variety of Skill Development Training programs.

The University has collaborations with Industries, universities abroad, research institutions, corporate training organizations, and Government agencies such as Florida International University, Oklahoma State University, Western Connecticut University, University of Alabama, Huntsville, Oracle India Ltd, Texas Instruments, Nokia University Relations, EMC2, VMware, SAP, Apollo etc., to facilitate student exchange and teacher–scholar exchange programs and conduct training programs. These collaborations with foreign universities also facilitate students studying some of the programs partly in REVA University and partly in foreign university, viz, M.S in Computer Science one year in REVA University and the next year in the University of Alabama, Huntsville, USA.

The University has also given greater importance to quality in education, research, administration, and all activities of the university. Therefore, it has established an independent Internal Quality division headed by a senior professor as Dean of Internal Quality. The division works on planning, designing, and developing different quality tools, implementing them, and monitoring the implementation of these quality tools. It concentrates on training the entire faculty to adopt the new tools and implement their use. The division further works on introducing various examination and administrative reforms.

To motivate the youth and transform them to become innovative entrepreneurs, successful leaders of tomorrow and committed citizens of the country, REVA organizes interaction between students and successful industrialists, entrepreneurs, scientists, and such others from time to time. As a part of this exercise great personalities such as Bharat Ratna Prof. C. N. R. Rao, a renowned Scientist, Dr. N R Narayana Murthy, Founder and Chairman and Mentor of Infosys, Dr. K Kasturirangan, Former Chairman ISRO, Member of Planning Commission, Government of India, Dr. Balaram, Former Director IISc., and noted Scientist, Dr. V S Ramamurthy, Former Secretary, DST, Government of India, Dr. V K Aatre, noted Scientist and former head of the DRDO and Scientific Advisor to the Ministry of Defence Dr. Sathish Reddy, Scientific Advisor, Ministry of Defence, New Delhi and many others have accepted our invitation and blessed our students and faculty members by their inspiring addresses and interaction.

As a part of our effort in motivating and inspiring the youth of today, REVA University also has instituted awards and prizes to recognize the services of teachers, researchers, scientists, entrepreneurs, social workers, and such others who have contributed richly for the development of the society and progress of the country. One of such awards instituted by REVA University is **'Lifetime Achievement Award'** to be awarded to successful personalities who have made mark in their field of work. This award is presented on occasion of the **"Founders Day Celebration"** of REVA University on 6th January of every year in presence of dignitaries, faculty members and students gathering. The first **"REVA Lifetime Achievement Award"** for the year 2015 has been awarded to Shri. Kiran Kumar, Chairman ISRO, followed by Shri. Shekhar Gupta, renowned Journalist for the year 2016, Dr K J Yesudas, renowned play back singer for the year 2017. REVA also introduced **"REVA Award of Excellence"** in the year 2017 and the first Awardee of this prestigious award is Shri Ramesh Aravind, Actor, Producer, Director, Screen Writer and Speaker.

REVA organizes various cultural programs to promote culture, tradition, ethical and moral values to our students. During such cultural events, the students are given opportunities to unfold their hidden talents and motivate them to contribute innovative ideas for the progress of the society. One of such cultural events is REVAMP, which is conducted every year. The event not only gives opportunities to students of REVA but also students at other Universities and Colleges. During three days of this mega event students participate in debates, Quizzes, Group discussion, Seminars, exhibitions, and variety of cultural events. Another important event is Shubha Vidaaya, - Graduation Day for the final year students of all the programs, wherein, the outgoing students are felicitated and are addressed by eminent personalities to take their future career in the right spirit, to be the good citizens and dedicate themselves to serve the society and make a mark in their respective spheres of activities. During this occasion, the students who have achieved top ranks and won medals and prizes in academic, cultural and sports activities are also recognized by distributing awards and prizes. The founders have also instituted medals and prizes for sports achievers every year. The physical education department conducts regular yoga classes every day to students, faculty members, administrative staff and their family members and organizes yoga camps for villagers around.

VISION

"To become a technologically advanced, sustainable global university dedicated to the wellbeing of all"

MISSION

- Provide learner-centric education leveraged with cutting edge technologies.
- Foster stewardship by nurturing talent, leadership qualities, and entrepreneurial thinking in a safe and secure environment.
- Promote liberal studies and foster the pursuit of performing arts, literature, sports, and other creative and intellectual disciplines.
- Promote a culture of collaboration and cooperation.
- Serve humanity and promote sustainability through higher education based on universal values.

OBJECTIVES

- Developing a sense of ethics in the University and community, making it conscious of its obligations to society and the nation.
- Performing all the functions of interest to its major constituents like faculty, staff, students, and the society to reach a leadership position.
- Smooth transition from teacher-centric focus to learner-centric processes and activities.
- To offer high-quality education in a competitive manner.
- Creation, preservation and dissemination of knowledge and attainment of excellence in different disciplines.

ABOUT SCHOOL OF APPLIED SCIENCES

The School of Applied Sciences offers graduate and post graduate programs in Biotechnology, Bioinformatics, Microbial Technology, Chemistry, Physics and Mathematics which are incredibly fascinating. It aims to attract talented youth and train them to acquire knowledge and skills useful to industrial sectors, research laboratories, and educational institutions. The school presently offers M.Sc. degree programs in Biotechnology, Bioinformatics, Microbial Technology, Chemistry, Physics, Mathematics and B Sc with various combinations viz, B.Sc. Bioinformatics, Statistics, Computer Science (BStCs), B.Sc. Biotechnology, Biochemistry, Genetics (BBG), B.Sc. Microbiology, Chemistry, Genetics (MCG). The school also facilitates research leading to PhD in Biotechnology, Microbiology, Biochemistry, Physics, Chemistry, Mathematics, and related areas of study.

The School of Applied Sciences is shouldered by well qualified, experienced, and highly committed faculty. The state-of-the-art infrastructure digital classrooms, well equipped laboratories, conference rooms and the serene academic atmosphere at REVA University will enhance the transfer as well as creation of knowledge. The school provides an interactive, collaborative peer tutoring environment that encourages students to break down complex problems and develop strategies for finding solutions across a variety of situations and disciplines. The school aims to develop a learning community of critical thinkers who serve as models of innovative problems solving in the university environment to enrich their academic and professional careers.

VISION

To nurture intellect, creativity, character, professionalism, and research culture among students and impart contemporary knowledge in various branches of Chemical, Biological, Physical and Mathematical Sciences that are socially relevant and transform them to become global citizens with leadership qualities.

MISSION

- To achieve excellence in studies and research through pedagogy and support interface between industry and academia
- To create intellectual curiosity, academic excellence, and integrity through multidimensional exposure
- To establish state of the art laboratories to support research and innovation and promote mastery of science.
- To inculcate an ethical attitude and make students competitive to serve the society and nation.

BOS PANEL MEMBERS – 2025

Program: B.Sc. (Bioinformatics, Statistics and Computer Science)

Bioinformatics Panel Members:

S. No	Name, Designation &Affiliation	External/Internal member
1	**Prof. Shilpa B.R** Director (I/C) School of Applied Sciences Head of the Department - Biotechnology School of Applied Sciences, REVA University, Bengaluru, Karnataka, India.	Chairperson
2	**Dr. Pasupuleti Visweswara Rao** Director, IRRC, REVA University, Bengaluru, Karnataka, India.	Invited Member
3	**Dr. Vidya Niranjan** Pro-Vice chancellor MIT Vishwaprayag University, Solapur - Pune Hwy, Kegaon, Maharashtra 413255	External Academic Member
4	**Dr. Nagesh KA** Director, Bioinformatics Division Eurofins Genomics, Bangalore, Karnataka, India.	External Industry Member
5	**Dr. P V Shivaprasad** FNA, FASc, FNASC, Associate Professor and Dean of Research, NCBS, TIFR Bangalore, Karnataka, India.	Member from Research Organization
6	**Mr. Mithun A** Bioinformatician Navipoint Health India Pvt.Ltd., Hyderabad, Telangana, India	Alumni Student
7	**Prof. Prashantha C N** Assistant Professor Department of Biotechnology, School of Applied Sciences REVA University, Bangalore, Karnataka, India	Internal Member
8	**Dr. Dasegowda KR** Assistant Professor Department of Biotechnology, School of Applied Sciences REVA University, Bangalore, Karnataka, India	Internal Member
9	**Dr. Vishu Kumar** Head, Department of Mathematics, SoAS REVA University	Invited Member
10	**Prof. Sathish Kumar** Assistant Professor Department of Computer Science, School of Applied Sciences, REVA University	Invited Member Department of Computer Science, SoAS
11	**Mr. Keshav Murthy SR** Assistant Placement Officer Career Development Cell, REVA University	Invited Member CDC Team
12	**Ms. Bavitha Reddy** 4th Semester B.Sc. BStCs REVA University, Bangalore, Karnataka, India	Current Student

B.Sc. Bioinformatics, Statistics, Computer Science (BStCs)

Bioinformatics has emerged as a powerful interdisciplinary field that merges biology, statistics, and computer science to address some of the most complex challenges in the life sciences. The rapid advancement of high-throughput technologies such as next-generation sequencing, proteomics, and metabolomics has led to an unprecedented generation of biological data. This has created a pressing need for professionals who can process, analyze, and interpret these data using computational and statistical approaches.

The B.Sc. Bioinformatics, Statistics, and Computer Science program offered by the School of Applied Sciences at REVA University is designed to cater to this need. It provides a unique blend of biological sciences with quantitative and computational skills, enabling students to explore diverse domains such as genomics, personalized medicine, drug discovery, molecular modeling, and health informatics. The program is structured to equip students with the ability to apply machine learning, artificial intelligence, and data mining techniques to biological datasets for meaningful discovery.

The curriculum is outcome-based and future-focused, integrating theoretical knowledge with hands-on training in programming, data analysis, and visualization. Students are exposed to industry-standard tools and platforms such as Python, R, Bioconductor, TensorFlow, SQL, and cloud computing environments like AWS and Google Cloud. This hands-on experience ensures that graduates are ready to tackle real-world problems in biomedical research, diagnostics, and healthcare technology.

In addition to technical proficiency, the program emphasizes interdisciplinary learning, ethical practices, communication skills, and scientific writing. These competencies are essential for students to succeed in collaborative research environments and contribute effectively to scientific innovation. Special focus is given to emerging trends such as reproducible research, FAIR data management, and AI-based solutions for biological and clinical applications.

Graduates of this program are prepared for diverse career paths, including roles in biotechnology and pharmaceutical industries, academic research institutions, clinical genomics labs, and healthcare IT companies. They are also well-positioned to pursue advanced studies in computational biology, biomedical informatics, systems biology, and allied disciplines at national and international levels.

The B.Sc. Bioinformatics, Statistics, and Computer Science program at REVA University stands out for its strong academic foundation, industry-aligned curriculum, modern infrastructure, and experienced faculty. With a focus on innovation and experiential learning, the program aims to nurture competent, ethical, and forward-thinking professionals who can lead the future of life sciences in the digital era.

Program Educational Objectives (PEOs)

After 3 +1 year of graduation, the graduate will:

PEO1	Apply integrated knowledge of **bioinformatics, statistics,** and **computer science** to design data-driven and sustainable solutions for real-world problems in life sciences, and related domains.
PEO2	Pursue successful careers or higher education in **interdisciplinary** and technology-driven environments by demonstrating strong **analytical, communication, and entrepreneurial skills**.
PEO3	Demonstrate **ethical, professional,** and **social responsibility** through lifelong learning, innovation, and the effective use of advanced tools and methodologies to address complex biological challenges.

Program Outcomes (POs)

After the successful completion of the program, the graduate will be able to:

POs	**Program Outcome Statement**
PO1	**Domain Knowledge**: Demonstrate and understanding of **bioinformatics, statistics, and computer science** to solve complex problems in biological data analysis and system modeling.
PO2	**Problem Analysis**: Identify, define, and analyse biological and computational problems using mathematical, statistical, and algorithmic reasoning.
PO3	**Research and Investigation**: Use scientific methods, design experiments, interpret data, and synthesize information to draw valid, data-driven conclusions in research contexts.
PO4	**Modern Tool Usage**: Employ appropriate tools, programming languages, and computational platforms to analyse and interpret biological data effectively.
PO5	**Environment and Sustainability**: Integrate environmentally sustainable and ethical practices in data management, software development, and life science applications.
PO6	**Ethics**: Demonstrate professional integrity and ethical behaviour in handling biological data, research practices, and technological development.
PO7	**Individual and Teamwork**: Perform effectively as an individual and in multidisciplinary teams in academic, research, and industrial settings.
PO8	**Communication**: Communicate complex technical and biological concepts clearly through oral presentations, written reports, and scientific documentation.
PO9	**Project Management and Finance**: Apply principles of project planning, execution, and resource management to lead and contribute to scientific and technical projects.
PO10	**Lifelong Learning**: Recognize the need for independent and continuous learning in a rapidly evolving scientific and technological landscape.
PO11	**Technological advancement**: Adapt to advancements in bioinformatics, artificial intelligence, and life sciences.

Program Specific Outcomes (PSOs)

After successful completion of the programme, the graduates shall be able to

PSO	Program Specific Outcome Statement
PSO1	Design and implement **bioinformatics workflows** and tools using modern programming languages, databases, and algorithms to process and interpret biological data.
PSO2	Integrate **statistical modelling, data visualization**, and **machine learning** techniques to solve domain-specific problems in Genomics, Transcriptomics, and Biomedical Informatics.
PSO3	Develop interdisciplinary solutions and deploy scalable data science and software platforms for applications in healthcare, pharmaceuticals, and computational life sciences.

Mapping of PEOS with Respect to POs and PSOs

PEOs	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
PEO1	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO2	√	√	√	√	√	√	√	√	√	√	√	√	√	√
PEO3	√	√	√	√	√	√	√	√	√	√	√	√	√	√

Mapping of Course Outcomes with Programme Outcomes

Course code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
B25AHK103	CO1	3	1	0	1	0	0	0	0	0	0	0	3	0	1
	CO2	1	0	1	0	0	1	1	0	1	0	0	2	1	1
	CO3	1	2	0	1	0	0	0	0	1	0	0	3	1	0
	CO4	1	2	0	0	0	0	1	0	1	1	0	2	1	0
	CO5	1	2	0	1	0	0	0	0	1	0	0	3	1	0
	CO6	1	2	0	0	0	0	1	0	1	1	0	2	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHA101	CO1	2	0	0	1	0	2	0	1	1	1	0	1	1	0
	CO2	1	0	1	2	0	0	1	1	1	2	0	3	0	0
	CO3	1	2	1	2	0	0	1	2	1	1	0	1	1	1
	CO4	1	0	0	2	0	0	0	1	1	1	0	1	1	0
	CO5	1	0	0	2	0	0	0	1	1	1	0	1	1	0
	CO6	1	0	0	2	0	0	0	1	1	1	0	1	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHH103	CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	0	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHE101	CO1	2	1	0	1	0	0	1	0	0	0	0	2	0	1
	CO2	1	0	1	1	0	1	1	2	1	1	1	2	1	1
	CO3	1	1	1	1	0	0	0	1	1	1	0	3	1	0
	CO4	1	0	0	0	0	0	1	2	1	2	0	2	1	0
	CO5	1	0	0	0	0	0	1	2	1	2	0	2	1	0
	CO6	1	0	0	0	0	0	1	2	1	2	0	2	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0101	CO1	3	2	1	1	1	0	1	1	0	2	1	3	2	1
	CO2	3	3	2	2	1	1	0	1	0	3	1	3	3	2
	CO3	3	3	2	2	1	1	1	1	1	3	2	3	3	2
	CO4	3	2	2	2	2	1	1	1	1	2	2	3	2	2
	CO5	3	2	1	1	2	1	1	1	1	2	2	3	2	1
	CO6	3	3	3	3	1	2	2	2	2	3	2	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0101	CO1	3	2	1	1	0	0	1	2	1	2	1	3	2	1
	CO2	3	3	2	3	0	1	1	2	1	3	2	3	3	2
	CO3	3	2	1	2	1	0	0	1	0	2	2	3	2	1
	CO4	3	2	2	2	1	1	0	1	0	2	2	3	2	2
	CO5	3	3	2	2	1	1	1	2	1	3	2	3	3	2
	CO6	3	3	2	2	1	1	1	1	1	3	2	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**

B25CP0101	**CO1**	3	2	1	2	0	0	0	1	1	2	2	3	2	1
	CO2	3	3	2	3	0	0	1	1	1	3	2	3	3	2
	CO3	3	2	2	2	0	1	1	1	1	2	3	3	2	2
	CO4	3	3	2	3	1	1	1	2	1	3	3	3	3	2
	CO5	3	3	3	3	1	1	1	2	2	3	3	3	3	3
	CO6	3	3	2	3	1	1	2	2	2	3	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CPS111	**CO1**	3	2	1	1	1	1	1	2	1	2	2	3	2	2
	CO2	3	3	2	3	1	1	1	1	1	2	3	3	3	2
	CO3	2	2	1	2	0	1	1	1	1	2	3	2	2	2
	CO4	3	3	2	3	1	1	1	2	1	3	3	3	3	3
	CO5	2	2	1	3	1	1	1	1	0	2	3	2	3	3
	CO6	2	2	1	2	2	3	2	3	2	3	3	2	2	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CPS112	**CO1**	3	2	1	2	1	1	1	2	1	2	2	3	2	2
	CO2	3	3	1	2	1	1	1	2	1	2	3	3	2	2
	CO3	3	2	1	3	2	1	1	1	1	2	2	3	3	2
	CO4	3	2	2	3	1	2	1	2	2	3	3	3	3	2
	CO5	2	2	1	2	3	2	1	1	1	3	3	2	2	3
	CO6	2	2	1	2	2	3	2	3	2	3	3	2	2	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0102	**CO1**	3	2	1	2	0	1	3	2	0	2	2	2	0	0
	CO2	3	3	3	3	0	2	0	2	0	2	3	3	2	0
	CO3	2	2	2	0	0	1	0	2	0	2	2	0	0	0
	CO4	2	3	2	0	0	1	2	2	0	3	3	0	2	0
	CO5	3	3	2	2	1	0	0	0	0	2	3	2	0	0
	CO6	3	3	3	3	2	2	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0102	**CO1**	3	2	0	3	0	0	0	2	0	2	2	2	0	0
	CO2	3	3	0	3	0	0	0	0	0	3	3	3	2	0
	CO3	3	2	0	2	0	0	0	0	0	2	2	2	0	0
	CO4	3	2	0	2	0	0	0	0	0	2	3	2	0	0
	CO5	3	3	2	3	0	0	0	2	0	3	3	3	2	1
	CO6	3	3	2	3	0	0	0	2	0	3	3	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0102	**CO1**	3	3	2	3	1	2	1	2	1	3	2	3	2	1
	CO2	3	2	2	3	1	2	2	2	1	2	3	3	3	2
	CO3	3	3	2	3	1	2	1	2	1	2	2	3	3	2
	CO4	3	3	2	3	2	3	1	2	1	3	3	3	3	2
	CO5	3	3	2	3	2	2	2	2	1	3	3	3	3	3
	CO6	3	3	3	3	2	2	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHK203	**CO1**	3	1	0	1	0	0	0	0	0	0	0	3	0	1
	CO2	1	0	1	0	0	1	1	0	1	0	0	2	1	1
	CO3	1	2	0	1	0	0	0	0	1	0	0	3	1	0
	CO4	1	2	0	0	0	0	1	0	1	1	0	2	1	0
	CO5	1	2	0	1	0	0	0	0	1	0	1	3	1	0
	CO6	1	2	0	0	0	0	1	0	1	1	1	2	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHA201	**CO1**	2	0	1	1	0	1	0	2	1	2	0	1	1	0
	CO2	0	1	0	1	0	0	1	0	0	1	0	1	0	1
	CO3	2	0	1	1	0	0	2	0	0	1	0	2	2	0
	CO4	1	0	1	1	1	0	1	0	1	1	0	3	1	0
	CO5	1	0	1	1	1	0	1	0	1	1	1	3	1	0
	CO6	1	0	1	1	1	0	1	0	1	1	1	3	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHH203	**CO1**	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHE201	**CO1**	1	0	0	1	0	1	1	2	1	1	0	2	0	0

	CO2	1	1	0	0	0	0	2	2	1	1	0	2	1	0
	CO3	2	1	1	1	0	0	2	2	1	1	0	2	1	0
	CO4	1	0	0	2	0	0	3	2	1	1	0	1	0	0
	CO5	1	0	0	2	0	0	3	2	1	1	1	1	0	0
	CO6	1	0	0	2	0	0	3	2	1	1	1	1	0	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0201	**CO1**	3	2	0	0	0	0	2	0	0	0	2	3	0	0
	CO2	3	3	2	0	0	0	0	0	0	0	2	3	2	0
	CO3	2	3	2	2	2	0	0	0	0	0	3	3	3	0
	CO4	2	3	3	3	2	0	0	0	0	2	3	2	3	2
	CO5	3	3	3	3	3	0	0	0	0	2	3	2	3	2
	CO6	3	3	3	3	2	2	0	0	0	2	3	2	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0201	**CO1**	3	3	2	2	1	1	1	1	0	2	2	2	2	1
	CO2	3	3	2	2	1	0	1	1	0	2	2	3	2	1
	CO3	3	3	2	2	1	0	1	1	0	2	2	3	2	2
	CO4	3	2	2	2	1	0	1	1	0	3	2	2	2	2
	CO5	3	3	2	2	2	1	1	1	1	3	3	2	3	3
	CO6	3	3	2	3	2	1	1	1	1	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0201	**CO1**	3	2	1	0	0	0	0	0	0	0	2	3	2	0
	CO2	3	3	3	2	0	0	0	0	1	0	2	3	3	1
	CO3	3	3	3	3	0	0	0	0	0	0	2	3	3	2
	CO4	3	3	3	3	2	0	0	0	0	0	3	3	3	2
	CO5	3	3	3	3	2	0	0	0	0	1	3	3	3	2
	CO6	3	3	3	3	2	1	0	0	1	2	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0202	**CO1**	3	2	0	2	3	0	2	0	2	1	2	3	2	1
	CO2	3	0	2	3	3	0	0	0	2	0	2	3	3	0
	CO3	3	2	2	3	3	0	0	0	2	1	3	3	3	1
	CO4	3	1	3	3	3	1	0	0	2	0	3	3	3	2
	CO5	3	0	2	3	3	1	2	0	2	0	3	3	3	2
	CO6	3	1	1	2	2	0	2	0	2	0	3	2	2	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0202	**CO1**	3	3	2	2	1	1	1	1	0	2	2	2	2	1
	CO2	3	3	2	3	1	0	1	1	0	2	2	3	2	1
	CO3	3	3	2	2	1	0	1	1	0	2	2	3	2	2
	CO4	3	2	2	2	1	0	1	1	0	3	2	2	2	2
	CO5	3	3	2	2	2	1	1	1	1	3	3	2	3	3
	CO6	3	3	2	3	2	1	1	1	1	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0202	**CO1**	3	2	2	2	1	0	0	0	1	2	2	3	2	1
	CO2	3	3	3	2	2	0	0	0	1	2	2	3	3	1
	CO3	3	3	3	2	2	0	0	1	1	2	2	3	3	1
	CO4	3	3	3	2	2	0	0	1	1	2	3	3	3	2
	CO5	3	3	3	2	3	0	0	0	1	2	3	3	3	2
	CO6	3	3	3	2	3	0	0	0	1	2	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0213	**CO1**	3	2	1	1	2	2	1	0	1	2	2	3	2	1
	CO2	3	3	2	2	2	2	1	0	1	2	2	3	3	2
	CO3	3	3	2	2	2	2	0	0	1	2	2	3	3	2
	CO4	3	2	1	2	1	3	0	0	1	2	2	2	2	3
	CO5	2	2	0	2	0	3	2	0	2	2	2	1	1	3
	CO6	2	2	0	2	2	3	0	1	2	2	2	1	1	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHK303	**CO1**	T	1	1	1	1	1	0	1	0	0	0	1	1	0
	CO2	1	1	1	0	1	1	0	0	0	0	0	1	0	0
	CO3	0	0	1	0	0	0	1	1	0	0	0	0	1	1
	CO4	0	0	1	1	0	0	1	0	1	0	0	1	1	1
	CO5	0	0	1	1	0	0	1	0	1	0	1	1	1	1
	CO6	0	0	1	1	0	0	1	0	1	0	1	1	1	1
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHH303	**CO1**	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0

	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHA301	**CO1**	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0301	**CO1**	3	2	2	1	2	1	1	1	2	2	3	3	2	2
	CO2	3	3	3	2	2	1	1	2	3	2	3	3	2	2
	CO3	2	3	3	2	2	1	1	2	2	1	3	3	2	2
	CO4	3	2	3	3	3	2	2	2	3	2	3	3	3	2
	CO5	3	3	3	3	3	2	2	2	3	2	3	3	3	3
	CO6	3	3	3	2	3	2	2	3	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0301	**CO1**	3	3	2	2	0	0	1	1	0	2	2	2	3	2
	CO2	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO3	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO4	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO5	3	3	3	2	1	0	1	1	0	2	2	2	3	2
	CO6	3	3	2	3	1	1	1	2	0	3	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0301	**CO1**	3	3	3	3	2	1	2	2	2	2	2	3	2	2
	CO2	3	3	3	3	2	1	2	2	2	2	2	3	2	3
	CO3	3	3	3	3	2	2	2	1	2	2	3	2	2	2
	CO4	3	3	2	3	3	2	2	2	2	3	3	3	2	2
	CO5	3	2	2	3	2	2	2	2	2	3	3	3	3	3
	CO6	3	3	3	2	3	3	2	2	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25STS311	**CO1**	3	3	2	2	2	1	1	1	0	2	2	2	3	2
	CO2	3	3	2	2	2	1	1	1	0	2	2	2	3	2
	CO3	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO4	3	3	2	2	0	0	1	1	0	2	2	2	3	2
	CO5	3	3	2	2	0	0	1	1	0	2	2	2	3	2
	CO6	3	2	2	2	3	2	1	2	2	3	3	2	2	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25STS312	**CO1**	3	3	2	2	1	1	1	1	0	3	3	2	3	3
	CO2	3	3	2	2	0	0	1	1	0	2	3	2	3	2
	CO3	3	3	2	2	0	0	1	1	0	2	3	2	3	2
	CO4	3	3	2	3	0	0	1	1	0	3	3	3	3	2
	CO5	3	3	2	3	0	0	1	1	0	3	3	3	3	2
	CO6	3	3	2	2	0	1	1	1	0	3	3	2	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0302	**CO1**	3	2	0	0	2	0	0	0	0	0	2	3	0	0
	CO2	3	3	2	3	3	0	0	0	0	0	2	3	2	0
	CO3	3	3	3	3	3	0	0	0	0	0	2	3	3	2
	CO4	3	3	2	3	3	0	0	0	0	0	2	3	3	3
	CO5	3	3	3	3	3	2	0	0	2	2	3	3	3	3
	CO6	3	2	0	0	2	0	0	0	0	0	2	3	0	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0302	**CO1**	3	2	2	2	0	0	0	0	0	0	2	3	2	2
	CO2	3	3	3	3	2	0	0	0	0	0	2	3	3	3
	CO3	3	3	3	3	3	0	0	0	1	1	3	3	3	3
	CO4	3	3	2	3	3	0	0	0	1	1	3	3	3	3
	CO5	2	2	3	2	2	0	0	1	2	2	3	3	3	3
	CO6	2	2	2	2	2	0	0	3	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0302	**CO1**	3	2	2	1	2	0	0	0	1	1	3	2	1	2
	CO2	3	3	3	2	2	0	0	0	1	1	3	2	2	3
	CO3	3	2	3	1	3	0	0	0	2	1	3	3	2	3

	CO4	2	3	3	2	3	0	0	0	1	2	3	3	3	3
	CO5	3	3	3	3	3	1	2	1	2	2	3	3	3	3
	CO6	3	3	3	2	3	1	2	0	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0303	**CO1**	3	3	2	2	2	2	1	1	2	1	1	3	2	2
	CO2	2	3	3	3	2	2	1	2	2	2	2	3	3	3
	CO3	3	3	3	3	3	2	2	2	2	2	2	3	3	3
	CO4	3	3	3	3	3	3	2	2	2	2	2	3	3	3
	CO5	3	3	3	3	3	2	2	2	2	3	3	3	3	3
	CO6	3	3	3	3	3	3	2	2	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25SB0301	**CO1**	2	3	3	3	3	3	1	3	3	3	1	1	3	3
	CO2	2	2	3	3	3	2	1	3	2	2	2	3	3	3
	CO3	2	1	3	3	3	3	2	3	2	2	2	2	3	2
	CO4	2	3	3	3	3	3	2	3	2	2	2	3	3	3
	CO5	2	3	3	3	3	2	3	3	2	2	3	2	3	3
	CO6	2	3	3	3	2	3	2	3	2	3	3	3	2	1
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25NS0108	**CO1**	3	2	0	0	0	3	0	0	0	2	3	3	0	0
	CO2	2	0	3	0	0	3	3	0	0	2	3	0	3	3
	CO3	3	2	0	2	0	2	0	2	0	2	3	3	0	0
	CO4	0	0	3	3	0	3	3	0	0	0	3	0	3	3
	CO5	3	2	0	0	2	3	0	0	3	3	3	0	3	0
	CO6	2	0	0	2	0	3	2	2	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25NC0109	**CO1**	0	0	3	2	2	2	0	0	0	0	3	3	2	2
	CO2	0	0	2	3	3	2	0	0	0	0	3	3	2	1
	CO3	0	0	2	3	3	2	0	0	0	0	3	3	1	1
	CO4	0	0	2	3	3	1	0	0	0	0	3	3	1	1
	CO5	0	0	1	2	3	1	0	0	0	0	3	3	2	1
	CO6	0	0	1	2	3	1	0	0	0	0	3	3	2	1
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHK403	**CO1**	T	1	1	1	1	1	0	1	0	0	0	1	1	0
	CO2	1	1	1	0	1	1	0	0	0	0	0	1	0	0
	CO3	0	0	1	0	0	0	1	1	0	0	0	0	1	1
	CO4	0	0	1	1	0	0	1	0	1	0	0	1	1	1
	CO5	0	0	1	1	0	0	1	0	1	0	1	1	1	1
	CO6	0	0	1	1	0	0	1	0	1	0	1	1	1	1
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHA401	**CO1**	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AHH403	**CO1**	0	0	1	0	1	1	1	1	1	2	0	2	2	0
	CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
	CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
	CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
	CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0401	**CO1**	3	2	2	1	1	1	1	2	1	1	3	3	2	2
	CO2	3	3	3	3	2	1	1	2	1	2	3	3	3	2
	CO3	3	3	3	3	3	2	2	2	2	2	3	3	3	3
	CO4	3	3	3	3	3	2	2	2	2	3	3	3	3	3
	CO5	3	3	3	3	3	2	2	2	2	3	3	3	3	3
	CO6	3	3	3	3	3	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0401	**CO1**	3	3	2	2	0	1	1	2	0	2	2	2	3	2
	CO2	3	3	2	2	0	1	1	2	0	2	2	2	3	2
	CO3	3	3	3	2	0	1	1	2	0	3	2	2	3	2
	CO4	3	3	3	2	0	1	1	2	0	3	2	2	3	2

	CO5	3	3	2	2	0	1	1	2	0	2	2	2	3	2
	CO6	3	3	3	2	0	1	1	2	0	3	2	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0401	**CO1**	3	2	2	2	1	1	1	1	1	2	2	3	2	1
	CO2	3	2	2	2	2	1	1	1	1	2	2	3	3	2
	CO3	3	2	3	2	3	2	1	2	2	2	2	3	3	2
	CO4	3	3	3	2	3	2	1	2	3	3	3	3	3	3
	CO5	3	3	3	3	2	2	1	2	3	3	3	3	3	3
	CO6	3	2	3	3	2	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0402	**CO1**	3	2	2	2	3	2	1	1	2	2	3	3	3	2
	CO2	3	3	3	3	3	2	1	1	2	2	3	3	3	3
	CO3	3	3	3	3	3	2	2	1	2	2	3	3	3	3
	CO4	3	3	3	3	3	2	2	1	2	2	3	3	3	3
	CO5	3	3	2	2	3	2	2	1	2	2	3	2	3	3
	CO6	3	3	3	3	3	2	2	2	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0402	**CO1**	3	3	2	3	0	0	1	1	0	2	2	3	3	2
	CO2	3	3	2	2	0	0	1	1	0	2	2	3	3	2
	CO3	3	3	2	3	0	0	1	1	0	3	3	3	3	2
	CO4	3	3	2	3	0	0	1	1	0	3	3	3	3	2
	CO5	3	3	2	3	0	0	1	1	0	3	3	3	3	2
	CO6	3	3	2	3	0	0	1	2	0	3	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0402	**CO1**	3	2	2	2	1	1	1	1	1	2	2	3	2	1
	CO2	3	2	2	2	2	1	1	1	1	2	2	3	3	2
	CO3	3	2	3	2	3	2	1	2	2	2	2	3	3	2
	CO4	3	3	3	2	3	2	1	2	3	3	3	3	3	3
	CO5	3	3	3	3	2	2	1	2	3	3	3	3	3	3
	CO6	3	2	3	3	2	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0403	**CO1**	3	2	2	0	0	0	1	1	0	0	0	3	0	0
	CO2	3	3	2	2	0	0	2	0	0	0	0	3	2	0
	CO3	3	3	2	2	0	0	3	0	0	0	0	2	2	0
	CO4	3	3	3	3	3	0	0	0	0	0	2	3	3	2
	CO5	2	2	3	3	2	0	1	0	0	0	3	3	2	2
	CO6	2	3	3	3	3	2	0	0	2	2	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0412	**CO1**	2	1	1	0	0	0	0	0	0	0	0	1	1	0
	CO2	2	1	1	1	1	0	0	0	0	0	0	1	1	0
	CO3	2	1	1	1	1	0	0	0	0	0	0	1	1	0
	CO4	2	1	1	1	1	0	0	0	0	1	1	1	1	0
	CO5	2	1	1	1	1	0	0	0	0	1	1	1	1	0
	CO6	2	1	1	1	1	0	0	0	0	1	1	1	1	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0501	**CO1**	3	2	2	2	2	1	1	2	1	2	2	3	2	2
	CO2	3	3	2	2	2	1	1	1	2	1	2	3	2	2
	CO3	3	2	3	3	3	1	1	2	2	2	3	3	3	2
	CO4	3	3	3	3	3	2	2	2	2	2	3	3	3	3
	CO5	3	3	3	2	3	2	2	3	3	2	3	3	3	3
	CO6	2	3	3	2	3	3	3	3	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0501	**CO1**	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO2	3	3	2	2	1	0	1	1	0	2	2	3	3	2
	CO3	3	3	2	2	1	0	1	1	0	2	2	3	3	2
	CO4	3	3	3	2	1	0	1	1	0	3	2	2	3	2
	CO5	3	3	2	2	1	1	1	2	0	3	3	2	3	2
	CO6	3	3	2	2	1	1	1	2	0	3	3	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0501	**CO1**	3	2	0	0	0	0	0	0	0	0	2	2	0	0
	CO2	3	3	2	0	0	0	0	0	0	0	2	2	0	0
	CO3	2	2	3	2	0	0	0	0	0	0	2	2	2	0
	CO4	2	3	3	2	0	0	0	0	2	0	2	3	2	0
	CO5	2	3	3	2	0	0	0	0	0	0	3	2	2	2

	CO6	2	3	2	3	2	0	0	0	2	2	3	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS511	**CO1**	3	2	0	0	0	0	0	0	0	1	2	3	0	0
	CO2	3	3	2	0	0	0	0	0	0	0	2	3	2	0
	CO3	3	3	3	2	3	0	0	0	1	0	3	3	3	2
	CO4	3	3	2	3	3	1	0	2	0	0	2	2	3	0
	CO5	2	2	3	2	3	0	0	0	0	2	3	2	3	2
	CO6	3	3	2	0	3	2	2	0	2	2	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS512	**CO1**	3	2	0	0	2	0	0	0	0	1	1	3	2	0
	CO2	2	3	2	0	0	0	0	0	0	0	0	3	3	1
	CO3	3	3	3	3	2	0	0	0	0	0	1	3	3	2
	CO4	2	2	2	3	3	0	0	0	0	0	0	3	3	2
	CO5	2	3	3	3	3	0	0	0	0	2	2	3	3	3
	CO6	3	3	2	3	3	1	1	1	2	2	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0502	**CO1**	3	2	3	2	0	0	0	0	2	2	2	3	3	0
	CO2	3	3	3	2	0	0	0	0	2	2	2	3	3	0
	CO3	3	2	3	2	0	0	0	0	2	2	2	3	2	0
	CO4	3	3	3	2	2	0	0	0	2	3	3	3	3	2
	CO5	3	3	3	2	2	0	0	0	2	3	3	3	3	2
	CO6	3	3	3	2	3	0	0	0	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0502	**CO1**	3	3	2	3	1	0	1	1	0	2	2	3	3	2
	CO2	3	3	2	3	1	0	1	1	0	2	2	3	3	2
	CO3	3	3	3	2	1	0	1	1	0	3	2	2	3	2
	CO4	3	3	2	3	1	1	1	2	0	3	3	2	3	2
	CO5	3	3	2	3	1	1	1	2	0	3	3	2	3	2
	CO6	3	3	2	3	1	1	1	3	0	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0502	**CO1**	3	2	3	3	2	1	1	2	1	2	2	3	1	3
	CO2	3	2	3	3	3	1	2	2	1	2	2	3	1	3
	CO3	3	3	3	3	3	1	2	2	1	2	2	3	3	3
	CO4	3	3	3	3	3	1	2	2	1	2	2	2	3	3
	CO5	3	3	3	3	3	1	1	2	1	3	3	3	2	3
	CO6	3	3	3	3	3	1	2	2	2	3	3	2	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0502	**CO1**	3	3	2	2	2	1	1	1	2	1	2	3	2	1
	CO2	3	3	3	2	2	1	2	2	2	1	2	3	3	2
	CO3	3	3	3	3	3	2	1	1	2	2	2	3	3	3
	CO4	3	3	2	3	2	2	2	2	2	2	2	3	2	2
	CO5	3	2	2	3	2	1	2	2	2	2	2	3	2	2
	CO6	3	3	3	3	3	2	2	2	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25LS0501	**CO1**	2	1	0	1	1	1	0	0	0	1	0	2	2	1
	CO2	1	1	1	0	1	1	0	0	1	1	0	2	2	1
	CO3	2	2	2	1	1	1	1	0	1	1	0	2	2	1
	CO4	2	1	1	1	3	1	0	0	1	1	0	2	2	0
	CO5	2	2	0	1	2	1	0	0	1	1	1	2	2	0
	CO6	2	2	1	1	3	1	1	0	2	1	1	2	2	0
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0601	**CO1**	3	2	1	2	2	1	1	1	1	1	2	3	2	1
	CO2	2	3	3	3	3	1	1	1	1	2	3	3	3	2
	CO3	2	3	2	3	3	1	1	1	1	2	3	3	3	3
	CO4	2	3	3	3	3	1	1	1	1	2	3	3	3	2
	CO5	2	3	2	3	3	2	2	1	2	2	3	3	2	2
	CO6	2	3	3	3	3	2	1	2	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0601	**CO1**	3	3	2	2	1	0	1	1	0	2	2	2	3	2
	CO2	3	3	3	2	1	0	1	2	0	3	2	2	3	2
	CO3	3	3	3	2	1	0	1	2	0	3	2	2	3	2
	CO4	3	3	2	2	1	0	1	1	0	3	2	2	3	2
	CO5	3	3	3	2	1	0	1	2	0	3	2	2	3	2
	CO6	3	3	2	2	1	0	1	1	0	3	2	2	3	2

Course code	CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
B25CP0601	**CO1**	3	3	2	3	2	1	2	3	2	2	2	2	3	2
	CO2	3	3	3	2	1	1	3	2	2	2	2	2	3	2
	CO3	3	2	3	1	1	1	2	1	1	3	2	2	3	2
	CO4	3	3	2	3	1	2	3	2	1	2	2	2	3	2
	CO5	2	1	2	1	1	1	0	1	0	1	2	2	3	2
	CO6	3	1	3	1	1	0	3	2	1	2	2	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0602	**CO1**	3	3	2	2	2	1	1	1	1	2	3	2	2	1
	CO2	3	3	2	2	3	1	1	1	2	2	3	3	3	2
	CO3	3	3	3	2	3	2	2	1	2	2	3	3	3	2
	CO4	3	3	3	3	3	2	2	1	2	2	3	3	3	2
	CO5	3	3	3	3	3	2	2	1	2	3	3	3	3	3
	CO6	3	3	3	3	3	2	2	2	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25ST0602	**CO1**	3	3	2	2	1	0	1	2	0	2	2	2	3	2
	CO2	3	3	2	2	1	0	1	2	0	2	2	2	3	2
	CO3	3	3	3	3	1	0	1	2	0	3	2	3	3	2
	CO4	3	3	2	2	1	0	1	1	0	3	2	2	3	2
	CO5	3	3	2	2	1	0	1	2	0	3	2	2	3	2
	CO6	3	3	2	3	1	0	1	3	0	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25CP0602	**CO1**	3	2	2	1	2	0	0	0	0	1	2	2	0	0
	CO2	3	2	3	2	2	0	0	0	0	1	2	2	1	0
	CO3	3	2	2	2	3	0	0	0	0	2	2	2	2	1
	CO4	3	3	3	3	3	0	0	0	0	2	2	3	3	2
	CO5	3	3	2	3	2	0	0	0	0	2	3	3	3	2
	CO6	3	3	3	3	3	0	0	0	0	2	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0603	**CO1**	3	2	1	2	1	3	3	3	2	2	2	2	2	1
	CO2	3	3	2	3	2	2	2	2	3	3	2	3	3	2
	CO3	2	2	1	2	2	3	3	2	2	3	2	2	2	2
	CO4	3	2	2	3	2	3	3	3	3	3	3	3	2	2
	CO5	3	3	2	2	2	3	3	3	3	3	2	2	2	2
	CO6	3	2	2	3	2	3	3	3	3	3	2	2	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25PT0601	**CO1**	2	2	3	3	3	2	2	1	2	2	0	1	0	3
	CO2	3	2	2	3	3	3	3	1	2	2	0	1	0	3
	CO3	3	3	1	3	3	3	3	1	2	2	0	1	1	3
	CO4	3	3	1	1	1	3	3	1	2	2	1	1	1	3
	CO5	2	2	2	2	2	2	2	2	2	2	1	2	1	1
	CO6	2	2	2	2	2	2	2	2	2	2	1	2	1	1
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0604	**CO1**	2	2	3	3	3	2	2	1	2	2	1	0	3	2
	CO2	3	2	2	3	3	3	3	1	2	2	1	0	3	3
	CO3	3	3	1	3	3	3	3	1	2	2	1	1	3	3
	CO4	3	3	1	1	1	3	3	1	2	2	1	1	3	3
	CO5	2	2	2	2	2	2	2	2	2	2	2	1	1	2
	CO6	2	2	2	2	2	2	2	2	2	2	2	1	1	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0701	**CO1**	3	2	0	0	0	0	0	0	0	2	3	3	0	0
	CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
	CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
	CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
	CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
	CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0702	**CO1**	3	2	2	1	2	3	1	2	1	2	2	2	2	1
	CO2	3	3	2	2	2	2	1	2	1	3	3	3	3	2
	CO3	2	3	3	2	1	2	2	2	2	3	3	3	3	3
	CO4	3	3	3	3	1	1	1	2	1	3	3	3	3	3
	CO5	2	2	2	1	3	3	1	2	1	2	2	2	2	2
	CO6	2	2	2	1	2	2	2	3	2	2	2	2	2	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**

B25BI0703	**CO1**	3	2	2	1	1	1	1	2	1	2	2	2	2	2
	CO2	3	3	3	3	1	1	1	2	1	2	3	3	3	2
	CO3	3	3	3	3	2	1	2	2	2	2	2	3	3	3
	CO4	3	3	2	3	2	1	1	2	2	3	3	3	3	3
	CO5	3	3	3	3	1	1	2	2	1	2	2	3	3	3
	CO6	3	2	3	2	1	2	2	3	2	3	3	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS711	**CO1**	3	3	2	3	1	1	1	2	1	2	3	3	2	2
	CO2	3	3	2	3	1	1	1	2	1	2	3	3	3	2
	CO3	2	2	3	3	1	1	1	2	1	2	3	3	3	3
	CO4	2	3	3	3	1	2	1	3	2	3	3	2	3	3
	CO5	3	3	2	3	2	2	2	3	3	3	3	3	3	3
	CO6	2	2	3	3	2	2	2	3	2	3	3	2	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS712	**CO1**	3	2	2	1	2	3	1	2	2	2	3	1	2	2
	CO2	2	3	3	2	2	3	2	2	3	2	3	3	2	3
	CO3	3	2	3	3	2	2	3	2	3	3	2	3	2	3
	CO4	2	2	3	3	3	3	1	2	2	2	3	2	3	2
	CO5	2	3	3	2	3	2	2	2	3	2	3	2	2	3
	CO6	1	1	2	2	1	2	3	3	3	3	3	1	2	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS713	**CO1**	3	2	0	0	0	0	0	0	0	2	3	3	0	0
	CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
	CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
	CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
	CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
	CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS714	**CO1**	3	2	2	2	1	1	1	1	2	2	2	3	2	2
	CO2	3	3	2	3	2	1	1	1	2	2	1	3	2	2
	CO3	3	3	3	3	2	1	1	1	2	3	2	3	3	3
	CO4	3	3	3	3	3	2	1	2	2	2	2	3	3	3
	CO5	3	3	2	3	2	2	1	2	2	2	2	3	3	3
	CO6	3	3	3	3	3	2	1	1	3	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0704	**CO1**	3	2	0	0	0	0	0	0	0	2	3	3	0	0
	CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
	CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
	CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
	CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
	CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0705	**CO1**	3	2	2	1	2	3	1	2	1	2	2	2	2	1
	CO2	3	3	2	2	2	2	1	2	1	3	3	3	3	2
	CO3	2	3	3	2	1	2	2	2	2	3	3	3	3	3
	CO4	3	3	3	3	1	1	1	2	1	3	3	3	3	3
	CO5	2	2	2	1	3	3	1	2	1	2	2	2	2	2
	CO6	2	2	2	1	2	2	2	3	2	2	2	2	2	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0706	**CO1**	3	2	2	1	1	1	1	2	1	2	2	2	2	2
	CO2	3	3	3	3	1	1	1	2	1	2	3	3	3	2
	CO3	3	3	3	3	2	1	2	2	2	2	2	3	3	3
	CO4	3	3	2	3	2	1	1	2	2	3	3	3	3	3
	CO5	3	3	3	3	1	1	2	2	1	2	2	3	3	3
	CO6	3	2	3	2	1	2	2	3	2	3	3	2	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0801	**CO1**	3	2	3	2	2	1	2	2	1	2	2	3	2	1
	CO2	3	3	3	3	2	1	1	2	1	1	2	3	2	2
	CO3	3	3	3	3	3	1	2	2	2	2	2	3	3	2
	CO4	3	2	2	3	3	2	1	2	1	1	2	3	3	2
	CO5	3	3	3	3	2	2	2	2	2	1	2	3	3	2
	CO6	3	3	3	3	3	2	2	2	2	1	2	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0802	**CO1**	3	2	1	0	0	0	0	2	1	2	2	2	2	2

	CO2	3	3	2	2	2	0	0	1	1	2	2	3	3	2
	CO3	3	3	3	3	3	1	0	1	2	2	3	3	3	3
	CO4	3	3	3	3	3	0	0	2	2	3	3	3	3	3
	CO5	3	3	2	3	2	3	2	2	2	3	3	3	3	3
	CO6	3	3	2	3	3	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0803	**CO1**	3	2	1	0	0	2	1	2	1	2	2	2	1	0
	CO2	3	3	2	1	1	0	1	2	1	2	2	3	2	0
	CO3	3	3	2	2	2	0	0	2	1	2	3	3	3	2
	CO4	3	3	3	3	3	0	0	2	2	2	3	3	3	3
	CO5	3	3	3	3	3	2	2	3	2	3	3	3	3	3
	CO6	3	3	2	3	2	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS811	**CO1**	3	2	0	2	2	0	0	0	1	2	1	3	2	1
	CO2	3	3	2	2	2	0	0	0	0	2	1	3	2	2
	CO3	3	3	3	3	2	1	0	0	0	2	2	3	3	3
	CO4	3	2	3	2	3	2	2	1	1	2	2	2	3	2
	CO5	2	3	3	3	3	1	1	0	1	2	2	3	3	3
	CO6	3	3	3	3	3	0	2	1	2	2	2	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BIS811	**CO1**	3	3	2	2	2	1	2	1	2	1	2	3	2	1
	CO2	3	3	2	3	3	2	2	1	2	2	3	3	3	2
	CO3	3	3	3	3	3	2	2	2	2	3	3	3	3	3
	CO4	3	2	3	3	3	2	3	2	3	2	3	3	2	2
	CO5	3	2	3	2	2	3	2	3	3	3	2	3	2	2
	CO6	3	3	3	2	2	2	3	2	2	2	3	3	3	2
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0804	**CO1**	3	2	3	2	2	1	2	2	1	2	2	3	2	1
	CO2	3	3	3	3	2	1	1	2	1	1	2	3	2	2
	CO3	3	3	3	3	3	1	2	2	2	2	2	3	3	2
	CO4	3	2	2	3	3	2	1	2	1	1	2	3	3	2
	CO5	3	3	3	3	2	2	2	2	2	1	2	3	3	2
	CO6	3	3	3	3	3	2	2	2	2	1	2	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0805	**CO1**	3	2	1	0	0	0	0	2	1	2	2	2	2	2
	CO2	3	3	2	2	2	0	0	1	1	2	2	3	3	2
	CO3	3	3	3	3	3	1	0	1	2	2	3	3	3	3
	CO4	3	3	3	3	3	0	0	2	2	3	3	3	3	3
	CO5	3	3	2	3	2	3	2	2	2	3	3	3	3	3
	CO6	3	3	2	3	3	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25BI0806	**CO1**	3	2	1	0	0	2	1	2	1	2	2	2	1	0
	CO2	3	3	2	1	1	0	1	2	1	2	2	3	2	0
	CO3	3	3	2	2	2	0	0	2	1	2	3	3	3	2
	CO4	3	3	3	3	3	0	0	2	2	2	3	3	3	3
	CO5	3	3	3	3	3	2	2	3	2	3	3	3	3	3
	CO6	3	3	2	3	2	3	2	3	2	3	3	3	3	3
Course code	**CO**	**PO1**	**PO2**	**PO3**	**PO4**	**PO5**	**PO6**	**PO7**	**PO8**	**PO9**	**PO10**	**PO11**	**PSO1**	**PSO2**	**PSO3**
B25AS0808	**CO1**	2	2	3	3	3	2	2	1	2	2	1	0	3	2
	CO2	3	2	2	3	3	3	3	1	2	2	1	0	3	3
	CO3	3	3	1	3	3	3	3	1	2	2	1	1	3	3
	CO4	3	3	1	1	1	3	3	1	2	2	1	1	3	3
	CO5	2	2	2	2	2	2	2	2	2	2	2	1	1	2
	CO6	2	2	2	2	2	2	2	2	2	2	2	1	1	2

B.Sc. Bioinformatics, Statistics, Computer Science (BStCs)

Scheme of Instruction and Syllabus as per NEP 2020

(Effective from Academic Year 2025-26)

Scheme of Instruction **Duration: 6 +2 Semesters (3 + 1 Years)**

Sem	Course code	Title of the Course	DSC/ DSE/ SEC/ AEC/ VAC/ IDC	Credit Pattern				Hours/ week
				L	T	P	Total	
First	B25AHK103	Language-II: Kannada I	AEC	3	0	0	3	3
	B25AHH103	Language-II: Hindi I		3	0	0	3	3
	B25AHA101	Language-II: Additional English I		3	0	0	3	3
	B25AHE101	Communicative English I	AEC	3	0	0	3	3
	B25BI0101	Biology for Bioinformatics	DSC	3	0	0	3	4
	B25ST0101	Basic Statistics and R-programming	DSC	3	0	0	3	4
	B25CP0101	Essentials of Programming in Python	DSC	3	0	0	3	4
	B25CPS111	Introduction to Artificial Intelligence	DSE	2	0	0	2	2
	B25CPS112	Introduction to Computer Networks						
	B25BI0102	Lab: Biology for Bioinformatics	DSC	0	0	2	2	3
	B25ST0102	Lab: Basic Statistics and R-programming	DSC	0	0	2	2	3
	B25CP0102	Lab: Programming in Python	DSC	0	0	2	2	3
	B25 BI0103	Skill Enhancement Course-1 (Bioinformatics)	SEC	0	0	3	3	3
		Total		**17**	**0**	**9**	**26**	**32**
Second	B25AHK203	Language-II: Kannada-II	AEC	3	0	0	3	3
	B25AHH203	Language-II: Hindi-II		3	0	0	3	3
	B25AHA201	Language-II: Additional English-II		3	0	0	3	3
	B25AHE201	Communicative English -II	AEC	3	0	0	3	3
	B25BI0201	Foundation of Bioinformatics and Algorithms	DSC	3	0	0	3	4
	B25ST0201	Mathematical Foundations for Bioinformatics	DSC	3	0	0	3	4
	B25CP0201	Data Structures and Algorithms using Python	DSC	3	0	0	3	4
	B25BI0202	Lab: Foundation of Bioinformatics	DSC	0	0	2	2	3
	B25ST0202	Lab: Mathematical Foundations for Bioinformatics	DSC	0	0	2	2	3
	B25CP0202	Lab: Data Structures and Algorithms using Python	DSC	0	0	2	2	3
	B25AS0213	Cyber Security	VAC	1	0	0	1	2
		Total		**16**	**0**	**6**	**22**	**29**
		1st Year Credits		**33**	**0**	**15**	**48**	61
Students exiting the program after securing 48 Credits will be awarded UG Certificate in Science (BStCs) provided they secure 4 credits in work-based vocational courses offered during summer term internship/apprenticeship in addition to 3 credits from skill-based courses earned during 1st and 2nd semesters.								
Third	B25AHK303	Language-II: Kannada III	AEC	3	0	0	3	3
	B25AHH303	Language-II: Hindi III		3	0	0	3	3
	B25AHA301	Language-II: Additional English III		3	0	0	3	3
	B25BI0301	Scripting for Bioinformatics: (BioPerl and BioPython)	DSC	3	0	0	3	4
	B25ST0301	Random variables and probability distributions	DSC	3	0	0	3	4
	B25CP0301	Advanced RDBMS	DSC	3	0	0	3	4
	B25BI0302	Lab: Scripting for Bioinformatics: BioPerl and BioPython	DSC	0	0	2	2	3

	B25ST0302	Lab: Random variables and probability distributions	DSC	0	0	2	2	3
	B25CP0302	Lab: Advanced RDBMS	DSC	0	0	2	2	3
	B25STS311	Applied Statistics	DSE	2	0	0	2	2
	B25STS312	Introduction to statistical learning						
	B25ST0303	Skill Enhancement Course-II (Statistics)	SEC	0	0	3	3	3
	B25SB0301	Health and Wellness	VAC	1	0	0	1	1
	B25NS0108	NSS activities						
	B25NC0109	NCC activities						
		Total		**15**	**00**	**09**	**24**	**30**
Fourth	B25AHK403	Language-II: Kannada-IV	AEC	3	0	0	3	3
	B25AHH403	Language-II: Hindi-IV		3	0	0	3	3
	B25AHA401	Language-II: Additional English-IV		3	0	0	3	3
	B25BI0401	Genomics and Transcriptomics	DSC	3	0	0	3	4
	B25ST0401	Statistical inference	DSC	3	0	0	3	4
	B25CP0401	Linux and Operating Systems	DSC	3	0	0	3	4
	B25BI0402	Lab: Genomics and Transcriptomics	DSC	0	0	2	2	3
	B25ST0402	Lab: Statistical inference	DSC	0	0	2	2	3
	B25CP0402	Lab: Linux, and Operating Systems	DSC	0	0	2	2	3
	B25AS0403	Introduction to Disease Biology	IDC	2	0	0	2	2
	B25AS0412	Environmental Studies	AEC	2	0	0	2	2
		Total		**16**	**0**	**06**	**22**	**28**
		2nd Year Credits		**31**	**0**	**15**	**46**	**58**
		2-Year Credits		**64**	**00**	**30**	**94**	**119**
Students exiting the program after securing 94 Credits will be awarded UG Diploma in Science (BStCs) provided they secure 4 credits in skill-based vocational courses offered during 1st year or 2nd year summer term.								
Fifth	B25BI0501	Proteomics and Metabolomics	DSC	3	0	0	3	4
	B25ST0501	Sampling Techniques and non-parametric tests	DSC	3	0	0	3	4
	B25CP0501	Fundaments of web technology	DSC	3	0	0	3	4
	B25BI0502	Lab: Proteomics and Metabolomics	DSC	0	0	2	2	3
	B25ST0502	Lab: Sampling Techniques and non-parametric tests	DSC	0	0	2	2	3
	B25CP0502	Lab: Fundaments of web technology	DSC	0	0	2	2	3
	B25BIS511	Microbial Informatics	DSE	2	0	0	2	2
	B25BIS512	AI Techniques in Biology						
	B25AS0502	Pharmaceutical biology	IDC	2	0	0	2	2
	B25LS0501	Constitution of India and Professional Ethics	AEC	2	0	0	2	2
		Total		**15**	**0**	**06**	**21**	**27**
Sixth	B25BI0601	Computational Drug Discovery	DSC	3	0	0	3	4
	B25ST0601	ANOVA & Design of Experiments	DSC	3	0	0	3	4
	B25CP0601	Data Mining and Warehousing	DSC	3	0	0	3	4
	B25BI0602	Lab: Computational Drug Discovery	DSC	0	0	2	2	3
	B25ST0602	Lab: ANOVA & Design of Experiments	DSC	0	0	2	2	3
	B25CP0602	Lab: Machine learning in Data Mining	DSC	0	0	2	2	3
	B25AS0603	Scientific Writing and Research Ethics	IDC	2	0	0	2	2
	B25PT0601	Soft Skill Training-I	SEC	1	0	0	1	2
	B25AS0604	Research Project/ Internship	DSE	0	0	3	3	4
		Total		**12**	**0**	**9**	**21**	**29**
		3rd Year Credits		**27**	**0**	**15**	**42**	**56**
		3 Years Degree Credits		**91**	**0**	**45**	**136**	**175**
Exit Option with Bachelor of Science – B.Sc. in Bioinformatics, Statistics, Computer Science – BStCs (with the completion of Courses equal to a minimum of 136 Credits) OR Continue studies to earn B.Sc. (Hons) / B.Sc. (Hons with Research) Degree								

Note: Students who secure 75% and above marks in the first SIX Semesters and wish to undertake Research at the Undergraduate level can choose a Research stream in the Fourth Year and such students are awarded B Sc.(Honors with Research) Degree								
		B.Sc. (Hons.) in Bioinformatics						
Seventh	B25BI0701	AI & Deep Learning in Bioinformatics	DSC	3	0	0	3	3
	B25BI0702	Clinical Genomics & Precision Medicine	DSC	3	0	0	3	3
	B25BI0703	Computational Systems Biology	DSC	3	0	0	3	3
	B25BI0704	Lab: AI & Deep in Bioinformatics	DSC	0	0	2	2	3
	B25BI0705	Lab: Clinical Genomics & Precision Medicine	DSC	0	0	2	2	3
	B25BI0706	Lab: Computational Systems Biology	DSC	0	0	2	2	3
	B25BIS711	Machine learning in Bioinformatics	DSE	3	0	0	3	3
	B25BIS712	Entrepreneurship in Life Sciences						
	B25BIS713	Biomedical Text Mining & NLP	DSE	2	0	0	2	2
	B25BIS714	Immunoinformatics						
		Total Credits		**14**	**0**	**6**	**20**	**23**
		B.Sc. (Hons.) in Bioinformatics						
Eighth	B25BI0801	Comparative Genomics	DSC	2	0	0	2	2
	B25BI0802	Molecular Diagnostics	DSC	2	0	0	2	2
	B25BI0803	Biodiversity Informatics	DSC	2	0	0	2	2
	B25BI0804	Lab: Comparative Genomics III	DSC	0	0	2	2	3
	B25BI0805	Lab: Molecular Diagnostics	DSC	0	0	2	2	3
	B25BI0806	Lab: Biodiversity Informatics	DSC	0	0	2	2	3
	B25BIS811	Agri-genomics	DSE	2	0	0	2	2
	B25BIS812	Medical Informatics						
	B25BI0807	Research Project/ Internship	DSE	0	0	6	6	12
		Total Credits		**8**	**0**	**12**	**20**	**29**
	Total Credits of 7th and 8th Sem (4th year credits)			**22**	**0**	**18**	**40**	**52**
	4-year degree credits			**113**	**0**	**63**	**176**	**227**
Award of Bachelor of Science (Honors) Degree in Bioinformatics/ Statistics/ Computer Science (with the completion of Courses equal to a minimum of 176 Credits) OR Continue studies for Masters' Degree								
B.Sc. (Honors with Research) Degree in Bioinformatics								
Eight	B25BI0801	Comparative Genomics	DSC	2	0	0	2	2
	B25BI0802	Molecular Diagnostics	DSC	2	0	0	2	2
	B25BI0804	Lab: Comparative Genomics	DSC	0	0	2	2	3
	B25BI0805	Lab: Molecular Diagnostics	DSC	0	0	2	2	3
	B25BI0808	Research Project/ Internship	DSE	0	0	12	12	24
	Total Credits of 8th Sem (Honors with Research)			**4**	**0**	**16**	**20**	**34**
	Total Credits of 7th and 8th Sem			**18**	**0**	**22**	**40**	**57**
	Total Credits of 1st to 8th Sem			**109**	**0**	**67**	**176**	**232**
Award of Bachelor of Science (Honors with Research) Degree in Bioinformatics/ Statistics/ Computer Science (with the completion of Courses equal to a minimum of 176 Credits) OR Continue studies for Masters' Degree								

Semester-wise Summary of Credit Distribution (Honors)

Semester	**Credit Patterns**				
	L	**T**	**P**	**Total Credits**	**Hours**
First	17	0	09	26	32
Second	16	0	06	22	29
Third	15	00	09	24	30
Fourth	16	0	06	22	28
Fifth	15	0	06	21	27
Sixth	12	0	09	21	29
Seventh	14	0	6	20	23

Eighth	8	0	12	20	29
Total	113	00	63	176	227

Semester-wise Summary of Credit Distribution (Honors with Research)

Semester	**Credit Patterns**				
	L	**T**	**P**	**Total**	**Hours**
First	**17**	**0**	**09**	**26**	**32**
Second	**16**	**0**	**06**	**22**	**29**
Third	**15**	**0**	**09**	**24**	**30**
Fourth	**16**	**0**	**06**	**22**	**28**
Fifth	**15**	**0**	**06**	**21**	**27**
Sixth	**12**	**0**	**09**	**21**	**29**
Seventh	**14**	**0**	**6**	**20**	**23**
Eighth	**4**	**0**	**16**	**20**	**34**
Total	**109**	**00**	**67**	**176**	**232**

Distribution of Credits Based on Type of Courses

Semester	**Ability Enhancement Course AEC**	**Discipline Common Course DSC**	**Discipline Specific Elective DSE**	**Interdisciplinary Course IDC**	**Skill Enhancement course SEC**	**Value added Course VAC**	**Total Credits**
First	6	15	2	-	3	-	26
Second	6	15	-	-	**-**	1	22
Third	3	15	2	-	3	**1**	24
Fourth	5	15	-	2	-	-	22
Fifth	2	15	2	2	-	**-**	21
Sixth	-	15	3	2	1	-	21
Seventh	-	15	5	-	-		20
Eighth	-	12	8	-	-	-	20
Total	**22**	**117**	**22**	**6**	**7**	**2**	**176**

B.Sc. Bioinformatics, Statistics, Computers (BStCs)
Detailed Syllabus
(Effective from Academic Year 2025-26)

FIRST SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHK103	**Language - II: Kannada - I**	**AEC**	3	**0**	**0**	**3**	**3**

Prerequisite / Pre reading for the course

- ಕನ್ನಡ ಭಾಷೆಯ ಬಗೆಗೆ ಪ್ರಾಥಮಿಕ ತಿಳುವಳಿಕೆ ಅಗತ್ಯ.
- ಭಾಷೆಯನ್ನು ಓದಲು ಮತ್ತು ಬರೆಯಲು ತಿಳಿದಿರಬೇಕು.
- ಪದವಿ ಪೂರ್ವ ಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯನ್ನು ಓದಿರಬೇಕು.

Course Objectives:

ನಾಲ್ಕು ಸೆಮಿಸ್ಟರ್‌ಗಳಲ್ಲಿ ಕನ್ನಡ ಸಾಹಿತ್ಯವನ್ನು ಒಳಗೊಂಡಂತೆ ವಿಷಯವಾರು ಪಠ್ಯಗಳನ್ನು ನೀಡಲಾಗಿದ್ದು, ಆ ಮೂಲಕ ಕನ್ನಡ ಭಾಷೆ, ಸಂಸ್ಕೃತಿಯ ಜೊತೆಗೆ ಮಾನವೀಯ ಗುಣಗಳನ್ನು ಪರಿಚಯಿಸುವ ಹಾಗೂ ಅಳವಡಿಸಿಕೊಳ್ಳಲು ಪ್ರೇರೇಪಿಸುವ ಉದ್ದೇಶವನ್ನು ಹೊಂದಿದೆ. ಅದರಂತೆ ಮೊದಲನೆಯ ಸೆಮಿಸ್ಟರ್‌ನಲ್ಲಿ ಕನ್ನಡ ನಾಡು-ನುಡಿ-ಚಿಂತನೆ, ಭೂಮಿ, ವೈಜ್ಞಾನಿಜ ಮನೋಧರ್ಮ ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂದಿಸಿದಂತೆ ವಿಷಯಗಳನ್ನು ನೀಡಿದ್ದು, ಅದಕ್ಕೆ ಪೂರಕವಾಗಿ ಸಾಹಿತ್ಯಿಕ ಪಠ್ಯವನ್ನಾಗಿ ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ. ಈ ಮೂಲಕ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಸಾಹಿತ್ಯದ ಬಗ್ಗೆ ಸದಭಿರುಚಿಯನ್ನು ಮೂಡಿಸಲಾಗುತ್ತದೆ. ಸಾಂಸ್ಕೃತಿಕ ತಿಳುವಳಿಕೆಯ ಜೊತೆಗೆ ವ್ಯಕ್ತಿತ್ವ ವಿಕಸನದ ಕಡೆಗೆ ಗಮನ ನೀಡಲಾಗುತ್ತದೆ.

1) ಭಾಷೆ, ಸಾಹಿತ್ಯ, ಇತಿಹಾಸ ಮತ್ತು ಸಂಸ್ಕೃತಿಗಳನ್ನು ಕನ್ನಡ, ಕರ್ನಾಟಕಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ. ಹಾಗೂ ವೈವಿಧ್ಯಮಯ ಭಾರತದ ಸಾಂಸ್ಕೃತಿಕ ನೆಲೆಗಳನ್ನು ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ
2) ವಿದ್ಯಾರ್ಥಿಗಳ ಸರ್ವತೋಮುಖ ಬೆಳವಣಿಗೆಗೆ ಅನುವಾಗುವಂತೆ ಹಾಗೂ ಅವರಲ್ಲಿ ಮಾನವ ಸಂಬಂಧಗಳ ಬಗ್ಗೆ ಗೌರವ, ಸಮಾನತೆ ಮೂಡಿಸಿ, ಬೆಳೆಸುವ ನಿಟ್ಟಿನಲ್ಲಿ ಪಠ್ಯಗಳ ಆಯ್ಕೆಯಾಗಿದೆ.
3) ಅವರಲ್ಲಿ ಸೃಜನಶೀಲತೆ, ಶುದ್ಧ ಭಾಷೆ, ಉತ್ತಮ ವಿಮರ್ಶಾ ಗುಣ, ನಿರರ್ಗಳ ಸಂಭಾಷಣೆ, ಭಾಷಣ ಕಲೆ ಬರಹ, ವೃತ್ತಿ ಪೂರ್ವಕ ಕೌಶಲ್ಯಗಳನ್ನು ಬೆಳೆಸುವುದು ಗುರಿಯಾಗಿದೆ
4) ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ಅನುಕೂಲವಾಗುವಂತಹ ವಿಷಯಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ಸೂಕ್ತ ಪಠ್ಯಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ.

Course Outcomes:

ಕನ್ನಡ ನಾಡು-ನುಡಿ-ಚಿಂತನೆ, ಭೂಮಿ, ವೈಜ್ಞಾನಿಕ ಮನೋಧರ್ಮ ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಸಾಹಿತ್ಯ ಪಠ್ಯಗಳ ಕಲಿಕೆಯ ಮೂಲಕ ಅವುಗಳ ಒಳನೋಟಗಳನ್ನು ಬೆಳೆಸುತ್ತದೆ.

1) ಸಾಮಾಜಿಕ, ರಾಜಕೀಯ, ಧಾರ್ಮಿಕ, ಸಾಂಸ್ಕೃತಿಕ, ಪರಿಸರ ಹಾಗೂ ಲಿಂಗಸಂಬಂಧಿ ಸೂಕ್ಷ್ಮತೆಯ ವಿಚಾರಗಳೆಡೆ ಗಮನ ಹರಿಸುವುದರೊಂದಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಚರ್ಚಾ ಮನೋಭಾವವು ಬೆಳೆಸುತ್ತದೆ.
2) ಜೀವನದಲ್ಲಿ ಬರುವ ಅಭಿಪ್ರಾಯ ಬೇಧಗಳ ವಿವಿಧ ಆಯಾಮಗಳೊಂದಿಗೆ ಆಧುನಿಕ ಸಂದರ್ಭದಲ್ಲಿ ಮಾನವೀಯತೆಯೊಂದಿಗೆ ನಿರ್ವಹಿಸುವಂತೆ ಪ್ರೇರೇಪಿಸುತ್ತದೆ.
3) ಉತ್ತಮ ಸಂವಹನ ಕಲೆಯನ್ನು ಬೆಳೆಸುವ ಉದ್ದೇಶವನ್ನು ಈಡೇರಿಸುತ್ತದೆ.
4) ಸಂಶೋದನಾ ಮನೋಭಾವ ಮತ್ತು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸುತ್ತದೆ.
5) ಭಾಷೆ ಮತ್ತು ಭಾಷೆ ಮತ್ತು ಸಾಹಿತ್ಯದ ಶ್ರೀಮಂತಿಕೆ ಜೊತೆಗೆ ಮಾನವೀಯ ಮೌಲ್ಯಗಳನ್ನು ಕಲಿಯುವಿರಿ.
6) ಸದೃಢ ಬೌದ್ಧಿಕ ಮತ್ತು ಮಾನಸಿಕ ವನುನ ವಿಕಾಸಿಸುತುದೆ.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	0	1	0	0	0	0	0	0	0	3	0	1
CO2	1	0	1	0	0	1	1	0	1	0	0	2	1	1

CO3	1	2	0	1	0	0	0	0	1	0	0	3	1	0
CO4	1	2	0	0	0	0	1	0	1	1	0	2	1	0
CO5	1	2	0	1	0	0	0	0	1	0	0	3	1	0
CO6	1	2	0	0	0	0	1	0	1	1	0	2	1	0

COURSE CONTENT/ SYLLABUS

Unit I: ಕನ್ನಡ ನಾಡು-ನುಡಿ-ಚಿಂತನೆ

10 Hours

1.1 ಆರಂಕುಶವಿಟ್ಟೊಡಂ ನೆನೆವುದೆನ್ನ ಬನವಾಸಿ ದೇಶಮಂ ಪಂಪ

1.2 ಕನ್ನಡ ಕಟ್ಟುವ ಕೆಲಸ ಹಾ. ಮ. ನಾಯಕ

1.3 ಕನ್ನಡ ಸಂಸ್ಕೃತಿ ಮತ್ತು ಸ್ವಾಯತ್ತತೆ ಬರಗೂರು ರಾಮಚಂದ್ರಪ್ಪ

Unit II: ಭೂಮಿ **10 Hours**

2.1 ಜನಪದ ಕಾವ್ಯ ಜನಪದ ತ್ರಿಪದಿಗಳು

2.2 ಭೂಮಿಗೀತೆ ಗೋಪಾಲ ಕೃಷ್ಣ ಅಡಿಗರು

2.3 ರೈತನ ದೃಷ್ಟಿ ಕುವೆಂಪು

Unit III: ವೈಜ್ಞಾನಿಕ ಮನೋಧರ್ಮ **10 Hours**

3.1 ಜಾಲಿಯ ಮರದಂತೆ ಪುರಂದರದಾಸ

3.2 ಮಹಿಳೆ ಮತ್ತು ವಿಜ್ಞಾನ ನೇಮಿಚಂದ್ರ

3.3 ವೈಚಾರಿಕ ಪ್ರಜ್ಞೆಗೆ ಅಡೆತಡೆಗಳು ಹೆಚ್. ನರಸಿಂಹಯ್ಯ

Unit IV: ಸಂಕೀರ್ಣ **9 Hours**

4.1 ಸಮಸ್ಯೆಯ ಮಗು ತ್ರಿವೇಣಿ

4.2 ಕರಕುಶಲ ಕಲೆ ಮೇಲೆ ತಂತ್ರಜ್ಞಾನದ ಪ್ರಭಾವ ಡಾ. ಕರೀಗೌಡ ಬೀಚನಹಳ್ಳಿ

4.3 ಎದೆಗೆ ಬಿದ್ದ ಅಕ್ಷರ ದೇವನೂರ ಮಹದೇವ

Textbooks/ Reference Books:

ಸಂಯೋಜಿತ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ "ಗಣಕ ವಿಜ್ಞಾನ ಸೌರಭ" – ಮೊದಲನೇ ಸೆಮಿಸ್ಟರ್ ಬಿಸಿಎ ಮತ್ತು ಬಿಎಸ್ಸಿ (ಎಎಸ್)

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು:

1. ಸಮಗ್ರಕಾವ್ಯ- ಗೋಪಾಲಕೃಷ್ಣ ಅಡಿಗ, ಕರ್ನಾಟಕ ಬುಕ್ ಏಜನ್ಸಿ, ಬೆಂಗಳೂರು,2015
2. ಪಂಪ ಮಹಾ ಕವಿ ವಿರಚಿತ ಪಂಪಭಾರತಂ – ಗದ್ಯಾನುವಾದ, ಅನಂತರಂಗಚಾರ್, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್ತು, ಬೆಂಗಳೂರು, 2018
3. ಸಾಹಿತ್ಯ ವೈಜ್ಞಾನಿಕ ಮೀಮಾಂಸೆ-ಗಿರಿ, ಮನೋಹರ ಗ್ರಂಥಮಾಲ, ಧಾರವಾಡ,2016
4. ಸ್ಕೃತಿ- ವಿಸ್ಕೃತಿ ಭಾರತೀಯ ಸಂಸ್ಕೃತಿ- ರಾಜರಾಮ ಹೆಗಡೆ, ವಸಂತ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು2018
5. ಎದೆಗೆ ಬಿದ್ದ ಅಕ್ಷರ- ದೇವನೂರು ಮಹಾದೇವ, ಅಭಿನವ ಪ್ರಕಾಶನ ಬೆಂಗಳೂರು,2013
6. ಕುವೆಂಪು ದರ್ಶನ ವಿಚಾರ- ದೇಜಗೌ, ಸ್ವಪ್ನ ಬುಕ್ ಹೌಸ್, ಬೆಂಗಳೂರು,2010
7. ದಕ್ಷಿಣ ಕರ್ನಾಟಕದ ಕಾವ್ಯ ಪ್ರಕಾರಗಳು- ಜಿ.ಶಂ.ಪ, ಅಭಿನವ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು.2016

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHA101	**Language – II: Additional English - I**	**AEC**	3	**0**	**0**	**3**	**3**

Prerequisite: Students should possess basic proficiency in English, including the ability to comprehend, speak, and write simple texts. A foundational understanding of grammar and vocabulary acquired at the higher secondary level is expected.

Course Objectives:

1. To equip students with the ability to acquire the functional use of language in context.
2. To motivate the students to explore and critique issues related to society and Ethics.
3. To develop in the students a genuine habit of reading and writing leading to effective and efficient communication.
4. To develop the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically on any topic

Course Outcomes:

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

1. Demonstrate the ability to write cohesively, coherently and flawlessly avoiding grammatical errors, using a wide vocabulary range, organizing their ideas logically
2. Develop soft skills for life and for the job market.
3. Communicate with clarity in content and speech.
4. Assess contemporary global and local events from a critical point of view.
5. Use language mindfully and get acquainted with international best practices and etiquettes.
6. Build ethical responsibilities in taking cognizance of issues relating to society and values.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	0	0	1	0	2	0	1	1	1	0	1	1	0
CO2	1	0	1	2	0	0	1	1	1	2	0	3	0	0
CO3	1	2	1	2	0	0	1	2	1	1	0	1	1	1
CO4	1	0	0	2	0	0	0	1	1	1	0	1	1	0
CO5	1	0	0	2	0	0	0	1	1	1	0	1	1	0
CO6	1	0	0	2	0	0	0	1	1	1	0	1	1	0

Course Content:

Unit-I: Values and Ethics **10 Hours**

Literature: Dalai Lama: The Paradox of our Times

William Wordsworth – London,1802

O Henry - The Last Leaf

Language: Vocabulary Building: Paragraph writing

Unit-II: Natural & Supernatural **10 Hours**

Literature: Edgar Allen Poe – Tell Tale Heart

Thomas Hardy – The Shadow on the Stone

Charles Dickens – The Trial for Murder

Language: News Report

Unit-III: Travel and Adventure **10 Hours**

Literature: Robert Frost – The Road Not Taken

Walt Whitman – Song of the Open Road

Jack London— The White Silence

Writing Skills: Travelogue writing

Unit-IV: Success Stories **9 Hours**

Literature: Rudyard Kipling - IF

Maya Angelo – Still I Rise

APJ Abdul Kalam – Thanksgiving Address to the Nation

Writing Skills: Brochure & Leaflet

References:

1. Tagore, Rabindranath**. Gitanjali.** Rupa Publications, 2002.
2. Wordsworth, William. **The Complete Works of William Wordsworth.** Andesite Press, 2017.
3. Munro, Hector Hugh. **The Complete Works of Saki.** Rupa Publications, 2000.
4. Shakespeare, William. **The Complete Works of William Shakespeare.** Sagwan Press, 2015.
5. Chindhade, Shirish. **Five Indian English Poets:** Nissim Ezekiel, A.K. Ramanujan, Arun Kolatkar, Dilip Chitre, R. Parthasarathy. Atlantic Publications, 2011.
6. Dickens, Charles. **The Signalman and Other Horrors: The Best Victorian Ghost Stories of Charles Dickens:** Volume 2. Createspace Independent Publications, 2015.
7. Anderson, Hans Christian. **The Fir Tree.** Dreamland Publications, 2011.
8. Colvin, Sidney (ed). **The Works of R. L. Stevenson.** (Edinburgh Edition). British Library, Historical Prints Edition, 2011.
9. Bishop, Elizabeth. **Poems. Farrar,** Straus and Giroux, 2011.
10. Swift, Jonathan. **Gulliver's Travels.** Penguin, 2003.
11. Dickinson, Emily. **The Complete Poems of Emily Dickinson.** Createspace Independent Publications, 2016.
12. Brooke, Rupert. **The Complete Poems of Rupert Brooke.** Andesite Press, 2017.
13. King, Martin Luther Jr. & James M. Washington**. I Have a Dream: Writings And Speeches That Changed The World.** Harper Collins, 1992.
14. Keller, Helen. **The Story of My Life.** Fingerprint Publishing, 2016.
15. Green, David. **Contemporary English Grammar Structures and Composition**. New Delhi: MacMillan Publishers, 2010.
16. Thorpe, Edgar and Showick Thorpe. **Basic Vocabulary.** Pearson Education India, 2012

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHH103	**Language – II: HINDI I**	**AEC**	3	**0**	**0**	**3**	**3**

Course Overview: अध्ययन संक्षिप्त विवरण:

यह पाठ्यक्रम नौसिखिया, अपनी भाषा की क्षमता का विकास करने हेतु तथा विभिन्न साहित्यिक प्रक्रियाओं द्वारा समाज, संस्कृति एवं जीवन के मूल्यों को समझने हेतु अभिकल्पित है।

Prerequisites/Pre reading for the course: पूर्वापेक्षा:

- अध्येता, पी.यु.सी के स्तर पर द्वितीय भाषा के रूप में हिन्दी का अध्ययन करना चाहिए।
- हिन्दी साहित्य के इतिहास का संक्षिप्त ज्ञान की आवश्यकता है।

- हिन्दी व्याकरण का अवबोधन आवश्यक है |
- अंग्रेज़ी – हिन्दी अनुवाद से संबंधित जानकारी जरुरी है |

Course Objectives: पाठ्यक्रम उद्देश्य :

1. संदर्भानुसार उचित भाषा का प्रयोग करने की दक्षता को छात्रों में उत्पन्न करना |
2. साहित्य के माध्यम से समाज एवं मानवीय मूल्यों को समझाकर, उन मूल्यों की रक्षा हेतु प्रेरित करना |
3. छात्रों में पुस्तक पठन एवं लेखन की अकृतिम प्रवृत्ति स्थापित करना |
4. अध्येताओं में साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास करना |

Course Outcomes अधिगम परिणाम :

अध्ययन की समाप्ति पर अध्येता –

1. हिंदी साहित्य की विविध विधाओं का परिचय प्राप्त कर सकता है |
2. सामाजिक मूल्य एवं नैतिक जवाबदेही को स्वीकार कर सकता है |
3. साहित्य की प्रासंगिकता को जीवन में समझने की दक्षता रखता है |
4. समाज में अंतर्निहित पद्धतियाँ एवं विचारधाराओं का व्याख्यान करने में सक्षम बन सकता है |
5. साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास कर सकता है |
6. अनुवाद एवं व्यावहारिक ज्ञान से अवगत हो सकता है |

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	0	2	2	0

Course Content : <u>अध्ययन विषय सूची / पाठ्यक्रम</u>

इकाई – 1: कहानी, व्यंग्य रचना **10 hours**

1. कहानी – प्रायश्चित – प्रेमचंद
2. कहानी – ढाई बीघा ज़मीन- मृदुला सिन्हा
3. व्यंग्य रचना – निंदा रस - हरिशंकर परसाई

इकाई – 2 : कहानी, निबंध **10 hours**

4. कहानी – अकाल मृत्यु - स्वयं प्रकाश
5. कहानी – निर्वासित - सूर्यबाला
6. निबंध - चरित्र संगठन - बाबू गुलाबराय

इकाई – 3 : कहानी, संस्मरण **10 hours**

7. कहानी – आशीर्वाद - सुषमा सिंह

8. कहानी – परदेशी - ममता कालिया

9 संस्मरण - शरद के साथ बिताया कुछ समय - अमृतलाल नागर

इकाई – 4: अनुवाद , संक्षेपण **10 hours**

अनुवाद : अंग्रेज़ी – हिन्दी (शब्द एवं अनुच्छेद)

संक्षेपण **:** परिच्छेद का एक तिहाई भाग में |

सूचना : प्रत्येक इकाई 25 अंक केलिए निर्धारित है |

Textbook/s: पाठ्य पुस्तक :

1. हिन्दी पाठ्य पुस्तक – रेवा विश्वविद्यालय |

References: सन्दर्भ ग्रन्थ :

1. सुबोध व्यवहारिक हिन्दी – डॉ. कुलदीप गुप्त
2. अभिनव व्यवहारिक हिन्दी – डॉ.परमानन्द गुप्त
3. हिन्दी साहित्य का इतिहास - डॉ. नागेन्द्र
4. आधुनिक हिन्दी साहित्य का इतिहास - डॉ. बच्चन सिंह
5. हिन्दी साहित्य का नवीन इतिहास - डॉ. लाल साहब सिंह
6. शुद्ध हिन्दी कैसे बोले कैसे लिखे- पृथ्वीनाथ पाण्डे
7. कार्यालय अनुवाद निदेशिका

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHE101	**Communicative English-I**	**AEC**	3	**0**	**0**	**3**	**3**

Course Description:

This course focuses on improving the spoken and written communication of the learners. The course develops personal, inter-personal and group skills among learners. It also addresses the functional aspects of language usage while providing specific linguistic tools through professional language learning software. The widespread reach of this course makes it highly practical and applicable.

Pre-requisites:

The student must have knowledge of intermediate English Grammar and LSRW skills.

Course Objectives:

1. To enhance functional communication skills.
2. To develop functional use of language in professional contexts.
3. To utilize oral presentations in multiple contexts.
4. To apply effective written skills in formal communication.

Course Outcomes:

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

1. Demonstrate Comprehensive knowledge about current topics and basic skills required to appraise contemporary issues.
2. Formulate responsible citizens with sound ethical values and concern for the community.
3. Illustrate an in-depth understanding in the chosen discipline, comprising theoretical and practical perspectives, and a basic understanding of emerging areas of study and practice.
4. Ability to apply knowledge to comprehend the dynamics of the workplace, society and world in order to find efficient and ethical solutions to problems.
5. Build a professional career and/or furthering higher education in the chosen areas of specialization.
6. Demonstrate a good command over language usage and refined interpersonal skills.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	0	1	0	0	1	0	0	0	0	2	0	1
CO2	1	0	1	1	0	1	1	2	1	1	1	2	1	1
CO3	1	1	1	1	0	0	0	1	1	1	0	3	1	0
CO4	1	0	0	0	0	0	1	2	1	2	0	2	1	0
CO5	1	0	0	0	0	0	1	2	1	2	0	2	1	0
CO6	1	0	0	0	0	0	1	2	1	2	0	2	1	0

Course Content:

Unit-I: Functional English **10 Hours**

Remedial Grammar: The Present Tense, Present Simple, Present Continuous, Present Perfect, Present Perfect continuous

Writing Skills: Official Letters; Apology Letter; Complaint Letter; Letter of Enquiry: (Internship, Fellowship, Job Options)

Literature: Jyoti Lanjewar - Mother

Unit-II: Interpersonal Skills **10 Hours**

Remedial Grammar: The Past Tense; Past Simple; Past Continuous; Past Perfect; Past Perfect continuous

Writing Skills: Essays: Descriptive Essay; Narrative Essay; Compare and contrast Essay; Argumentative Essay

Literature: Nissim Ezekiel – Poet, Lover and Bird Watcher

Unit-III: Multitasking Skills **10 Hours**

Remedial Grammar: The Future Tense; Future Simple; Future Continuous; Future Perfect; Future Perfect continuous

Writing Skills: Note Making; Note Taking; Precis writing

Literature: Sadaat Hasan Manto – Toba Tek Singh

Unit-IV: Communication Skills **10 Hours**

Remedial Grammar: Prepositions of Place and Time; Collocations; Idioms and Phrases

Writing Skills: Comprehension (Unseen Passages followed by questions)

Literature: RK Narayan – A Horse and Two Goats

References:

- Green, David. **Contemporary English Grammar Structures and Composition.** MacMillan, 2010.
- Thorpe, Edgar and Showick Thorpe. **Basic Vocabulary.** Pearson Education India, 2012.
- Leech, Geoffrey and Jan Svartvik. **A Communicative Grammar of English.** Longman, 2003.
- Murphy, Raymond. Murphy's **English Grammar with CD**. Cambridge University Press, 2004.
- Rizvi, M. Ashraf**. Effective Technical Communication.** Tata McGraw-Hill, 2005.
- Riordan, Daniel. **Technical Communication.** New Delhi: Cengage Publications, 2011.
- Sen et al. **Communication and Language Skills.** Cambridge University Press, 2015.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0101	Biology for Bioinformatics	DSC	3	0	0	3	4

Prerequisite

Basic understanding of cell biology, biomolecules (DNA, RNA, proteins), and principles of inheritance at the 10+2 level.

Course Objectives

1. Understand the molecular mechanisms governing the storage, replication, and transmission of genetic information.
2. Explore the role of genes, DNA, RNA, and proteins in the regulation of cellular and organismal functions.
3. Study patterns of inheritance, gene interactions, and chromosomal behaviour in both prokaryotes and eukaryotes.
4. Apply theoretical knowledge through experiments and simulations to understand molecular genetics processes.

Course Outcomes

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

1. Describe the structure and function of nucleic acids and their role in heredity.
2. Explain the mechanisms of gene expression and regulation in prokaryotes and eukaryotes.
3. Apply Mendelian and non-Mendelian principles to solve genetic problems.
4. Analyse chromosomal behaviour and genetic variation and relate them to disorders.
5. Evaluate gene regulation processes and their implications in health and disease.
6. Perform and interpret basic experiments in molecular biology and genetics using laboratory and digital tools.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	0	1	1	0	2	1	3	2	1
CO2	3	3	2	2	1	1	0	1	0	3	1	3	3	2
CO3	3	3	2	2	1	1	1	1	1	3	2	3	3	2
CO4	3	2	2	2	2	1	1	1	1	2	2	3	2	2
CO5	3	2	1	1	2	1	1	1	1	2	2	3	2	1
CO6	3	3	3	3	1	2	2	2	2	3	2	3	3	3

Course Content

Unit I: Cell Biology and Cellular Components **12 Hours**

Discovery of Cell and Cell Theory; Types of Cells: Prokaryotic vs. Eukaryotic; Structure and Function of Cellular Organelles: *Nucleus, Mitochondria, Endoplasmic Reticulum, Golgi Complex, Lysosomes, Ribosomes*; Plasma Membrane Structure and Transport Mechanisms: *Passive, Active, and Facilitated transport*; Cytoskeleton and Cell Motility; Cell Cycle Phases: *G1, S, G2, M*; Apoptosis and Cell Signalling Pathways: *Kinase Cascade, GPCRs, RTKs.*

Unit II: Foundations of Molecular Biology **12 Hours**

Historical Perspective and Central Dogma; DNA: Structure (A, B, Z forms), Properties, and Topology: *Supercoiling, Denaturation, Renaturation*; RNA Types and Structure: *mRNA, tRNA, rRNA, snRNA, miRNA*; DNA Replication in Prokaryotes and Eukaryotes: *Semi-conservative Mechanism, Origin of Replication*, Enzymes: *DNA Polymerases, Helicase, Primase, Ligase, Topoisomerases, Telomerase*; Proofreading and DNA Repair Mechanisms: *Mismatch Repair, Base/Nucleotide Excision Repair.*

Unit-III: Gene Expression and Regulation **12 Hours**

Transcription (Prokaryotic & Eukaryotic): *Initiation, Elongation, Termination*; RNA Processing: *5'Capping, Splicing (introns/exons), 3' Polyadenylation*; Genetic Code and Translation: *Ribosome Structure, tRNA Function, Codon-Anticodon Pairing*, Translation Phases: *Initiation, Elongation, Termination*, Post-Translational Modifications. Gene Regulation Mechanisms: Operon Models: *Lac and Trp*; Eukaryotic Gene Regulation: *Chromatin Remodeling, DNA Methylation, Histone Acetylation*; Regulatory RNAs: *siRNA, miRNA*; CRISPR-Cas Mechanism; Regulatory Elements: *Enhancers, Silencers, Transcription Factors*

Unit-IV: Genetics – Classical and Molecular Aspects **12 hours**

Mendelian Principles: Dominance, Segregation, Independent Assortment. Extensions of Mendelian Inheritance: *Incomplete Dominance, Codominance, Epistasis, Multiple Alleles*; Linkage, Crossing Over, Gene Mapping Techniques; Sex-Linked and Mitochondrial Inheritance; Pedigree Analysis; Chromosome Structure and Behaviour; Chromosomal Mutations: *Deletion, Duplication, Inversion, Translocation*; Aneuploidy and Polyploidy: Case Examples: Down Syndrome, Klinefelter's Syndrome, Turner Syndrome

Recommended Textbooks

1. Alberts, B. et al. (2022). **Molecular Biology of the Cell** (7th ed.). Garland Science.
2. Pierce, B. A. (2023). **Genetics: A Conceptual Approach** (7th ed.). W.H. Freeman.
3. Lodish, H. et al. (2021). **Molecular Cell Biology** (9th ed.). Macmillan Learning.
4. Snustad, D. P., & Simmons, M. J. (2020). **Principles of Genetics** (8th ed.). Wiley.
5. Alberts, B. et al. (2022). **Essential Cell Biology** (6th ed.). Garland Science.

Reference Books

1. Craig, N. L. et al. (2020). **Molecular Biology: Principles of Genome Function** (3rd ed.). Oxford University Press.

2. Brown, T. A. (2023**). Genomes 5** (5th ed.). Garland Science.
3. Krebs, J. E., & Goldstein, E. S. (2021**). Lewin's Genes XII (12th ed.)**. Jones & Bartlett Learning.
4. Griffiths, A. J. F. et al. (2020). Introduction to Genetic Analysis (12th ed.). W.H. Freeman.
5. Pevsner, J. (2022). **Bioinformatics and Functional Genomics (3rd ed.).** Wiley-Blackwell.

Online Resources

1. NCBI Bookshelf: https://www.ncbi.nlm.nih.gov/books/
2. Learn. Genetics – University of Utah: https://learn.genetics.utah.edu/

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0101	Basic Statistics and R-programming	DSC	3	0	0	3	4

Prerequisites: Basic knowledge of mathematics at the higher secondary level.

Course objectives

1. To impart foundational knowledge of statistical data collection, classification, tabulation, and visualization.
2. To introduce R programming and its application in data analysis using real-world datasets.
3. To develop skills to analyse univariate and bivariate data using statistical measures.
4. To apply basic probability principles and hypothesis testing in scientific contexts, especially in biological and health data.

Course Outcomes

1. Organize and present statistical data using tables, graphs, and charts.
2. Understanding the basic R programs for statistical analysis.
3. Compute and interpret measures of central tendency and dispersion.
4. Analyse data using moments, skewness, and kurtosis to study distribution shape.
5. Explore correlation and regression analysis to interpret bivariate relationships.
6. Apply the principles of probability and related theorems to solve problems in scientific contexts.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	0	0	1	2	1	2	1	3	2	1
CO2	3	3	2	3	0	1	1	2	1	3	2	3	3	2
CO3	3	2	1	2	1	0	0	1	0	2	2	3	2	1
CO4	3	2	2	2	1	1	0	1	0	2	2	3	2	2
CO5	3	3	2	2	1	1	1	2	1	3	2	3	3	2
CO6	3	3	2	2	1	1	1	1	1	3	2	3	3	2

Course content

Unit I: Introduction to Statistics **12 Hours**

Statistics: Meaning, importance, scope, and limitations of statistics; Concepts: *population vs. sample, variable vs. attribute*; Data: *meaning, quantitative (discrete and continuous) and qualitative, cross-sectional and time-series*; Scales of measurement: *nominal, ordinal, interval, ratio*; Classification, tabulation, and construction of statistical tables; Diagrammatic presentation: bar chart, pie chart; Frequency distribution:

basic concepts, definition and types; graphical presentation: histogram, frequency polygon, ogive, frequency curve. Boxplot. Application problems related to life sciences.

Unit-II: Introduction to R Programming **12 Hours**

Introduction to R and RStudio; features, advantages, and applications of R; Installation and environment setup; Syntax, operators, comments, keywords, I/O, data types and variable; Installing and loading packages :install.Packages(), library(); Data structures: Vectors, matrices, arrays, lists, factors, data frames; Control structures: conditional statements(if, if-else, if-else-if) , loops (for, while), functions; Packages: Introduction to dplyr, ggplot2, readr, readxl and summarytools; Basic data cleaning and transformation; Writing simple statistical programs in R; Reproducible reports using R Markdown (basic introduction).

Unit III: Univariate Data Analysis and EDA **12 Hours**

Measures of central tendency: Mean, median, mode, geometric and harmonic mean; Quantiles: quartiles, deciles, percentiles; Measures of dispersion: Range, SD, variance, quartile deviation, coefficient of variation; Moments: Raw and central moments (with relation); Skewness and kurtosis: Concepts, types, measures and interpretation. Application problems related to life sciences.

Unit IV: Bivariate Analysis and Basic Probability **12 Hours**

Bivariate data analysis**:** Bivariate data, Scatter plots, covariance, correlation (Pearson's and Spearman's), Curve fitting-concept, principle of least squares, fitting of linear equation; Linear regression, regression lines, fitting of lines of regression by the least squares method, interpretation of slope and intercept, regression equations, regression co-efficients and their properties. Probability: Basic terms, Classical, empirical, and axiomatic definitions of probability, Addition and multiplication theorems, conditional probability, Bayes' theorem with biological examples.

Reference Books

1. Sundar Rao, P.S.S., & Richard, J. (2012). **Introduction to Biostatistics and Research Methods.** PHI.
2. Veer Bala Rastogi (2015). **Biostatistics**, MedTech, New Delhi.
3. Wayne W. Daniel & Chad L. Cross (2014). **Biostatistics: Basic Concepts and Methodology for the Health Sciences.** Wiley.
4. Hadley Wickham & Garrett Grolemund. **R for Data Science.** O'Reilly (freely available online).
5. Mukhopadhyay, P. (2015). **Mathematical Statistics.** Books & Allied Pvt Ltd, Kolkata.
6. Gupta, S.C. & Kapoor, V.K. (2020). **Fundamentals of Mathematical Statistics.** Sultan Chand & Sons.
7. Goon, A.M., Gupta, M.K., & Das Gupta, B. (2017). **Fundamentals of Statistics,** Vol. I. World Press.
8. Crawley, M. (2013). **Statistics: An Introduction Using R.** Wiley.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0101	Essentials of Programming in Python	DSC	3	0	0	3	4

Prerequisites: Basic knowledge of computer operations and logic building

Course Objectives

- To introduce the fundamentals of Python programming language.

- To develop logic-building and problem-solving skills using structured and modular programming.
- To apply Python in scientific computation and data manipulation.
- To introduce libraries useful for data science, bioinformatics, and statistical computing.

Course Outcomes

- Understand the structure and syntax of Python programs.
- Apply data types, operators, control structures, and functions to solve basic problems.
- Handle files and perform error handling using exceptions.
- Use built-in and third-party modules for scientific and statistical applications.
- Manipulate and analyse data using NumPy and Pandas.
- Develop simple applications and scripts for real-life and scientific tasks.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	0	0	0	1	1	2	2	3	2	1
CO2	3	3	2	3	0	0	1	1	1	3	2	3	3	2
CO3	3	2	2	2	0	1	1	1	1	2	3	3	2	2
CO4	3	3	2	3	1	1	1	2	1	3	3	3	3	2
CO5	3	3	3	3	1	1	1	2	2	3	3	3	3	3
CO6	3	3	2	3	1	1	2	2	2	3	3	3	3	2

Course content

Unit-I: Python Fundamentals and Control Structures **12 Hours**

Introduction to Python: Features, Installation, IDEs (Jupyter/VS Code); Python syntax, variables, keywords, data types, typecasting; Operators: Arithmetic, Logical, Relational, Assignment, Bitwise; Input and Output functions *(input(), print());* Conditional statements: *if, if-else, if-elif-else*; Looping structures: *for, while, break, continue, pass*.

Unit-II: Sequences and Functions **12 Hours**

Strings: creation, indexing, slicing, built-in methods; Lists: creation, indexing, slicing, mutability, list methods; Tuples: creation, accessing elements, operations; Dictionaries: key-value pairs, updating, deleting elements, built-in methods; Functions: def, parameters, return values, default/keyword arguments, recursion, lambda. Recursion; Modules and Packages: Importing and creating custom modules.

Unit-III: File and Exception Handling **12 Hours**

File operations: Opening, reading, writing, appending, closing; Working with text and CSV files; Exception handling: try, except, else, finally, raising exceptions; Debugging techniques and use of assert; User-defined exceptions and multiple exception handling.

Unit-IV: Introduction to Libraries and Applications **12 Hours**

Introduction to NumPy: Arrays, array operations, reshaping, broadcasting; Introduction to Pandas: Data Frames, Series, reading/writing data, filtering, indexing; Plotting with Matplotlib: Line plots, bar charts, histograms, scatter plots.

Textbooks

1. Reema Thareja (2023), **Python Programming Using Problem Solving Approach,** Oxford University Press.
2. R. Nageswara Rao (2021), **Core Python Programming,** Dreamtech Press.
3. Tushar Gupta (2023), **Python Programming: A Modern Approach**, BPB Publications.
4. Dr. M. K. Sharma (2022) – **Fundamentals of Python Programming,** Laxmi Publications.

Reference Books

1. Mark Lutz (2021), **Learning Python (5th Edition),** O'Reilly Media.
2. Charles R. Severance (2023), **Python for Everybody: Exploring Data in Python 3**, available via py4e.com.
3. Allen B. Downey (2023), **Think Python: How to Think Like a Computer Scientist,** Green Tea Press / O'Reilly.
4. Paul Barry (2023), **Headfirst Python (2nd Edition),** O'Reilly Media.
5. Yashavant Kanetkar (2021), **Let Us Python,** BPB Publications.
6. Python Crash Course: **A Hands-On, Project-Based Introduction to Programming** (2nd Edition).
7. Python Cookbook: **Recipes for Mastering Python 3** (3rd Edition).
8. Michel Dawson, **"Python Programming for Absolute Beginners",** Third Edition, Course Technology Cengage Learning Publications, 2013.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CPS111	Introduction to Artificial Intelligence	DSE	2	0	0	2	2

Prerequisite

Basic knowledge of programming logic, mathematics (sets, logic, functions), and problem-solving skills.

Course Objectives

1. To introduce the fundamental concepts and goals of Artificial Intelligence (AI).
2. To provide a basic understanding of problem-solving techniques using AI.
3. To expose students to search algorithms, knowledge representation, and reasoning.
4. To provide an overview of machine learning, intelligent agents, and real-world AI applications.

Course Outcomes

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

1. Explain the fundamentals, history, and scope of Artificial Intelligence.
2. Apply AI problem-solving techniques using uninformed and informed search algorithms.
3. Demonstrate the working of intelligent agents and their environment interactions.
4. Illustrate the principles of knowledge representation, propositional and predicate logic, and inference mechanisms.
5. Understand the foundational concepts of machine learning and its types.
6. Evaluate the ethical issues and real-world applications of AI in domains such as healthcare, robotics, and NLP.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	1	1	1	1	2	1	2	2	3	2	2
CO2	3	3	2	3	1	1	1	1	1	2	3	3	3	2
CO3	2	2	1	2	0	1	1	1	1	2	3	2	2	2
CO4	3	3	2	3	1	1	1	2	1	3	3	3	3	3
CO5	2	2	1	3	1	1	1	1	0	2	3	2	3	3
CO6	2	2	1	2	2	3	2	3	2	3	3	2	2	3

Course content

Unit I: Introduction to Artificial Intelligence **8 Hours**

Definition, history and evolution of AI; Characteristics of AI problems; Applications of AI: healthcare, robotics, natural language processing, computer vision; Intelligent agents: types of agents, agent architecture; Turing Test and foundations of AI.

Unit II: Problem Solving and Search Techniques **8 Hours**

Problem-solving as search; Problem formulation; Uninformed search strategies: Breadth-first search (BFS), Depth-first search (DFS), Uniform Cost Search; Informed search strategies: Greedy Best-First Search, A* Algorithm.

Unit III: Knowledge Representation and Reasoning **8 Hours**

Knowledge-based agents; Propositional logic: syntax and semantics; First-order logic: syntax, semantics, quantifiers; Inference in FOL: unification, forward and backward chaining; Semantic networks, frames, ontologies; Rule-based systems and production rules

Unit IV: Basics of Machine Learning and AI Applications **8 Hours**

Introduction to machine learning: supervised, unsupervised, reinforcement learning, Overview of algorithms: Decision Trees, k-NN, k-means (basic idea only); AI in real-world: recommendation systems, chatbots, autonomous vehicles; Ethics in AI: bias, transparency, fairness, accountability; Future trends in AI.

Textbooks and References

1. Elaine Rich, Kevin Knight, Shivashankar B. Nair, **Artificial Intelligence**, 3rd Edition, 2017, McGraw-Hill Education.
2. Nils J. Nilsson, **The Quest for Artificial Intelligence: A History of Ideas and Achievements,** 1st Edition, 2010, Cambridge University Press.
3. Tom M. Mitchell, **Machine Learning,** 1st Edition, 1997, McGraw-Hill Education.
4. Kevin P. Murphy, **Machine Learning: A Probabilistic Perspective,** 1st Edition, 2012, MIT Press.
5. George F. Luger, **Artificial Intelligence: Structures and Strategies for Complex Problem Solving,** 6th Edition, 2008, Pearson.
6. Deepak Khemani, **A First Course in Artificial Intelligence,** 1st Edition, 2013, McGraw-Hill Education.
7. Stuart Russell & Peter Norvig, **Artificial Intelligence: A Modern Approach,** 4th Edition, 2020, Pearson.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CPS112	Introduction to Computer Networks	DSE	2	0	0	2	2

Prerequisite: Basic knowledge of computer organization and operating systems.

Course Objectives:

1. To understand the fundamental concepts of data communication and networking models.
2. To explore various networking devices, protocols, and architectures.
3. To analyse the functionalities of different network layers in the OSI and TCP/IP models.
4. To introduce wireless communication, network security, and emerging trends.

Course Outcomes

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

1. Describe the fundamentals of computer networks, their types, and architectures.
2. Explain the OSI and TCP/IP models and the role of each layer.
3. Analyse different network transmission media, devices, and topologies.
4. Understand the principles of data transmission, error detection, and flow control.
5. Interpret addressing schemes (IP, MAC), subnetting, and routing protocols.
6. Discuss the basics of wireless networks, network security, and modern network applications.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	1	1	2	1	2	2	3	2	2
CO2	3	3	1	2	1	1	1	2	1	2	3	3	2	2
CO3	3	2	1	3	2	1	1	1	1	2	2	3	3	2
CO4	3	2	2	3	1	2	1	2	2	3	3	3	3	2
CO5	2	2	1	2	3	2	1	1	1	3	3	2	2	3
CO6	2	2	1	2	2	3	2	3	2	3	3	2	2	3

Course content

Unit I: Introduction to Computer Networks **8 Hours**

Introduction to computer networks; Network types: LAN, MAN, WAN, PAN; Network topologies: Star, Bus, Ring, Mesh; Network devices: Hub, Switch, Router, Bridge, Gateway; Network architectures: Peer-to-peer, Client-server; Applications of networks.

Unit II: Reference Models and Data Transmission **8 Hours**

OSI Model – Functions of 7 layers; TCP/IP Model and comparison with OSI; Transmission media – Guided (Twisted pair, Coaxial, Fiber optic) and Unguided (Radio, Microwave, Infrared); Analog and digital transmission; Bandwidth, throughput, latency; Transmission impairments – attenuation, noise, distortion.

Unit III: Data Link and Network Layer **8 Hours**

Framing, error detection and correction (CRC, parity); Flow control and access mechanisms (Stop and wait, sliding window, CSMA/CD); MAC addressing; IP addressing: IPv4 and IPv6, subnetting, CIDR; Routing algorithms: Distance vector, Link state.

Unit IV: Transport, Application Layers and Modern Networks **8 Hours**

Transport layer protocols: TCP, UDP; Ports and sockets; Application layer protocols: DNS, HTTP, SMTP, FTP, DHCP; Basics of wireless and mobile networks: Wi-Fi, Bluetooth, Cellular; Introduction to network security: Encryption, Firewall, VPN, IDS.

Recommended Books and References

1. Andrew S. Tanenbaum, ***Computer Networks*****,** 5th Edition, Pearson, 2017.
2. Behrouz A. Forouzan, ***Data Communications and Networking*****,** 5th Edition, McGraw-Hill, 2017.
3. James F. Kurose and Keith W. Ross, ***Computer Networking: A Top-Down Approach*****,** 7th Edition, Pearson, 2016.
4. William Stallings, ***Data and Computer Communications*****,** 10th Edition, Pearson, 2013.
5. Douglas E. Comer, ***Internetworking with TCP/IP – Principles, Protocols and Architecture***, 6th Edition, Pearson, 2013.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0102	Lab: Biology for Bioinformatics	DSE	0	0	2	2	3

Prerequisite

Basic understanding of cell biology, biomolecules (DNA, RNA, proteins), and principles of inheritance at the 10+2 level.

Course Objectives

1. Understand the molecular mechanisms governing the storage, replication, and transmission of genetic information.
2. Explore the role of genes, DNA, RNA, and proteins in the regulation of cellular and organismal functions.
3. Study patterns of inheritance, gene interactions, and chromosomal behaviour in both prokaryotes and eukaryotes.
4. Apply theoretical knowledge through experiments and simulations to understand molecular genetics processes.

Course Outcomes

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

1. Describe the structure and function of nucleic acids and their role in heredity.
2. Explain the mechanisms of gene expression and regulation in prokaryotes and eukaryotes.
3. Apply Mendelian and non-Mendelian principles to solve genetic problems.
4. Analyse chromosomal behaviour and genetic variation and relate them to disorders.
5. Evaluate gene regulation processes and their implications in health and disease.
6. Perform and interpret basic experiments in molecular biology and genetics using laboratory and digital tools.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	0	1	3	2	0	2	2	2	0	0
CO2	3	3	3	3	0	2	0	2	0	2	3	3	2	0

CO3	2	2	2	0	0	1	0	2	0	2	2	0	0	0
CO4	2	3	2	0	0	1	2	2	0	3	3	0	2	0
CO5	3	3	2	2	1	0	0	0	0	2	3	2	0	0
CO6	3	3	3	3	2	2	2	3	2	3	3	3	3	3

Course Content

1. Microscopic Observation of Prokaryotic and Eukaryotic Cells
2. Staining and Visualization of Cell Organelles
3. Study of Mitosis using Onion Root Tip Squash (Identifying G1, S, G2, and M phases)
4. Isolation and quantification of genomic DNA from plant/ bacterial sources
5. Agarose gel electrophoresis for DNA visualization and purity check
6. Estimation of DNA Concentration Using UV Spectrophotometer
7. Protein expression analysis: SDS-PAGE or Western blot
8. Pedigree Analysis Practice (Paper-based/Worksheet)
9. Observation of Human Traits for Genetic Variation
10. Karyotyping and analysis of chromosomal disorders (e.g., Down Syndrome)

Bioinformatics Lab

1. Introduction to NCBI Databases
2. Understanding of Genome Browsers
3. Understanding of chromosomes and genome arrangements
4. Identification of Down Syndrome using biological database
5. Understanding of SNP databases

Reference Books

1. Alberts B. et al. – **Molecular Biology of the Cell,** 6th Edition, Garland Science, 2015.
2. Karp G. **– Cell and Molecular Biology: Concepts and Experiments,** 8th Edition, Wiley, 2018.
3. Dee Unglaub Silverthorn – **Human Physiology: An Integrated Approach**, 8th Edition, Pearson, 2019.
4. Watson J.D. et al. – **Molecular Biology of the Gene,** 7th Edition, Pearson, 2013.
5. Lodish H. et al. – **Molecular Cell Biology,** 9th Edition, W.H. Freeman, 2021.
6. David Freifelder – **Molecular Biology, 2nd Edition,** Narosa Publishing, 2008.
7. Snustad D.P. & Simmons M.J. – **Principles of Genetics,** 7th Edition, Wiley, 2015.
8. Griffiths A.J.F. et al. – **Introduction to Genetic Analysis,** 12th Edition, W.H. Freeman, 2020.
9. T.A. Brown – Genomes 4, Garland Science, 2017. (genomics + molecular genetics)
10. Jonathan Pevsner – **Bioinformatics and Functional Genomics,** 3rd Edition, Wiley-Blackwell, 2015.
11. Rastogi S.C. et al. – **Bioinformatics: Concepts, Skills & Applications,** 2nd Edition, CBS Publishers, 2018.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0102	Lab: Basic Statistics and R-programming	DSE	0	0	2	2	3

Prerequisite: Basic knowledge of mathematics and computer usage.

Course Objectives

1. To introduce data organization and statistical summarization using R programming.
2. To provide practical experience in descriptive and inferential statistical methods.
3. To enable students to analyse univariate and bivariate data using R.
4. To apply probability concepts and basic modelling techniques for biological data.

Course Outcomes (COs)

After completing this course, students will be able to:

1. Construct frequency distributions and visualize data graphically using R.
2. Understanding R programming syntax to perform statistical operations and manage data structures.
3. Compute and interpret measures of central tendency for life science datasets.
4. Analyse variability and data distribution using dispersion, skewness, and kurtosis measures.
5. Apply regression and correlation techniques to explore data relationships.
6. Solve fundamental principles of probability to model uncertainty and solve real world problems.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	3	0	0	0	2	0	2	2	2	0	0
CO2	3	3	0	3	0	0	0	0	0	3	3	3	2	0
CO3	3	2	0	2	0	0	0	0	0	2	2	2	0	0
CO4	3	2	0	2	0	0	0	0	0	2	3	2	0	0
CO5	3	3	2	3	0	0	0	2	0	3	3	3	2	1
CO6	3	3	2	3	0	0	0	2	0	3	3	2	2	0

Course Content

1. Construct frequency distributions and perform graphical presentation of data
2. Calculate and interpret Mean (AM, GM, HM) and Weighted AM
3. Calculate and interpret Median, Mode, Quartiles, Deciles, Percentiles.
4. Compute and interpret Range, Quartile Deviation, Mean Deviation.
5. Calculate and interpret Standard Deviation and Coefficient of Variation.
6. Compute and interpret moments, skewness and kurtosis.
7. Fit linear and quadratic curves using the method of least squares.
8. Perform correlation analysis using scatter diagram, Karl Pearson and Spearman methods .
9. Fit simple linear regression and interpret regression coefficients.
10. Compute probabilities using combinatorial methods, addition and multiplication theorems.
11. Calculate conditional probabilities and solve problems using Bayes' theorem.
12. Mini Project: Life science dataset analysis (gene expression/survey data) using complete R workflow.

Reference Books

1. Sundar Rao P.S.S. & Richard J. **– Introduction to Biostatistics and Research Methods,** 5th Ed., PHI, 2012.
2. Veer Bala Rastogi – **Biostatistics,** 3rd Ed., MedTech, 2015.
3. Wayne W. Daniel & Chad L. Cross – **Biostatistics: Basic Concepts and Methodology for the Health Sciences,** 10th Ed., Wiley, 2014.

4. Mukhopadhyay, P. – **Mathematical Statistics,** Books and Allied, 2015.
5. S.C. Gupta & V.K. Kapoor – **Fundamentals of Mathematical Statistics,** 11th Ed., Sultan Chand, 2020.
6. Tilman M. Davies – **The Book of R: A First Course in Programming and Statistics,** No Starch Press, 2016.
7. John Verzani – **Using R for Introductory Statistics,** 2nd Ed., CRC Press, 2014.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0102	Lab: Programming in Python	DSE	0	0	2	2	3

Prerequisite: Basic knowledge of computer operations and logical thinking.

Course Objectives

1. To introduce the fundamental concepts and syntax of Python programming.
2. To develop problem-solving skills using Python's data structures and functions.
3. To equip students with practical knowledge of file handling and exception management.
4. To provide exposure to libraries like NumPy, Pandas, and Matplotlib for scientific computing and data visualization.

Course Outcomes

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

1. Understand and apply core Python syntax, data types, operators, and control structures.
2. Manipulate strings, lists, tuples, and dictionaries for real-time applications.
3. Write modular programs using user-defined functions, recursion, and lambda expressions.
4. Implement file operations and exception handling techniques in Python programs.
5. Use Python libraries (NumPy, Pandas) for data analysis and Matplotlib for visualization.
6. Develop, debug, and test small applications relevant to data analysis and scripting tasks.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	1	2	1	2	1	3	2	3	2	1
CO2	3	2	2	3	1	2	2	2	1	2	3	3	3	2
CO3	3	3	2	3	1	2	1	2	1	2	2	3	3	2
CO4	3	3	2	3	2	3	1	2	1	3	3	3	3	2
CO5	3	3	2	3	2	2	2	2	1	3	3	3	3	3
CO6	3	3	3	3	2	2	2	3	2	3	3	3	3	3

Course Content

1. **Write a Python program to demonstrate variable declaration, data types, type casting, and basic operators.**

- Includes arithmetic, relational, and logical operations with *input()* and *print()*.

2. **Write a Python program to check whether a given number is even, odd, or prime using if-else statements.**

- Incorporates conditional logic and loops for simple decision making.

3. **Write a Python program to generate a multiplication table and calculate factorial using both for and while loops.**

- Demonstrates loop control with break, continue, pass.

4. **Write a Python program to perform string operations – slicing, indexing, and use of built-in methods (e.g., *.lower(), .find(), .replace()).***
5. **Write a Python program to perform list and tuple operations:**

- Create a list, modify, append, sort, and remove elements.
- Demonstrate tuple indexing and immutability.

6. **Write a Python program to use dictionaries:**

- Add, update, delete key-value pairs.
- Iterate over dictionary items.
- Count word occurrences from a sentence.

7. **Write a Python program using functions:**

- Create a function with default and keyword arguments.
- Create a recursive function to compute factorial.
- Use lambda to filter even numbers from a list.

8. **Write a Python program to read a text file and count the number of uppercase, lowercase, digits, and special characters.**

- Handle file not found and other exceptions using try-except-finally.

9. **Write a Python program to create a CSV file containing student details and read it back using Python file and CSV module.**

- Demonstrates reading/writing structured data with exception handling.

10. **Write a Python program using NumPy, Pandas, and Matplotlib to:**

- Create a NumPy array and perform basic operations.
- Load a CSV file using Pandas and perform basic filtering.
- Generate a bar plot and scatter plot using Matplotlib.

Textbooks and Reference Books

1. R. Nageswara Rao – ***Core Python Programming*****,** Dream tech Press, 2nd Edition, 2023.
2. Mark Lutz – ***Learning Python*****,** O'Reilly Media, 5th Edition, 2023.
3. Allen B. Downey – ***Think Python: How to Think Like a Computer Scientist*****,** Green Tea Press / O'Reilly, 2nd Edition, 2020.
4. Reema Thareja – ***Python Programming: Using Problem Solving Approach*****,** Oxford University Press, 1st Edition, 2022.
5. Dr. R. S. Salaria – ***Programming in Python*****,** Khanna Publishing House, 2021.
6. Zed A. Shaw – ***Learn Python the Hard Way*****,** Addison-Wesley, 3rd Edition, 2021.
7. Paul Barry – ***Headfirst Python*****,** O'Reilly Media, 2nd Edition, 2019.
8. John Zelle – ***Python Programming: An Introduction to Computer Science*****,** Franklin, Beedle & Associates Inc., 3rd Edition, 2022.
9. Y. Daniel Liang – ***Introduction to Programming Using Python*****,** Pearson, 2021.
10. Luciano Ramalho – ***Fluent Python: Clear, Concise, and Effective Programming*****,** O'Reilly Media, 2nd Edition, 2022.

SECOND SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHK203	Language - II: Kannada - II	AEC	3	0	0	3	3

Prerequisite / Pre reading for the course

- ಕನ್ನಡ ಭಾಷೆಯ ಬಗೆಗೆ ಪ್ರಾಥಮಿಕ ತಿಳುವಳಿಕೆ ಅಗತ್ಯ.
- ಭಾಷೆಯನ್ನು ಓದಲು ಮತ್ತು ಬರೆಯಲು ತಿಳಿದಿರಬೇಕು.
- ಪದವಿ ಪೂರ್ವ ಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯನ್ನು ಓದಿರಬೇಕು.

Course Objectives:

1. ಭಾಷೆ, ಸಾಹಿತ್ಯ, ಇತಿಹಾಸ ಮತ್ತು ಸಂಸ್ಕೃತಿಗಳನ್ನು ಕನ್ನಡ, ಕರ್ನಾಟಕಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ. ಹಾಗೂ ವೈವಿಧ್ಯಮಯ ಭಾರತದ ಸಾಂಸ್ಕೃತಿಕ ನೆಲೆಗಳನ್ನು ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ
2. ವಿದ್ಯಾರ್ಥಿಗಳ ಸರ್ವತೋಮುಖ ಬೆಳವಣಿಗೆಗೆ ಅನುವಾಗುವಂತೆ ಹಾಗೂ ಅವರಲ್ಲಿ ಮಾನವ ಸಂಬಂಧಗಳ ಬಗ್ಗೆ ಗೌರವ, ಸಮಾನತೆ ಮೂಡಿಸಿ, ಬೆಳೆಸುವ ನಿಟ್ಟಿನಲ್ಲಿ ಪಠ್ಯಗಳ ಆಯ್ಕೆಯಾಗಿದೆ.
3. ಅವರಲ್ಲಿ ಸೃಜನಶೀಲತೆ, ಶುದ್ಧ ಭಾಷೆ, ಉತ್ತಮ ವಿಮರ್ಶಾ ಗುಣ, ನಿರರ್ಗಳ ಸಂಭಾಷಣೆ, ಭಾಷಣ ಕಲೆ ಬರಹ, ವೃತ್ತಿ ಪೂರ್ವಕ ಕೌಶಲ್ಯಗಳನ್ನು ಬೆಳೆಸುವುದು ಗುರಿಯಾಗಿದೆ
4. ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ಅನುಕೂಲವಾಗುವಂತಹ ವಿಷಯಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ಸೂಕ್ತ ಪಠ್ಯಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ.

Course Outcomes:

ಜೀವನ ಕಲೆ, ಕನಸು, ದಾಂಪತ್ಯ ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಸಾಹಿತ್ಯ ಪಠ್ಯಗಳ ಕಲಿಕೆಯ ಮೂಲಕ ಅವುಗಳ ಒಳನೋಟಗಳನ್ನು ಬೆಳೆಸುತ್ತದೆ.

1. ಸಾಮಾಜಿಕ, ರಾಜಕೀಯ, ಧಾರ್ಮಿಕ, ಸಾಂಸ್ಕೃತಿಕ, ಪರಿಸರ ಹಾಗೂ ಲಿಂಗಸಂಬಂಧಿ ಸೂಕ್ಷ್ಮತೆಯ ವಿಚಾರಗಳೆಡೆ ಗಮನ ಹರಿಸುವುದರೊಂದಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಚರ್ಚಾ ಮನೋಭಾವವು ಬೆಳೆಸುತ್ತದೆ.
2. ಜೀವನದಲ್ಲಿ ಬರುವ ಅಭಿಪ್ರಾಯ ಬೇಧಗಳ ವಿವಿಧ ಆಯಾಮಗಳೊಂದಿಗೆ ಆಧುನಿಕ ಸಂದರ್ಭದಲ್ಲಿ ಮಾನವೀಯತೆಯೊಂದಿಗೆ ನಿರ್ವಹಿಸುವಂತೆ ಪ್ರೇರೇಪಿಸುತ್ತದೆ.
3. ಉತ್ತಮ ಸಂವಹನ ಕಲೆಯನ್ನು ಬೆಳೆಸುವ ಉದ್ದೇಶವನ್ನು ಈಡೇರಿಸುತ್ತದೆ.
4. ಸಂಶೋದನಾ ಮನೋಭಾವ ಮತ್ತು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸುತ್ತದೆ.
5. ಭಾಷೆ ಮತ್ತು ಭಾಷೆ ಮತ್ತು ಸಾಹಿತ್ಯದ ಶ್ರೀಮಂತಿಕೆ ಜೊತೆಗೆ ಮಾನವೀಯ ಮೌಲ್ಯಗಳನ್ನು ಕಲಿಯುವಿರಿ.
6. ಸದೃಢ ಬೌದ್ಧಿಕ ಮತ್ತು ಮಾನಸಿಕ ವನುನ ವಿಕಾಸಿಸುತುದೆ.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	1	0	1	0	0	0	0	0	0	0	3	0	1
CO2	1	0	1	0	0	1	1	0	1	0	0	2	1	1
CO3	1	2	0	1	0	0	0	0	1	0	0	3	1	0
CO4	1	2	0	0	0	0	1	0	1	1	0	2	1	0
CO5	1	2	0	1	0	0	0	0	1	0	1	3	1	0
CO6	1	2	0	0	0	0	1	0	1	1	1	2	1	0

Course Content

Unit I: ಜೀವನ ಕಲೆ

10 Hours

1.1 ಬುದ್ಧ — ದ. ರಾ. ಬೇಂದ್ರೆ

1.2 ಒಡಲಾಳ — ದೇವನೂರು ಮಹದೇವ

1.3 ಸಂಸ್ಕೃತಿಯ ಪರಿಚಿತಿಗೆ — ಶಿವರಾಮ ಕಾರಂತ

Unit II: ಕನಸು **10 Hours**

2.1 ಒಂದಿರಳು ಕನಸಿನಲಿ — ಕೆ. ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ

2.2 ಕನಸೆಂಬ ಕುದುರೆಯನೇರಿ — ಅಮರೇಶ್ ನುಗಡೋಣಿ
2.3 ನನಗೊಂದು ಕನಸಿದೆ — ಮಾರ್ಟಿನ್ ಲೂಥರ್ ಕಿಂಗ್ (ಜೂ.)

Unit III: ದಾಂಪತ್ಯ **10 Hours**

3.1 ಎಲ್ಲರಂತವನಲ್ಲ ನನಗಂಡ — ಶಿಶುನಾಳ ಶರೀಫ
3.2 ಅಕ್ಕು — ವೈದೇಹಿ
3.3 ಸರಳ ಮದುವೆಗಾಗಿ — ಕಡಿದಾಳು ಶಾಮಣ್ಣ

Unit IV: ಸಂಕೀರ್ಣ **9 Hours**

4.1 ಮಾನವ ನಿರ್ಮಿತ ಮಹಾಸಮಸ್ಯೆಗಳು — ನಗೇಶ್ ಹೆಗಡೆ
4.2 ಆನ್ಲೈನ್ ಮಾರುಕಟ್ಟೆಯ ಕಷ್ಟ-ಸುಖ — ಯಶವಂತ ಡೊಂಗ್ರೇ
4.3 ದೇಶಪ್ರೇಮ ಮತ್ತು ಸರ್ಕಾರ — ಕೆ. ಮರುಳಸಿದ್ದಪ್ಪ

TextBooks:

ಸಂಯೋಜಿತ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ **'ಗಣಕ-ವಿಜ್ಞಾನ ಸೌರಭ' – ಎರಡನೇ ಸೆಮಿಸ್ಟರ್ ಬಿಸಿಎ ಮತ್ತು ಬಿಎಸ್ಸಿ (ಎಎಸ್)**

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು:

1. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಸಂಕತನ-ಡಾ ಕರಿಗೌಡ ಬೀಚನಹಳ್ಳಿ, ಪ್ರಸಾರಾಂಗ ಕನ್ನಡ ವಿ ವಿ ಹಂಪಿ, 2017
2. ಪರಿಸರ ಅಧ್ಯಯನ- ಪ್ರೋ. ಕೆ ಬೈರಪ್ಪ, ಸ್ವಪ್ನ ಬುಕ್ ಹೌಸ್, ಬೆಂಗಳೂರು, 2006
3. ಕುವೆಂಪು ಸಂಚಯ- ಸಂ. ಡಾ. ದೇಜಗೌ, ಕುವೆಂಪು ಭಾಷಾ ಭಾರತಿ ಪ್ರಾದಿಕಾರ, ಬೆಂಗಳೂರು, 2009
4. ಸಾಹಿತ್ಯ ಸಂಸ್ಕೃತಿ ಮತ್ತು ದಲಿತ ಪ್ರಜ್ಞೆ - ಡಾ ಅರವಿಂದ ಮಾಲಗತ್ತಿ, ಕನ್ನಡ ಸಾಹಿತ್ಯ ಪರಿಷತ್ತು, ಬೆಂಗಳೂರು, 2014
5. ಎದೆಗೆ ಬಿದ್ದ ಅಕ್ಷರ- ದೇವನೂರು ಮಹಾದೇವ, ಅಭಿನವ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು, 2013
6. ನಮ್ಮ ಸಂಸ್ಕೃತಿ ಪರಂಪರೆ - ಬೆಟಗೇರಿ ಕೃಷ್ಣಶರ್ಮ, ಕನ್ನಡ ಸಂಸ್ಕೃತಿ ಇಲಾಖೆ, ಬೆಂಗಳೂರು, 2011
7. ಲೋಹಿಯಾ ವ್ಯಕ್ತಿ ಮತ್ತು ವಿಚಾರ- ಬಾಪೂ ಹೆದ್ದೂರ ಶೆಟ್ಟಿ, ಲಡಾಯಿ ಪ್ರಕಾಶನ ಗದಗ, 2012

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHA201	Language – II: Additional English - II	AEC	3	0	0	3	3

Course Description:

This is a 3 credit course designed to help the learner gain a deeper understanding of the society and the world at large, which will be not only beneficial for his professional competence but also contribute towards his/her social and cultural development.

Course Objectives:

1. To help the student understand the multiple values of the society.
2. To develop a cultural understanding in the student to sharpen his/her social skills.
3. To ensure a gradual development of literary interest in the student.
4. To develop in the students a genuine habit of reading and writing leading to effective and efficient communication.

Course Outcomes:

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

1. Get acquainted with major religious, political and social movements and their influence on literature.
2. Design various interpretative techniques to approach literary texts of varied genres.
3. Analyse literary works for their structure and meaning.
4. Demonstrate a deep understanding of the society and its values.
5. Develop a constructive understanding of the cultural dimensions of the human world.
6. Make use of his understanding to become a responsible global citizen of tomorrow.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	0	1	1	0	1	0	2	1	2	0	1	1	0
CO2	0	1	0	1	0	0	1	0	0	1	0	1	0	1
CO3	2	0	1	1	0	0	2	0	0	1	0	2	2	0
CO4	1	0	1	1	1	0	1	0	1	1	0	3	1	0
CO5	1	0	1	1	1	0	1	0	1	1	1	3	1	0
CO6	1	0	1	1	1	0	1	0	1	1	1	3	1	0

Course Content:

Unit-I: Ecology & Environment **10 Hours**

Literature: William Wordsworth – Lines Written in Early Spring

Robert Frost – The Sound of Trees

Rachael Carson- *Silent Spring* (Extracts)

Language: Degrees of Comparison

Unit-II: Voices from the Margin **10 Hours**

Literature: Langston Hughes- Dream Deferred

Pavel Friedmann – The Butterfly

Prem Chand – The Thakur's Well

Language: Book / Movie Review

Unit-III: Women & Society **10 Hours**

Literature: Audre Lorde – A Woman Speaks

Charlotte Anna Perkins Gilman – To the Indifferent Women

Amrita Pritam : The Weed

Writing Skills: Dialogue Writing

Unit-IV: Popular Culture **9 Hours**

Literature: Rudyard Kipling – The Beginning

Aldous Huxley – Beauty Industry

Alvin Toffler – *Future Shock* (Extracts)

Writing Skills: Story Writing

Reference Books

1. Agrawal, K.A. *Toru Dutt the Pioneer Spirit of Indian English Poetry - A Critical Study*. Atlantic Publications, 2009.

2. Latham, Edward Connery (ed). *The Poetry of Robert Frost*. Holt Paperbacks, 2002.
3. Gale, Cengage Learning. *A Study Guide for Tomas Rivera's The Harvest*. Gale, Study Guides, 2017.
4. Basu, Tejan Kumar. *The Life and Times of C.V. Ram*an. Prabhat Prakashan, 2016.
5. Rozewicz, Tadeusz. *New Poems*. Archipelago, 2007.
6. Manohar, Murli. *Critical Essays on Dalit Literature*. Atlantic Publishers, 2013.
7. Hansda, Sowvendra Shekhar. *The Adivasi Will Not Dance: Stories*. Speaking Tiger Publishing Private Limited, 2017.
8. Jacobs, Harriet. *Incidents in the Life of a Slave Girl*. Createspace Independent Publication, 2014.
9. Das, Kamala. *Selected Poems*. Penguin Books India, 2014.
10. Tagore, Rabindranath. *Selected Short Stories of Rabindranath Tagore*. Maple Press, 2012.
11. Gale, Cengage Learning. *A Study Guide for Jamaica Kincaid's Girl*. Gale, Study Guides, 2017.
12. Kipling, Rudyard. *The Absent-Minded Beggar*. Hardpress Publishing, 2013.
13. Doyle, Arthur Conan. *The Hound of the Baskervilles*. General Press, 2017.
14. Dixson, Robert J. *Everyday Dialogues in English*. Prentice Hall India Pvt Ltd., 1988.
15. Turton, Nigel D. *ABC of Common Errors*. Mac Millan Publishers, 1995.
16. Samson, T. (ed.) *Innovate with English.* Cambridge University Press, 2010.
17. Kumar, E Suresh, J. Savitri and P Sreehari (ed). *Effective English*. Pearson Education, 2009.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHH203	Language – II: HINDI-II	AEC	3	0	0	3	3

Course Overview: अध्ययन संक्षिप्त विवरण :

यह पाठ्यक्रम नौसिखिया, अपनी भाषा की क्षमता का विकास करने हेतु तथा विभिन्न साहित्यिक प्रक्रियाओं द्वारा समाज, संस्कृति एवं जीवन के मूल्यों को समझने हेतु अभिकल्पित है |

Prerequisites/Pre reading for the course: पूर्वापेक्षा:

- अध्येता, पी.यु.सी के स्तर पर द्वितीय भाषा के रूप में हिन्दी का अध्ययन करना चाहिए |
- हिन्दी साहित्य के इतिहास का संक्षिप्त ज्ञान की आवश्यकता है |
- हिन्दी व्याकरण का अवबोधन आवश्यक है |
- अंग्रेज़ी – हिन्दी अनुवाद से संबंधित जानकारी जरुरी है |

Course Objectives: पाठ्यक्रम उद्देश्य :

1. संदर्भानुसार उचित भाषा का प्रयोग करने की दक्षता को छात्रों में उत्पन्न करना |
2. साहित्य के माध्यम से समाज एवं मानवीय मूल्यों को समझाकर, उन मूल्यों की रक्षा हेतु प्रेरित करना |
3. छात्रों में पुस्तक पठन एवं लेखन की अकृतिम प्रवृत्ति स्थापित करना |
4. अध्येताओं में साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास करना |

Course Outcomes अधिगम परिणाम :

अध्ययन की समाप्ति पर अध्येता –

1. हिंदी साहित्य की विविध विधाओं का परिचय प्राप्त कर सकता है।
2. सामाजिक मूल्य एवं नैतिक जवाबदेही को स्वीकार कर सकता है।
3. साहित्य की प्रासंगिकता को जीवन में समझने की दक्षता रखता है।
4. समाज में अंतर्निहित पद्धतियाँ एवं विचारधाराओं का व्याख्यान करने में सक्षम बन सकता है।
5. साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास कर सकता है।
6. अनुवाद एवं व्यावहारिक ज्ञान से अवगत हो सकता है।

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0

Course Content: <u>अध्ययन विषय सूची / पाठ्यक्रम</u>

इकाई – 1 कविता - प्राचीन एवं आधुनिक **10 Hours**

1. कबीर के दोहे
2. कविता – सखी, वे मुझसे कहकर जाते- मैथिलीशरण गुप्त
3. कविता – प्रेत का बयान- नागार्जुन

इकाई – 2 कविता - प्राचीन एवं आधुनिक **10 Hours**

4. सूरदास के पद
5. कविता – संध्या सुंदरी - सूर्यकांत त्रिपाठी 'निराला'
6. कविता – छिप छिप अश्रु बहानेवालों - गोपालदास नीरज

इकाई – 3: कविता - प्राचीन एवं आधुनिक **10 Hours**

7. रहीम के दोहे
8. कविता – क्या करूँ संवेदना लेकर तुम्हारी - हरिवंशराय बच्चन
9. कविता – माँ के लिए ससुराल जाने से पहले - निर्मला पुतुल

इकाई – 4: अनुवाद , युनिकोड **9 Hours**

10. अनुवाद : शब्द (हिन्दी से अंग्रेज़ी)
11. अनु े द (ि◌ह ◌ी से अं े ज़ी)
12. यु◌िनकोड ि◌विध

सूचना : प्रत्येक इकाई 25 अंक केलिए निर्धारित है।

Textbook/s: पाठ्य पुस्तक :

1. हिन्दी पाठ्य पुस्तक – रेवा विश्वविद्यालय।

References: सन्दर्भ ग्रन्थ :

1. सुबोध व्यवहारिक हिन्दी – डॉ. कुलदीप गुप्त
2. अभिनव व्यवहारिक हिन्दी – डॉ.परमानन्द गुप्त
3. हिन्दी साहित्य का इतिहास - डॉ. नागेन्द्र
4. आधुनिक हिन्दी साहित्य का इतिहास - डॉ. बच्चन सिंह
5. हिन्दी साहित्य का नवीन इतिहास - डॉ. लाल साहब सिंह
6. शुद्ध हिन्दी कैसे बोले कैसे लिखे- पृथ्वीनाथ पाण्डे
7. इलेक्ट्रॉनिक मीडिया भाषा, लेखन कला तथा प्राविधि - डॉ. माया सगरे – लक्का
8. प्रयोजनमूलक हिंदी - डॉ. माया सगरे – लक्का

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHE201	Communicative English-II	AEC	3	0	0	3	3

Course Description:

This course focuses on enhancing written proficiency required for professional enhancement. It also polishes the spoken skills of the learners to make them effective and confident presenters. It also addresses the functional aspects of language usage while providing specific linguistic tools through professional language learning software. The practical components discussed in this course enables a fruitful transition from academia to the industry of their choice.

Pre-requisites: The student must possess functional knowledge of LSRW skills.

Course Objectives:

1. To build skills essential for corporate communication.
2. To enhance context specific language skills.
3. To discover the creative linguistic potential through language and literature.
4. To develop communication skills necessary for employability.

Course Outcomes:

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

1. Apply acquired skills to communicate effectively in a corporate scenario.
2. Demonstrate command over rhetoric of language.
3. Develop critical and creative thinking through assimilated language skills.
4. Utilize the communication skills learnt to match industry standards.
5. Make use of the writing skills learnt to enhance official communication.
6. Design official reports and presentations.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	1	0	0	1	0	1	1	2	1	1	0	2	0	0
CO2	1	1	0	0	0	0	2	2	1	1	0	2	1	0
CO3	2	1	1	1	0	0	2	2	1	1	0	2	1	0
CO4	1	0	0	2	0	0	3	2	1	1	0	1	0	0
CO5	1	0	0	2	0	0	3	2	1	1	1	1	0	0
CO6	1	0	0	2	0	0	3	2	1	1	1	1	0	0

Course Content:

Unit-I: Language Acquisition **10 Hours**

Remedial Grammar: Sentence Structure - I

Simple; Compound; Complex; Compound- Complex

Writing Skills: Official Communication

Blog writing: Letters to the News Papers, Public Notices; Circulars, Minutes of the meeting

Literature: Saki – The Lumber Room

Unit-II: Persuasive Skills **10 Hours**

Remedial Grammar: Sentence Structure - II

Declarative; Interrogative; Imperative; Exclamative

Writing Skills: Report writing

Survey report; Feasibility report

Literature: Barack Obama - Farewell address at Chicago

Unit-III: Cognitive Skills **10 Hours**

Remedial Grammar:

Direct and Indirect speech**;** Active and Passive Voice

Writing Skills: Creative writing

Short story writing; PPT Presentation

Literature: Edgar Allen Poe – The black Cat

Unit-IV: Employability Skills **10 Hours**

Remedial Grammar:

Conditional sentences**;** Degrees of Comparison; Modals; Word formation

Writing Skills: Cover letter and Curriculum Vitae writing

Literature: W H Auden – Everything you need for every book you read

References:

1. Bansal, R.K. and J.B. Harrison. Spoken English. Orient Blackswan, 2013.
2. Raman, Meenakshi and Sangeeta Sharma. Technical Communication. Oxford University Press, 2015.
3. Thorpe, Edgar and Showick Thorpe. Objective English. Pearson Education, 2013.
4. Dixson, Robert J. Everyday Dialogues in English. Prentice Hall India Pvt Ltd., 1988.
5. Turton, Nigel D. ABC of Common Errors. Mac Millan Publishers, 1995.
6. Samson, T. (ed.) Innovate with English. Cambridge University Press, 2010.
7. Kumar, E Suresh, J. Savitri and P Sreehari (ed). Effective English. Pearson Education, 2009.

8. Goodale, Malcolm. Professional Presentation. Cambridge University Press, 2013

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0201	Foundation of Bioinformatics and Algorithms	DSC	3	0	0	3	3

Prerequisite:

Basic understanding of biology (DNA, RNA, proteins), and familiarity with computer fundamentals and logical reasoning.

Course Objectives

1. To introduce the core concepts, applications, and limitations of bioinformatics.
2. To equip students with knowledge of biological databases and sequence data formats.
3. To develop foundational algorithmic thinking for sequence alignment and analysis.
4. To introduce tools and algorithms used in gene prediction and molecular structure prediction.

Course Outcomes (COs)

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

1. Understand the goals, applications, and scope of bioinformatics.
2. Retrieve and interpret biological data from various types of databases.
3. Analyse sequence similarity and perform pairwise alignments using standard algorithms.
4. Perform multiple sequence alignments and construct phylogenetic trees.
5. Predict gene and protein structures using bioinformatics tools.
6. Evaluate sequence and structure prediction results for biological inference.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	2	0	0	0	2	3	0	0
CO2	3	3	2	0	0	0	0	0	0	0	2	3	2	0
CO3	2	3	2	2	2	0	0	0	0	0	3	3	3	0
CO4	2	3	3	3	2	0	0	0	0	2	3	2	3	2
CO5	3	3	3	3	3	0	0	0	0	2	3	2	3	2
CO6	3	3	3	3	2	2	0	0	0	2	3	2	3	3

(Note: *The demonstrations must be conducted in the Bioinformatics Lab using real-time database access and recorded as part of practical sessions. Each session must include exploration, data retrieval, and result documentation.*)

Unit I: Introduction to Bioinformatics and Biological Databases **12 Hours**

Introduction to Bioinformatics: Goals, Scope, Applications, and Limitations; Types of Biological Data (Nucleotide, Protein, Metabolomic, Interactome, Literature); Literature Databases: PubMed, PubMed Central (open access/open source concepts); Nucleotide & Genome Databases: Viral: ICTVdb, VirGen; Bacterial: GOLD, MBGD; Organism-specific: OMIM, OMIA, SGD, Worm Base, PlasmoDB, FlyBase, TAIR; Genome Browsers: UCSC Genome Browser, NCBI Genome Data Viewer, Ensembl, VEGA; Protein Databases: UniProt, Pfam, PDB; Metabolomic and Ligand Databases: KEGG, HMDB, LIPID MAPS;

Carbohydrate Structure Databases: GlyTouCan, UniCarbKB; Sequence formats: FASTA, GenBank, GCG; Disease-specific databases: COSMIC, DisGeNET, ClinVar

Unit II: Pairwise Sequence Alignment and Similarity Search 12 Hours

Basic concepts: Similarity, Identity, Homology; Types of homologs: Orthologs, Paralogs, Xenologs; Scoring matrices: Concepts, PAM, BLOSUM series, and derivation; Pairwise Alignment: Dot Plot. Needleman-Wunsch Algorithm (Global Alignment); Smith-Waterman Algorithm (Local Alignment); Gap penalties, affine gaps; Database Similarity Searches: BLAST: Algorithms, Types, Parameters, Result Interpretation; FASTA: Algorithm, Types, Parameters, Result Interpretation.

Unit III: Multiple Sequence Alignment & Phylogenetic Analysis 12 Hours

Introduction and Need for MSA; Algorithms for MSA: CLUSTAL OMEGA, HMM-based approaches (overview of MUSCLE, T-Coffee), Phylogenetic Tree Concepts: Tree Types: Rooted, Unrooted; Algorithms: Distance-based: UPGMA, Neighbour-Joining; Character-based: Maximum Parsimony, Maximum Likelihood; Tree Evaluation: Bootstrapping; Tools: MEGA, PHYLIP, PAUP

Unit IV: Gene and Protein Structure Prediction 12 Hours

Gene Prediction: Gene structure: Exons, Introns, ORFs, ESTs; Regulatory regions; Prokaryotic vs Eukaryotic Gene Prediction; Tools: GENSCAN, GLIMMER, Augustus; **RNA Structure Prediction**: Tools: RNAFold; **Protein Structure Prediction**: Physicochemical property prediction: ProtParam; Secondary structure: Chou-Fasman, GOR; Tertiary structure: Comparative modeling (SWISS-MODEL), Fold recognition (I-TASSER); Structural Classification: CATH, SCOP.

Reference Textbooks:

1. Lesk, A.M. (2023). **Introduction to Bioinformatics.** 5th Edition, Oxford University Press.
2. Mount, D.W. (2022). **Bioinformatics: Sequence and Genome Analysis.** 2nd Edition, Cold Spring Harbor Laboratory Press.
3. Pevzner, P. (2021). **Bioinformatics Algorithms: An Active Learning Approach.** Vol. 1 & 2, Active Learning Publishers.
4. Jones, N.C., & Pevzner, P.A. (2018). **An Introduction to Bioinformatics Algorithms.** MIT Press.
5. Rashidi, H., & Buehler, L.K. (2021). **Bioinformatics Basics: Applications in Biological Science and Medicine.** CRC Press.
6. Claverie, J-M. & Notredame, C. (2020). **Bioinformatics for Dummies**. 2nd Edition, Wiley.
7. Andreas D. Baxevanis, B.F. Francis Ouellette. (2009) **"Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins",** 2nd Edition, Willy publishing.
8. Andrew R. Leach., (2001) **"Molecular Modelling Principles and Applications"** (2nd Ed.), Prentice Hall, USA.
9. G. E. Schulz., (2009) **"Principles of Protein Structure",** Springer.
10. Jin Xiong, (2006) **"Essential Bioinformatics",** Cambridge University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0201	Mathematical Foundations for Bioinformatics	DSC	3	0	0	3	3

Prerequisite

Basic understanding of algebra, functions, and high school-level mathematics. Prior exposure to biological data and basic computational tools is desirable.

Course Objectives

1. To introduce fundamental concepts of discrete mathematics, including set theory, logic, relations, and functions, and their applications.
2. To equip students with a strong foundation in linear algebra, covering matrices, determinants, vector spaces, and their use in solving systems of equations and eigenvalue problems.
3. To develop students' understanding of calculus, including limits, derivatives, and integrals, along with their practical applications.
4. To enable students to formulate and solve linear programming problems using graphical and simplex methods for optimization.

Course Outcomes (COs)

By the end of the course, students will be able to:

1. Perform operations on sets, understand logical equivalences, and identify different types of relations and functions.
2. Apply matrix operations, calculate determinants, and solve systems of linear equations.
3. Determine the rank of a matrix and understand concepts of vector spaces, including linear independence and basis.
4. Compute limits, derivatives, and integrals of various functions and find maxima/minima.
5. Formulate real-world problems as Linear Programming Problems (LPPs).
6. Solve Linear Programming Problems (LPPs) using both graphical and simplex methods.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	0	2	2	2	2
CO2	3	3	2	2	1	0	1	1	0	2	2	3	2
CO3	3	3	2	2	1	0	1	1	0	2	2	3	2
CO4	3	2	2	2	1	0	1	1	0	3	2	2	2
CO5	3	3	2	2	2	1	1	1	1	3	3	2	3
CO6	3	3	2	3	2	1	1	1	1	3	3	3	3

Course content

Unit-I: Sets, Logic and Functions **12 Hours**

Set theory and operations: union, intersection, complement, difference; Venn diagrams, power sets, Cartesian products. Relations: reflexive, symmetric, transitive properties; equivalence relations and partitions.

Functions: domain, co-domain, one-one, onto, bijective mappings, inverse. Mathematical Logic: Propositions and logical connectives, truth tables, logical equivalence, predicate logic, and quantifiers. Applications related to life sciences.

Unit-II: Linear Algebra **12 Hours**

Matrices, Types of matrices, Operations on Matrices, Elementary operations (Transformations) of a matrix, Echelon form of a matrix, Rank of a matrix. Determinants and its properties, Consistent and inconsistent systems and its solution sets; Guass Elimination. Eigenvalues and eigenvectors. Vector Spaces: Vector spaces; subspaces; linearly independent and dependent vectors; Base and dimension. Application problems related to life sciences.

Unit I: Calculus **12 Hours**

Limits, continuity and differentiability, First and second order derivatives of functions, Maxima and Minima of function. Introduction to Partial Differentiation. Integration: Integration of functions, Integration by partial fractions, Integration by parts, Definite integrals. Applications in biology.

Unit IV: Linear Programming Problems (LPP) **12 Hours**

Introduction to optimization, slack and surplus variables, standard and canonical forms, formulation of LPP, solution, basic and non-basic solutions, feasible solution, basic feasible solution, degenerate and non-degenerate solutions, optimal solution, Graphical method to solve an LPP. Simplex method of solving LPP.

Reference Textbooks

1. Larson, Martin G. (2009). ***Mathematics for Bioinformatics: A Guide for Life Science Students.*** Wiley-Interscience.
2. Murray, James D. (2002). ***Mathematical Biology I: An Introduction*** (3rd Edition). Springer.
3. Rosen, Kenneth H. (2019). ***Discrete Mathematics and Its Applications*** (8th Edition). McGraw-Hill Education.
4. Strang, Gilbert. (2016). ***Linear Algebra and Its Applications*** (5th Edition). Cengage Learning.
5. Mital, K.V., & Mohan, C. (2003). ***Optimization: Theory and Applications.*** New Age International Publishers.
6. Dr. B.S Grewal, **Higher engineering Mathematics**, 42nd edition, Khanna publisher
7. Erwin Kreyszig**, "Advanced Engineering Mathematics",** Wiley Publications, 10th edition, 2015.
8. S.S Rao, **Engineering Optimization: theory and practice,** Third Edition.
9. David C. Lay, **"Linear Algebra and its Applications",** Cambridge University Press 3rd Edition, 2017.
10. Schaum's **outline of Linear Algebra,** 4th edition.

Supplementary References

1. Buffalo, Vince. (2015). ***Bioinformatics Data Skills.*** O'Reilly Media.

2. Bondy, J.A., & Murty, U.S.R. (1976). ***Graph Theory with Applications*.** North-Holland.
3. Lehman, Eric; Leighton, Tom; & Meyer, Albert R. (2017). ***Mathematics for Computer Science*.** MIT OpenCourseWare. *(Available as a free eTextbook)*
4. Grolemund, Garrett & Wickham, Hadley. (2017). ***R for Data Science*.** O'Reilly Media.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0201	Data Structures and Algorithms using Python	DSC	3	0	0	3	3

Prerequisite:

Basic knowledge of programming concepts in Python and fundamental computational logic.

Course Objectives:

1. To provide foundational knowledge of data structures and algorithmic techniques.
2. To enable students to implement, analyse and apply various data structures for problem-solving.
3. To promote algorithmic thinking and efficient coding practices.
4. To develop skills in time and space complexity analysis for performance evaluation.

Course Outcomes (COs):

Upon successful completion of this course, students will be able to:

1. Understand the classification, need, and functionality of various data structures.
2. Implement linear data structures such as arrays, stacks, and queues for different applications.
3. Demonstrate the use of non-linear data structures like trees and graphs in computational problems.
4. Apply searching and sorting algorithms and analyse their complexities.
5. Evaluate the performance of algorithms using asymptotic analysis and implement hashing techniques.
6. Select and apply appropriate data structures and algorithms for solving real-life problems efficiently.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	0	0	0	0	0	0	2	3	2	0
CO2	3	3	3	2	0	0	0	0	1	0	2	3	3	1
CO3	3	3	3	3	0	0	0	0	0	0	2	3	3	2
CO4	3	3	3	3	2	0	0	0	0	0	3	3	3	2
CO5	3	3	3	3	2	0	0	0	0	1	3	3	3	2
CO6	3	3	3	3	2	1	0	0	1	2	3	3	3	3

Course Content

Unit-I: Introduction and Linear Data Structures **12 Hours**

Introduction to Data Structures and Algorithms: Definition & Importance, ADTs (Abstract Data Types) Classification: Primitive vs Non-Primitive, Linear vs Non-linear; Algorithm Analysis: Time and Space Complexity, Asymptotic Notations: Big O, Omega, Theta Notations.

Unit-II: Arrays and Stack **12 Hours**

Arrays: One-dimensional and Multi-dimensional arrays, Array operations: Traversal, Insertion, Deletion, Searching, Sorting; Dynamic array allocation; Stack: Concept and operations: push, pop, peek; Stack

implementation using arrays; Applications: Expression evaluation (Infix to Postfix), Recursion, Syntax parsing.

Unit-III: Queue and Linked list **12 Hours**

Queue: Concept and types: Simple Queue, Circular Queue, Double-ended Queue (Deque); Implementation using arrays and linked lists; Priority Queues and their applications; Applications: Job Scheduling, Call Center Queues, Keyboard Buffers. Linked Lists: Singly Linked List: Structure, Insertion, Deletion; Doubly Linked List: Insertion and Deletion; Circular Linked List; Comparison between Arrays and Linked Lists.

Unit-IV: Trees and Graphs **12 Hours**

Trees: Tree terminology: Node, Root, Degree, Height; Binary Tree and Binary Search Tree (BST); Operations: Insertion, Deletion, Searching; Tree Traversals: Preorder, Inorder, Postorder (Recursive and Iterative); Balanced Trees: AVL Tree (basics), Heap Trees (Min-Heap, Max-Heap). **Graphs:** Graph Terminology, Graph Traversal Algorithms: BFS and DFS.

Reference Textbook

1. Sartaj Sahni and Ellis Horowitz (2008). **Fundamentals of Data Structures in C,** Universities Press.
2. Mark Allen Weiss (2014). **Data Structures and Algorithm Analysis in C,** 2nd Edition, Pearson Education.
3. Narasimha Karumanchi (2011). **Data Structures and Algorithms Made Easy,** CareerMonk Publications.
4. Alfred V. Aho, Jeffrey D. Ullman, John E. Hopcroft (1983). **Data Structures and Algorithms,** Addison-Wesley.
5. Thomas H. Cormen et al. (2009). **Introduction to Algorithms**, 3rd Edition, MIT Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0202	Lab: Foundation of Bioinformatics	DSC	0	0	2	2	3

Prerequisite

Basic understanding of biology (DNA, RNA, proteins), and familiarity with computer fundamentals and logical reasoning.

Course Objectives

1. Introduce students to various biological databases and sequence data formats commonly used in bioinformatics.
2. Equip students with fundamental skills in performing sequence alignment and similarity searches using standard bioinformatics tools.
3. Enable students to perform multiple sequence alignments and construct phylogenetic trees using suitable software.
4. Develop practical skills for gene and protein structure prediction using computational tools and evaluate biological data for real-world applications.

Course Outcomes (COs)

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

1. Understand the goals, applications, and scope of bioinformatics.
2. Retrieve and interpret biological data from various types of databases.
3. Analyse sequence similarity and perform pairwise alignments using standard algorithms.
4. Perform multiple sequence alignments and construct phylogenetic trees.
5. Predict gene and protein structures using bioinformatics tools.
6. Evaluate sequence and structure prediction results for biological inference.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	2	3	0	2	0	2	1	2	3	2	1
CO2	3	0	2	3	3	0	0	0	2	0	2	3	3	0
CO3	3	2	2	3	3	0	0	0	2	1	3	3	3	1
CO4	3	1	3	3	3	1	0	0	2	0	3	3	3	2
CO5	3	0	2	3	3	1	2	0	2	0	3	3	3	2
CO6	3	1	1	2	2	0	2	0	2	0	3	2	2	2

Course Content

Sl. No	Experiment Titles	Tools and Software's
1	Literature Search	NCBI PubMed, PMC, Google Scholar
2	Sequence Retrieval	NCBI Entrez, UniProt, Ensembl, EBI Search
3	Sequence Format Handling	UGENE, Jalview, EMBOSS Seqret
4	Pairwise Alignment	EMBOSS Needle/Water, BLAST+ (NCBI), FASTA
5	Multiple Sequence Alignment	CLUSTAL Omega, MUSCLE, MAFFT, Jalview
6	Phylogenetics	MEGA11
7	Gene Prediction	Augustus, GeneMark-ES, FGENESH
8	Motif & Domain Analysis	MEME Suite, InterproScan, SMART, CDD
9	Primary Structure Prediction	Protparam, SignalP. TMHMM
9	Secondary Structure Prediction	PSIPRED, JPred4, SOPMA
10	Tertiary Structure Prediction	SWISS-MODEL, I-TASSER, Phyre2, AlphaFold
11	Protein Visualization	PyMol, UCSF Chimera, ChimeraX

Reference Books

1. Lesk, A.M. (2023). **Introduction to Bioinformatics.** 5th Edition, Oxford University Press.
2. Mount, D.W. (2022). **Bioinformatics: Sequence and Genome Analysis.** 2nd Edition, Cold Spring Harbor Laboratory Press.
3. Pevzner, P. (2021). **Bioinformatics Algorithms: An Active Learning Approach.** Vol. 1 & 2, Active Learning Publishers.
4. Jones, N.C., & Pevzner, P.A. (2018). **An Introduction to Bioinformatics Algorithms.** MIT Press.
5. Rashidi, H., & Buehler, L.K. (2021). **Bioinformatics Basics: Applications in Biological Science and Medicine.** CRC Press.
6. Claverie, J-M. & Notredame, C. (2020). **Bioinformatics for Dummies**. 2nd Edition, Wiley.

7. Andreas D. Baxevanis, B.F. Francis Ouellette. (2009) **"Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins",** 2nd Edition, Willy publishing.
8. Andrew R. Leach., (2001) **"Molecular Modelling Principles and Applications"** (2nd Ed.), Prentice Hall, USA.
9. G. E. Schulz., (2009) **"Principles of Protein Structure",** Springer.
10. Jin Xiong, (2006) **"Essential Bioinformatics",** Cambridge University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0202	Lab: Mathematical Foundations for Bioinformatics	DSC	0	0	2	2	3

Prerequisite

Basic understanding of algebra, functions, and high school-level mathematics. Prior exposure to biological data and basic computational tools is desirable.

Course Objectives

1. To develop proficiency in applying theoretical concepts of discrete mathematics to practical problem-solving.
2. To gain hands-on experience in performing linear algebraic computations and solving related problems.
3. To cultivate practical skills in applying calculus techniques to solve analytical problems.
4. To acquire the ability to formulate and solve optimization problems using linear programming methods and software tools.

Course Outcomes (COs)

By the end of the course, students will be able to:

1. Construct truth tables for logical expressions and demonstrate set operations using Venn diagrams.
2. Perform matrix operations and solve systems of linear equations using computational tools or manual methods.
3. Determine eigenvalues and eigenvectors for given matrices.
4. Compute derivatives and integrals for various functions using appropriate techniques.
5. Graphically represent and find feasible regions for Linear Programming Problems (LPPs).
6. Use R programming to implement the simplex method to solve Linear Programming Problems (LPPs).

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	0	2	2	2	2	1
CO2	3	3	2	3	1	0	1	1	0	2	2	3	2	1
CO3	3	3	2	2	1	0	1	1	0	2	2	3	2	2
CO4	3	2	2	2	1	0	1	1	0	3	2	2	2	2
CO5	3	3	2	2	2	1	1	1	1	3	3	2	3	3
CO6	3	3	2	3	2	1	1	1	1	3	3	3	3	3

Course content

1. Solve problems on operations on sets
2. Create truth tables for given compound prepositions

3. Find Echelon form of the matrix and hence find its rank
4. Check consistency of system of equations
5. Find the solution of system of equations using Gauss-elimination method
6. Check whether the given vectors are linearly independent or not
7. Find the derivative of functions.
8. Find integral of functions.
9. Solve LPP by Graphical method.
10. Solve LPP by simplex method.

Reference Textbooks

1. Larson, Martin G. (2009). ***Mathematics for Bioinformatics: A Guide for Life Science Students.*** Wiley-Interscience.
2. Murray, James D. (2002). ***Mathematical Biology I: An Introduction*** (3rd Edition). Springer.
3. Rosen, Kenneth H. (2019). ***Discrete Mathematics and Its Applications*** (8th Edition). McGraw-Hill Education.
4. Strang, Gilbert. (2016). ***Linear Algebra and Its Applications*** (5th Edition). Cengage Learning.
5. Mital, K.V., & Mohan, C. (2003). ***Optimization: Theory and Applications.*** New Age International Publishers.
6. Dr. B.S Grewal, **Higher engineering Mathematics**, 42nd edition, Khanna publisher
7. Erwin Kreyszig**, "Advanced Engineering Mathematics",** Wiley Publications, 10th edition, 2015.
8. S.S Rao, **Engineering Optimization: theory and practice,** Third Edition.
9. David C. Lay, **"Linear Algebra and its Applications",** Cambridge University Press 3rd Edition, 2017.
10. Schaum's **outline of Linear Algebra,** 4th edition.

Supplementary References

1. Buffalo, Vince. (2015). ***Bioinformatics Data Skills.*** O'Reilly Media.
2. Bondy, J.A., & Murty, U.S.R. (1976). ***Graph Theory with Applications.*** North-Holland.
3. Lehman, Eric; Leighton, Tom; & Meyer, Albert R. (2017). ***Mathematics for Computer Science.*** MIT OpenCourseWare. *(Available as a free eTextbook)*
4. Grolemund, Garrett & Wickham, Hadley. (2017). ***R for Data Science.*** O'Reilly Media.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0202	Lab: Data Structures and Algorithms Using Python	DSC	0	0	2	2	3

Prerequisites

Students must have basic knowledge of programming concepts using Python and fundamental computational logic.

Course Objectives

1. To introduce students to fundamental data structures, algorithms, and their role in problem-solving and software development.

2. To equip students with the ability to implement linear and non-linear data structures using array and linked structures.
3. To provide insights into efficient searching, sorting, and hashing methods for data manipulation.
4. To analyse time and space complexity of algorithms for performance optimization.

Course Outcomes

By the end of the course, students will be able to:

1. Explain the basics of data structures, abstract data types (ADTs), and analyse algorithms using asymptotic notations.
2. Implement arrays and linked lists to perform operations such as insertion, deletion, traversal, and searching.
3. Develop stack and queue implementations and apply them in expression evaluation, syntax parsing, and scheduling.
4. Construct and traverse binary trees and graphs using appropriate traversal techniques for real-world applications.
5. Apply and analyse searching and sorting algorithms based on time and space complexity.
6. Implement hashing techniques and apply them to solve database and dictionary-based problems.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	0	0	0	1	2	2	3	2	1
CO2	3	3	3	2	2	0	0	0	1	2	2	3	3	1
CO3	3	3	3	2	2	0	0	1	1	2	2	3	3	1
CO4	3	3	3	2	2	0	0	1	1	2	3	3	3	2
CO5	3	3	3	2	3	0	0	0	1	2	3	3	3	2
CO6	3	3	3	2	3	0	0	0	1	2	3	3	3	2

Course Content

1. Implementation of array operations: insertion, deletion, searching
2. Implementation of singly linked list: insertion and deletion
3. Implementation of doubly linked list: insertion and deletion
4. Implementation of stack using array and linked list
5. Conversion of infix to postfix expression using stack
6. Implementation of queue, circular queue, and dequeue
7. Implementation of binary tree: insertion, deletion, and traversal
8. Implementation of binary search tree (BST): search and traversal
9. Graph representation using adjacency matrix and list; traversal using BFS and DFS
10. Implementation of linear and binary search algorithms

Textbooks/ Reference Books

1. Sartaj Sahni, Ellis Horowitz, and Susan Anderson-Freed (2008). **Fundamentals of Data Structures in C**, 2nd Edition, Universities Press.
2. Mark Allen Weiss (2012). **Data Structures and Algorithm Analysis in C++**, 4th Edition, Pearson Education.

3. Thomas H. Cormen, Charles E. Leiserson, Ronald L. Rivest, and Clifford Stein (2009). **Introduction to Algorithms**, 3rd Edition, MIT Press.
4. Robert Lafore (2002). **Data Structures and Algorithms in Java,** 2nd Edition, Sams Publishing.
5. Narasingh Deo (2003). **Graph Theory with Applications to Engineering and Computer Science**, PHI Learning.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0213	Cyber Security	VAC	1	0	0	1	2

Prerequisite

The student should have prior knowledge of computer science fundamentals, especially basic networking, operating systems, and computer applications.

Course Objectives

1. To introduce the foundations of cyber security and the evolving threat landscape.
2. To equip students with technical knowledge and practical skills to identify, prevent, and respond to cyber threats.
3. To develop student ability to plan, implement, and monitor cyber security mechanisms for IT asset protection.
4. To familiarize students with cyber laws, governance models, and ethical dimensions of cyber security.

Course outcomes

After completion of this module, students would be able to

1. Understand the basic principles and concepts of cyber security.
2. Identify and analyse issues and challenges in the field of cyber security.
3. Understand different types of cybercrimes and cyber threats.
4. Explain the nature, categories, and motives behind cybercrimes.
5. Understand the Indian legal framework and international laws related to cybercrime.
6. Demonstrate knowledge of procedures to report cybercrimes and utilize available reporting platforms.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11		PSO1	PSO2	PSO3
CO1	3	2	1	1	2	2	1	0	1	2	2		3	2	1
CO2	3	3	2	2	2	2	1	0	1	2	2		3	3	2
CO3	3	3	2	2	2	2	0	0	1	2	2		3	3	2
CO4	3	2	1	2	1	3	0	0	1	2	2		2	2	3
CO5	2	2	0	2	0	3	2	0	2	2	2		1	1	3
CO6	2	2	0	2	2	3	0	1	2	2	2		1	1	3

Course Content

Unit I: Introduction to Cyber security **6 Hours**

Defining Cyberspace and Overview of Computer and Web-technology, Architecture of cyberspace, Communication and web technology, Internet, World wide web, Advent of internet, Internet infrastructure

for data transfer and governance, Internet society, Regulation of cyberspace, Concept of cyber security, Issues and challenges of cyber security

Unit II: Cyber-Crime and Cyber Law **6 Hours**

Classification of cyber-crimes, Common cybercrimes- cyber-crime targeting computers and mobiles, cyber-crime against women and children, financial frauds, social engineering attacks, malware and ransomware attacks, zero day and zero click attacks, Cybercriminals modus-operandi , Reporting of cyber-crimes, Remedial and mitigation measures, Legal perspective of cyber-crime, IT Act 2000 and its amendments, Cybercrime and offences, Organizations dealing with Cyber-crime and Cyber security in India, Case studies.

Reference Books

1. Mishra, R. C. (2010). **Cyber Crime Impact in the New Millennium**. New Delhi: Author Press.
2. Belapure, S., & Godbole, N. (2011). **Cyber Security: Understanding Cyber Crimes, Computer Forensics and Legal Perspectives** (1st ed.). New Delhi: Wiley India Pvt. Ltd.
3. Gupta, B. B., Perez, G. M., Agrawal, D. P., & Gupta, D. (2020). **Handbook of Computer Networks and Cyber Security.** Cham: Springer.
4. Kumar, K. (n.d.). **Cyber Laws: Intellectual Property & E-Commerce Security.** New Delhi: Dominant Publishers.
5. Moseley, R. (2021). **Advanced Cybersecurity Technologies.** Boca Raton: CRC Press.

THIRD SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHK303	Language-II: Kannada III	AEC	3	0	0	3	3

Course Overview

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯ ಪ್ರಕಾರವಾಗಿ ಭಾಷೆಯನ್ನು ಮಾತನಾಡುವ ಬರೆಯುವ ಕೌಶಲ್ಯ, ಸಾಹಿತ್ಯದ ಬಗ್ಗೆ ಸ್ಥೂಲವಾಗಿ ಪರಿಚಯಿಸುವ ಮೂಲಕ ವಿದ್ಯಾರ್ಥಿಗಳ ವ್ಯಕ್ತಿತ್ವ ವಿಕಾಸ ಹಾಗು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು, ಪ್ರಸ್ತುತ ಸಂದರ್ಭಕ್ಕೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸಲು ಪಠ್ಯವನ್ನು ರೂಪಿಸಲಾಗಿದೆ. ಸಾಹಿತ್ಯ, ಕಲೆ, ವಾಣಿಜ್ಯ, ಆಡಳಿತಾತ್ಮಕ ಮತ್ತು ವಿಜ್ಞಾನದ ವಿಚಾರಗಳಿಗೆ ಒತ್ತನ್ನು ನೀಡಲಾಗಿದೆ. ಇದು ನಾಲ್ಕು ಸೆಮಿಸ್ಟರ್‌ಗಳಲ್ಲಿ ಮೂರು ಕ್ರೆಡಿಟ್‌ಗಳನ್ನು ಹೊಂದಿದೆ.

Prerequisite / Pre reading for the course

- ಕನ್ನಡ ಭಾಷೆಯ ಬಗೆಗೆ ಪ್ರಾಥಮಿಕ ತಿಳುವಳಿಕೆ ಅಗತ್ಯ.
- ಭಾಷೆಯನ್ನು ಓದಲು ಮತ್ತು ಬರೆಯಲು ತಿಳಿದಿರಬೇಕು.
- ಪದವಿ ಪೂರ್ವ ಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯನ್ನು ಓದಿರಬೇಕು.

Course Objectives:

ನಾಲ್ಕು ಸೆಮಿಸ್ಟರ್‌ಗಳಲ್ಲಿ ಕನ್ನಡ ಸಾಹಿತ್ಯವನ್ನು ಒಳಗೊಂಡಂತೆ ವಿಷಯವಾರು ಪಠ್ಯಗಳನ್ನು ನೀಡಲಾಗಿದ್ದು, ಆ ಮೂಲಕ ಕನ್ನಡ ಭಾಷೆ, ಸಂಸ್ಕೃತಿಯ ಜೊತೆಗೆ ಮಾನವೀಯ ಗುಣಗಳನ್ನು ಪರಿಚಯಿಸುವ ಹಾಗೂ ಅಳವಡಿಸಿಕೊಳ್ಳಲು ಪ್ರೇರೇಪಿಸುವ ಉದ್ದೇಶವನ್ನು ಹೊಂದಿದೆ. ಅದರಂತೆ ಮೂರನೇ ಸೆಮಿಸ್ಟರ್‌ನಲ್ಲಿ ಮಾನವೀಯತೆ, ಪ್ರವಾಸ, ವಿಚಾರಕ್ರಾಂತಿ ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂದಿಸಿದಂತೆ ವಿಷಯಗಳನ್ನು ನೀಡಿದ್ದು, ಅದಕ್ಕೆ ಪೂರಕವಾಗಿ ಸಾಹಿತ್ಯಿಕ ಪಠ್ಯವನ್ನಾಗಿ ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ. ಈ ಮೂಲಕ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಸಾಹಿತ್ಯದ ಬಗ್ಗೆ ಸದಭಿರುಚಿಯನ್ನು ಮೂಡಿಸಲಾಗುತ್ತದೆ. ಸಾಂಸ್ಕೃತಿಕ ತಿಳುವಳಿಕೆಯ ಜೊತೆಗೆ ವ್ಯಕ್ತಿತ್ವ ವಿಕಸನದ ಕಡೆಗೆ ಗಮನ ನೀಡಲಾಗುತ್ತದೆ.

1. ಭಾಷೆ, ಸಾಹಿತ್ಯ, ಇತಿಹಾಸ ಮತ್ತು ಸಂಸ್ಕೃತಿಗಳನ್ನು ಕನ್ನಡ, ಕರ್ನಾಟಕಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ. ಹಾಗೂ ವೈವಿಧ್ಯಮಯ ಭಾರತದ ಸಾಂಸ್ಕೃತಿಕ ನೆಲೆಗಳನ್ನು ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ
2. ವಿದ್ಯಾರ್ಥಿಗಳ ಸರ್ವತೋಮುಖ ಬೆಳವಣಿಗೆಗೆ ಅನುವಾಗುವಂತೆ ಹಾಗೂ ಅವರಲ್ಲಿ ಮಾನವ ಸಂಬಂಧಗಳ ಬಗ್ಗೆ ಗೌರವ, ಸಮಾನತೆ ಮೂಡಿಸಿ, ಬೆಳೆಸುವ ನಿಟ್ಟಿನಲ್ಲಿ ಪಠ್ಯಗಳ ಆಯ್ಕೆಯಾಗಿದೆ.
3. ಅವರಲ್ಲಿ ಸೃಜನಶೀಲತೆ, ಶುದ್ಧ ಭಾಷೆ, ಉತ್ತಮ ವಿಮರ್ಶಾ ಗುಣ, ನಿರರ್ಗಳ ಸಂಭಾಷಣೆ, ಭಾಷಣ ಕಲೆ ಬರಹ, ವೃತ್ತಿ ಪೂರ್ವಕ ಕೌಶಲ್ಯಗಳನ್ನು ಬೆಳೆಸುವುದು ಗುರಿಯಾಗಿದೆ
4. ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ಅನುಕೂಲವಾಗುವಂತಹ ವಿಷಯಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ಸೂಕ್ತ ಪಠ್ಯಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ.

Course Outcomes:

ಮಾನವೀಯತೆ, ಪ್ರವಾಸ, ವಿಚಾರಕ್ರಾಂತಿ ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಸಾಹಿತ್ಯ ಪಠ್ಯಗಳ ಕಲಿಕೆಯ ಮೂಲಕ ಅವುಗಳ ಒಳನೋಟಗಳನ್ನು ಬೆಳೆಸುತ್ತದೆ.

1. ಸಾಮಾಜಿಕ, ರಾಜಕೀಯ, ಧಾರ್ಮಿಕ, ಸಾಂಸ್ಕೃತಿಕ, ಪರಿಸರ ಹಾಗೂ ಲಿಂಗಸಂಬಂಧಿ ಸೂಕ್ಷ್ಮತೆಯ ವಿಚಾರಗಳೆಡೆ ಗಮನ ಹರಿಸುವುದರೊಂದಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಚರ್ಚಾ ಮನೋಭಾವವು ಬೆಳೆಸುತ್ತದೆ.
2. ಜೀವನದಲ್ಲಿ ಬರುವ ಅಭಿಪ್ರಾಯ ಬೇಧಗಳ ವಿವಿಧ ಆಯಾಮಗಳೊಂದಿಗೆ ಆಧುನಿಕ ಸಂದರ್ಭದಲ್ಲಿ ಮಾನವೀಯತೆಯೊಂದಿಗೆ ನಿರ್ವಹಿಸುವಂತೆ ಪ್ರೇರೇಪಿಸುತ್ತದೆ.
3. ಉತ್ತಮ ಸಂವಹನ ಕಲೆಯನ್ನು ಬೆಳೆಸುವ ಉದ್ದೇಶವನ್ನು ಈಡೇರಿಸುತ್ತದೆ.
4. ಸಂಶೋದನಾ ಮನೋಭಾವ ಮತ್ತು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸುತ್ತದೆ.
5. ಭಾಷೆ ಮತ್ತು ಸಾಹಿತ್ಯದ ಶ್ರೀಮಂತಿಕೆ ಜೊತೆಗೆ ಮಾನವೀಯ ಮೌಲ್ಯಗಳನ್ನು ಕಲಿಯುವಿರಿ.
6. ಸದೃಢ ಬೌದ್ಧಿಕ ಮತ್ತು ಮಾನಸಿಕ ವನುನ ವಿಕಾಸಿಸುತುದೆ.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	T	1	1	1	1	1	0	1	0	0	0	1	1	0
CO2	1	1	1	0	1	1	0	0	0	0	0	1	0	0
CO3	0	0	1	0	0	0	1	1	0	0	0	0	1	1
CO4	0	0	1	1	0	0	1	0	1	0	0	1	1	1
CO5	0	0	1	1	0	0	1	0	1	0	1	1	1	1
CO6	0	0	1	1	0	0	1	0	1	0	1	1	1	1

COURSE CONTENT

Unit-I: ಮಾನವೀಯತೆ **10 Hours**

1.1 ಜನಪದ ಗೀತೆ (ಹಬ್ಬಲಿ ಅವರ ರಸಬಳ್ಳಿ) ಜನಪದ
1.2 ದೇವರ ಹೆಣ ಕುಂ. ವೀರಭದ್ರಪ್ಪ
1.3 ನೆಲ್ಸನ್ ಮಂಡೇಲ ರಂಜಾನ್ ದರ್ಗಾ

Unit II: ಪ್ರವಾಸ **10 Hours**

2.1 ಮುಂಬೈ ಜಾತಕ ಜಿ. ಎಸ್. ಶಿವರುದ್ರಪ್ಪ
2.2 ಹಬ್ಬ ಮತ್ತು ರಥೋತ್ಸವ ಗೋರುರು ರಾಮಸ್ವಾಮಿ ಅಯ್ಯಂಗರ್
2.3 ಬುದ್ಧ ಬಿಸಿಲೂರಿನವನು ನಾಗತೀಹಳ್ಳಿ ಚಂದ್ರಶೇಖರ್

Unit III: ವಿಚಾರ ಕ್ರಾಂತಿ **10 Hours**

3.1 ವಚನಗಳು ಬಸವಣ್ಣ
3.2 ಹರಕೆಗಳು ಎ. ಎನ್. ಮೂರ್ತಿರಾವ್
3.3 ಚಾರ್ವಾಕರು ಪಿ. ಎನ್ ರಂಗನ್

Unit IV: ಸಂಕೀರ್ಣ **9 Hours**

4.1 ಯಾರೂ ಅರಿಯದ ವೀರ ಕುವೆಂಪು
4.2 ಮೊಬೈಲ್ ಎಂಬ ಮೋಹಿನಿ ಡಿ. ರಾಮನಮಿಲಿ
4.3 ಪ್ರೀತಿಯ ವಸ್ತುಗಳು ಕೆ. ವಿ. ನಾರಾಯಣ

TextBooks:

ಸಂಯೋಜಿತ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ **'ಗಣಕ-ವಿಜ್ಞಾನ ಸೌರಭ' – ಮೂರನೇ ಸೆಮಿಸ್ಟರ್ ಬಿಸಿಎ ಮತ್ತು ಬಿಎಸ್ಸಿ (ಎಎಸ್)**

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು:

1. ವಚನ ಭಾರತ- ಎ ಆರ್. ಕೃಷ್ಣಶಾಸ್ತ್ರಿ, ಗೀತಾ ಬುಕ್ ಹೌಸ್, 2012
2. ಕನ್ನಡ ಸಾಹಿತ್ಯ ಕೋಶ, ಸಂ. ಡಾ.ಸಿ.ಚಿ. ನಿಂಗಣ್ಣ, ಶ್ರೀ ಸಿದ್ಧಲಿಂಗಯ್ಯ ಪ್ರಕಾಶನ, ಗುಲ್ಬರ್ಗ, 2010
3. ಬದುಕು ಬದಲಿಸುವುದು- ನೇಮಿಚಂದ್ರ, ನವ ಕರ್ನಾಟಕ ಪ್ರಕಾಶನ, 2022
4. ದಕ್ಷಿಣ ಕರ್ನಾಟಕದ ಕಾವ್ಯ ಪ್ರಕಾರಗಳು- ಜಿ.ಶಂ.ಪ, ಅಭಿನವ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು, 2016
5. ಹೊಸ ವಿಚಾರಗಳು- ತೇಜಸ್ವಿ, ಪುಸ್ತಕ ಪ್ರಕಾಶನ, ಮೈಸೂರು, 2024
6. ಜಾಗತಿಕ ವಿಚಾರ ಸಾಹಿತ್ಯ- ಸಂ. ದಂಡಪ್ಪ, ಕುವೆಂಪು ಭಾಷಾ ಭಾರತಿ ಪ್ರಾಧಿಕಾರ, ಬೆಂಗಳೂರು, 2017

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHH303	Language-II: Hindi III	AEC	3	0	0	3	3

Course Overview: अध्ययन संक्षिप्त विवरण :

यह पाठ्यक्रम नौसिखिया, अपनी भाषा की क्षमता का विकास करने हेतु तथा विभिन्न साहित्यिक प्रक्रियाओं द्वारा समाज, संस्कृति एवं जीवन के मूल्यों को समझने हेतु अभिकल्पित है |

Prerequisites/Pre reading for the course: पूर्वापेक्षा:

- अध्येता, पी.यु.सी के स्तर पर द्वितीय भाषा के रूप में हिन्दी का अध्ययन करना चाहिए।
- हिन्दी साहित्य के इतिहास का संक्षिप्त ज्ञान की आवश्यकता है।
- हिन्दी व्याकरण का अवबोधन आवश्यक है।
- अंग्रेज़ी – हिन्दी अनुवाद से संबंधित जानकारी जरुरी है।

Course Objectives: पाठ्यक्रम उद्देश्य :

1. संदर्भानुसार उचित भाषा का प्रयोग करने की दक्षता को छात्रों में उत्पन्न करना।
2. साहित्य के माध्यम से समाज एवं मानवीय मूल्यों को समझाकर, उन मूल्यों की रक्षा हेतु प्रेरित करना।
3. छात्रों में पुस्तक पठन एवं लेखन की अकृतिम प्रवृत्ति स्थापित करना।
4. अध्येताओं में साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास करना।

Course Outcomes अधिगम परिणाम :

अध्ययन की समाप्ति पर अध्येता –

1. हिंदी साहित्य की विविध विधाओं का परिचय प्राप्त कर सकता है।
2. सामाजिक मूल्य एवं नैतिक जवाबदेही को स्वीकार कर सकता है।
3. साहित्य की प्रासंगिकता को जीवन में समझने की दक्षता रखता है।
4. समाज में अंतर्निहित पद्धतियाँ एवं विचारधाराओं का व्याख्यान करने में सक्षम बन सकता है।
5. साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास कर सकता है।
6. अनुवाद एवं व्यावहारिक ज्ञान से अवगत हो सकता है।

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0

Course Content : <u>अध्ययन विषय सूची / पाठ्यक्रम</u>

इकाई – 1: सामाजिक–आर्थिक और ऐतिहासिक एकांकी **10 Hours**

1. सामाजिक–आर्थिक एकांकी: *साइकिल* – भुवनेश्वर
2. ऐतिहासिक–टीकात्मक एकांकी: *अशोक की प्रतिज्ञा* – डॉ. धर्मवीर भारती

इकाई – 2: दार्शनिक, नैतिक और यथार्थपरक एकांकी

3. दार्शनिक–टीकात्मक एकांकी: *महाभारत की एक साँझ* – भारतभूषण अग्रवाल
4. नैतिक, टीकात्मक, यथार्थपरक एकांकी: *रीढ़ की हड्डी* – जगदीशचंद्र माथुर

इकाई – 3: व्यंग्यात्मक और सामाजिक परिवर्तनीय एकांकी

5. व्यंग्यात्मक सामाजिक एकांकी: *जोक* – उपेन्द्रनाथ अश्क
6. सामाजिक–परिवर्तनशील एकांकी: *नए मेहमान* – उदयशंकर भट्ट

इकाई – 4: लेखन कौशल और जनसंचार

7. जनसंचार माध्यम
8. वृत्तांत लेखन (जैसे: वृक्षारोपण का वृत्तांत, अतिथि स्वागत का वृत्तांत आदि)

पाठ्यपुस्तक (Text Book):

1. हिन्दी पाठ्यपुस्तक – रेवा विश्वविद्यालय द्वारा प्रकाशित

References:

सन्दर्भ ग्रन्थ :

1. नाटक : उत्पत्ति और विकास – डॉ. दशरथ ओझा
2. मीडिया लेखन एवं जनसंचार – डॉ. संजीव कुमार
3. हिन्दी साहित्य का इतिहास – डॉ. नागेन्द्र
4. आधुनिक हिन्दी साहित्य का इतिहास – डॉ. बच्चन सिंह
5. हिन्दी साहित्य का नवीन इतिहास – डॉ. लाल साहब सिंह
6. शुद्ध हिन्दी कैसे बोलें कैसे लिखें – पृथ्वीनाथ पाण्डेय
7. कार्यालय अनुवाद सन्देशिका
8. मीडिया समीक्षा – रामशरण जयसिंह
9. संस्कृति, जनसंचार और बाजार – नन्द भारद्वाज
10. प्रयोजनमूलक हिन्दी – डॉ. अम्बादास देशमुख
11. प्रयोजनमूलक हिन्दी – डॉ. माया नागरे-लक्का

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHA301	Language – III: Additional English - III	AEC	3	0	0	3	3

Course Objectives

1. To ensure the development of the linguistic prowess of the students.
2. To motivate the students to appreciate literature.
3. To promote an appreciable reading habit among the students.
4. To explore the use of electronic media such as internet and supplement the learning materials used in the classroom.

Course Outcomes:

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

1. Demonstrate a thorough understanding of sensitive and critical social issues.
2. Develop ideas that contribute to the betterment of society and culture.
3. Discuss opinions in a coherent and communicable manner.
4. Demonstrate speaking ability with clarity and confidence.
5. Assess the nuances of pertinent issues of gender and identity.
6. Appraise the relevance of literature and its impact in changing the society.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0

Course Content

Unit-I: Gender & Identity **10 Hours**

Slyvia Plath – The Moon and the Yew Tree

Alice Walker – Be Nobody's Darling

Toni Morrison - Recitatif

Suniti Namjoshi – Extracts from Feminist Fables

Unit-II: Love & Romance **10 Hours**

Pablo Neruda – Tonight I can Write

William Shakespeare – Sonnet 116

Francis Bacon – Of Love

DH Lawrence – A Modern Lover

Unit-III: War & Trauma **10 Hours**

Czeslaw Milosz – A song on the end of the world

Wilfred Owen – Strange Meeting

Thomas Hardy's – The Man I Killed

Katherine Mansfield – The Fly

Unit-IV: Children's Literature **10 Hours**

Rabindranath Tagore – Paper Boats

Sarojini Naidu – The Gift of India

Leo Tolstoy – Little girls are wiser than men

Ruskin Bond – The Blue Umbrella

References:

1. Sexton, Anne. ***The Complete Poems.*** Houghton Mifflin, 1999.
2. Namjoshi, Suniti. **Feminist Fables**. Spinifex Press, 1998.
3. Vanita, Ruth & Saleem Kidwai (ed.) **Same Sex Love in India.** Penguin India, 2008.
4. Gilman, Charlotte Perkins. **The Yellow Wallpaper**. Rockland Press, 2017.
5. Gale, Cengage Learning. **A Study Guide for Alfred Noyes's "The Highwayman".** Gale, Study Guides, 2017. (Kindle Edition Available)
6. Shakespeare, William. **Poems and Sonnets of William Shakespeare.** Cosimo Classics, 2007.
7. Stockton, Frank Richard. **The Lady, or the Tiger? Create space** Independent Publications, 2017.
8. Wilde, Oscar. **The Collected Works of Oscar Wilde.** Wordsworth Editions Ltd., 1997.
9. Shakespeare, William. **Romeo and Juliet.** Rupa, 2001.
10. Tennyson, Lord Alfred. **The Complete Works of Alfred Tennyson.** Forgotten Books, 2017.
11. Owen, Wilfred. **The Poems of Wilfred Owen.** Wordsworth Editions Ltd., 1994.
12. Maupassant, Guy de. **Guy de Maupassant-The Complete Short Stories**. Projapati, 2015.
13. Manto, Sadaat Hasan. **Manto: Selected Short Stories**. RHI, 2012.
14. Brecht, Bertolt**. Fear and Misery in the Third Reich.** Methuen Drama, 2012.
15. Ricks, Christopher. **Metaphysical Poetry.** Penguin, 2006.
16. Anderson, Hans Christian. **Fairy Tales by Hans Christian Anderson.** Read Books, 2010.
17. Sewell, Anna. **The Black Beauty.** Maple Press, 2014.
18. Kipling, Rudyard. **The Jungle Book.** Amazing Reads, 2018.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0301	Scripting for Bioinformatics: (Bioperl and Biopython)	DSC	3	0	0	3	4

Prerequisite: Basic knowledge of molecular biology, bioinformatics and programming experience in any language (preferably Python or Perl)

Course objectives

1. To understand scripting fundamentals and their application in bioinformatics data manipulation.
2. To develop proficiency in using Bioperl for sequence data analysis and automation.
3. To build competency in using Biopython libraries for accessing and analyzing biological databases.
4. To apply scripting techniques in real-time bioinformatics problem-solving, such as BLAST parsing, sequence alignment, and data retrieval.

Course Outcomes

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

1. Understand the syntax and structure of Perl and Python programming languages.
2. Write Bioperl scripts for reading, writing, and manipulating sequence data.
3. Access and parse biological data from databases like NCBI using Bioperl modules.
4. Use Biopython libraries to retrieve and analyse nucleotide, protein, and structure data.
5. Develop scripts for automation of common tasks like BLAST result parsing and sequence alignment.
6. Apply scripting skills to develop mini projects in genomics and proteomics workflows.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	1	1	1	2	2	3	3	2	2
CO2	3	3	3	2	2	1	1	2	3	2	3	3	2	2
CO3	2	3	3	2	2	1	1	2	2	1	3	3	2	2
CO4	3	2	3	3	3	2	2	2	3	2	3	3	3	2
CO5	3	3	3	3	3	2	2	2	3	2	3	3	3	3
CO6	3	3	3	2	3	2	2	3	3	3	3	3	3	3

Course content

Unit-I: Introduction to Perl for Bioinformatics **12 Hours**

Introduction to Scripting in bioinformatics, Scope, Role and significance, importance and Applications of perl in bioinformatics, installing perl and writing perl scripts, Data type and structures: Scalars, Arrays, Hashes; Array and Hash Operations (Bioinformatics applications: storing sequence data, genetic code tables, gene expression data). Control Structures: Conditional statements (if, unless, elseif,) and looping constructs (for, foreach, while, until), Subroutines: definition, arguments, and scope; File handling: Reading from and writing to files, Parsing biological data formats: FASTA, GenBank; Regular expressions: pattern matching and substitution, motif search in sequences; String manipulation functions: split, join, tr/// (transliteration), Applications in GC content calculation and ORF detection, Debugging Perl scripts, Common error types and troubleshooting.

Unit-II: Understanding of BioPerl Modules **12 Hours**

Introduction to BioPerl and its architecture, Installing and configuring BioPerl modules, Sequence handling using Bio::Seq and Bio::SeqIO, Reading and writing sequence formats: FASTA, GenBank, EMBL, Annotation handling and feature extraction, Bio::Tools modules for sequence analysis, Working with remote databases using BioPerl (e.g., GenBank fetch), Parsing BLAST results using Bio::SearchIO, Practical scripts: motif detection, restriction map generation, sequence alignment handling, Introduction to pipeline scripting using BioPerl modules, Project: Develop a small sequence analysis tool using BioPerl

Unit-III: Introduction to BioPython **12 Hours**

Introduction to Biopython and its architecture, Working with biological sequences using Bio.Seq; Transcription, translation, reverse complement, GC content; Sequence slicing and motif identification; Parsing sequence files using Bio.SeqIO (FASTA, GenBank); Writing sequence data to files; Case studies in sequence analysis and annotation.

Unit–IV: Experimental Biopython Programming **12 Hours**

Accessing NCBI databases using Bio.Entrez; Retrieving sequences and metadata programmatically; Performing BLAST searches using Bio.Blast; Parsing and analyzing BLAST output; Handling multiple sequence alignments with Bio.AlignIO; Reading and writing alignment files (Clustal, FASTA, Phylip); Phylogenetic tree analysis using Bio.Phylo; Visualizing and interpreting phylogenetic data

Recommended Textbooks and References

1. James, D. Tisdall (2003). **Mastering Perl for Bioinformatics.** O'Reilly Media.
2. Chapman, B., & Chang, J. T. (2000). **Biopython Tutorial and Cookbook.** Available online.
3. Hetland, M. L. (2017). **Beginning Python: From Novice to Professional.** Apress.
4. Mitchell, T. (2018). **Python for Data Science and Bioinformatics.** Independently published.
5. Mungall, C. & Batchelor, C. (2021). **Practical Bioinformatics with Perl.** CRC Press.
6. Cock, P. J. A. et al. (2020). **Biopython Tutorial and Cookbook.** Biopython Project.
7. Tisdall, J. (2022). **Beginning Perl for Bioinformatics.** O'Reilly Media.
8. Mitchell, R. (2019). **Bioinformatics Programming Using Python**. O'Reilly Media.
9. Rashidi, H. & Buehler, L. K. (2018). **Bioinformatics Basics: Applications in Biological Science and Medicine** (3rd ed.). CRC Press.
10. Baxevanis, A. D. & Ouellette, B. F. F. (2020). **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins** (4th ed.). Wiley-Blackwell.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0301	Random variables and probability distributions	DSC	3	0	0	3	4

Prerequisites: Basic understanding of Elementary probability theory and Basic statistics.

Course objectives

1. To introduce the concepts of discrete and continuous random variables and their probability functions.
2. To develop an understanding of mathematical expectation, variance, moments, and generating functions.

3. To study standard discrete and continuous probability distributions with real-life applications.
4. To analyze bivariate random variables and evaluate joint, marginal, and conditional distributions, along with measures like covariance and correlation.

Course outcomes

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

1. Explain and apply the concepts of discrete and continuous random variables and their distributions.
2. Compute expectation, variance, moments, and use moment-generating functions.
3. Apply discrete distributions to model real-life problems.
4. Describe and apply continuous distributions to real-life problems.
5. Evaluate joint, marginal, and conditional distributions of bivariate variables.
6. Calculate covariance and correlation of bivariate random variables.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO2	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO3	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO4	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO5	3	3	3	2	0	0	1	1	0	2	2	2	3	2
CO6	3	3	2	2	0	0	1	1	0	2	2	2	3	2

Course content

Unit I: Univariate Random Variables **12 Hours**

Concept and definition of random variables: discrete and continuous, Probability mass function (p.m.f.), probability density function (p.d.f.): definitions, properties, and examples, Distribution function: definition, properties, and illustrations, Expectation, mean, variance, standard deviation: definitions and properties, Moments and moment-generating functions (m.g.f.): definition, properties, and applications; Cauchy-Schwarz inequality and its significance; Transformation of random variables: definition and illustrative examples.

Unit II: Discrete Probability Distributions **12 Hours**

Discrete uniform, Bernoulli, Binomial, Poisson, geometric, negative binomial, and hyper geometric probability distributions – definition, properties, mean, variance, moments, and m.g.f. Illustration of real-life situations and approximation/limiting cases of these distributions.

Unit III: Continuous Probability Distributions **12 Hours**

Continuous Uniform (Rectangular), Exponential, Normal, Gamma, Beta, and Cauchy distributions; Definitions, properties, mean, variance, moments, and m.g.f.; Normal approximation to Binomial and Poisson; Applications in biological sciences, reliability analysis, and computational modeling.

Unit IV: Bivariate Random Variables and Distributions **12 Hours**

Definition of discrete and continuous bivariate random variables; Joint, marginal, and conditional p.m.f./p.d.f./c.d.f.: definitions and properties; Independence of random variables; Theorems on sum and

product of expectations; Conditional expectation and variance; Covariance and correlation: definitions, properties, and interpretation; Mean and variance of linear combinations; m.g.f. of the sum of independent random variables.

Reference Books

1. Sundar Rao, P.S.S., & Richard, J. (2012). ***Introduction to Biostatistics and Research Methods*** (5th ed.). PHI Learning Pvt. Ltd., India.
2. Veer Bala Rastogi (2015). ***Biostatistics*** **(3rd ed.).** Medtech, New Delhi.
3. Wayne W. Daniel & Chad L. Cross (2014). ***Biostatistics: Basic Concepts and Methodology for the Health Sciences*** **(10th ed.).** Wiley.
4. Gupta, S.C. & Kapoor, V.K. (2020). ***Fundamentals of Mathematical Statistics*** **(11th ed., Reprint)**. Sultan Chand & Sons, New Delhi.
5. Mukhopadhyay, P. (2015). ***Mathematical Statistics*****.** Books and Allied Pvt. Ltd., Kolkata.
6. Goon, A.M., Gupta, M.K., & Das Gupta, B. (2017). ***Fundamentals of Statistics*****,** Vol. I. World Press, Kolkata.
7. Gupta, S.C. (2012). ***Statistical Methods*****.** Sultan Chand & Sons, New Delhi.
8. Spiegel, M.R. (2001). ***Probability and Statistics*** (4th ed.). Schaum's Outline Series, McGraw Hill, London.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0301	Advanced RDBMS	DSC	3	0	0	3	4

Prerequisite: Basic knowledge of database concepts, SQL, and programming fundamentals.

Course Objectives

1. Understand the architecture and key components of database systems.
2. Design relational databases using E-R modeling and normalization techniques.
3. Develop queries using relational algebra, SQL, and PL/SQL programming.
4. Explore advanced concepts in DBMS, including distributed, spatial, mobile, and multimedia databases.

Course outcomes

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

1. Explain the architecture and advantages of DBMS over traditional file systems.
2. Design conceptual and logical models using ER diagrams and normalization techniques.
3. Apply relational algebra operations and construct efficient SQL queries.
4. Develop and debug PL/SQL programs including procedures, cursors, and triggers.
5. Compare and contrast architectures of distributed, mobile, and multimedia DBMS.
6. Analyze modern DBMS trends like web-based systems and spatial databases.

Mapping of Course Outcomes with Programme Outcomes

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

CO4	3	3	2	3	3	2	2	2	2	3	3	3	2	2
CO5	3	2	2	3	2	2	2	2	2	3	3	3	3	3
CO6	3	3	3	2	3	3	2	2	2	3	3	3	3	3

Course content

Unit I: Database Architecture and Environment **12 Hours**

Introduction to Database Management System (DBMS); File-based vs. DBMS Approach; Three-Level Architecture: External, Conceptual, and Internal; Physical DBMS Architecture; DBMS Users and Roles: DBA responsibilities; Types of Databases: Relational, Object-Oriented, Hierarchical, Network, NoSQL (overview); Database System Environment and Classification of DBMS

Unit II: Data Modeling and Normalization **12 Hours**

Data Models: Relational, Hierarchical, Network; Relational Model: Domains, Tuples, Attributes, Relations; Keys: Super Key, Candidate Key, Primary Key, Foreign Key; Relational Constraints: Domain, Key, Entity, and Referential Integrity; E-R Model: Entities, Attributes, Relationships, E-R Diagrams; Conversion of ER to Relational Model; Functional Dependencies; Normalization: 1NF, 2NF, 3NF, BCNF; Design guidelines for relational schemas.

Unit III: Query Processing with SQL and PL/SQL **12 Hours**

Relational Algebra: Union, Intersection, Difference, Selection, Projection, Join, Division; SQL: DDL, DML, DCL, TCL; SQL Queries: ORDER BY, GROUP BY, HAVING, Nested Queries, Subqueries; Aggregate Functions; Introduction to PL/SQL: Architecture, Variables, Control Structures; Cursors, Exceptions, Triggers.

Unit IV: Advanced Topics in DBMS **12 Hours**

Distributed Databases: Architecture, Homogeneous vs. Heterogeneous, Distributed Transactions, Commit Protocols, Concurrency Control, Recovery; Web-Based Systems: Client-Server Architecture, N-Tier Architecture, Web-DB Connectivity (e.g., SOAP, REST concepts); Mobile Databases: Characteristics, Challenges, Synchronization; Multimedia Databases: Types, Storage, Retrieval; Spatial Databases: GIS basics, spatial data types, indexing

Recent Textbooks and Reference Books

1. Raghu Ramakrishnan and Johannes Gehrke (2020), ***Database Management Systems*****,** 3rd Ed., McGraw-Hill Education.
2. Elmasri, R., and Navathe, S. B. (2020), ***Fundamentals of Database Systems*****,** 7th Ed., Pearson.
3. Silberschatz, A., Korth, H. F., and Sudarshan, S. (2020), ***Database System Concepts*****,** 7th Ed., McGraw-Hill Education.
4. Date, C. J. (2019), ***An Introduction to Database Systems*****,** 8th Ed., Addison Wesley.
5. Coronel, C., and Morris, S. (2019), ***Database Systems: Design, Implementation, & Management*****,** 13th Ed., Cengage Learning.
6. Tamer Özsu and Patrick Valduriez (2011), ***Principles of Distributed Database Systems*****,** Springer.

7. Vikram Vaswani (2009), ***MySQL: The Complete Reference*****,** McGraw-Hill Education.
8. J.A. Hoffer, V. Rames & H. Topi, ***"Modern Database Management"*** Pearson, 2011.
9. Krishna P. Radha, Das Gupta Pranab Kumar, ***"Database Management System Oracle SQL and PL/SQL"*** Prentice-Hall of India Pvt. Ltd, 2013.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25STS311	Applied Statistics	DSE	2	0	0	2	2

Prerequisite: Basic knowledge of descriptive statistics, graphical representation of data, and introductory probability.

Course objectives

1. To study the demographic data with its sources and measures.
2. To learn the fundamentals of index numbers and their types along with their construction.
3. To understand time series data, components of time series and their measurements.
4. To know about official statistical system in India and functions of different agencies.

Course outcomes

After completing this course, students will be able to:

1. Describe vital statistics and compute fertility and mortality rates.
2. Construct and interpret life tables and population growth rates.
3. Construct, evaluate and interpret the index numbers.
4. Understand the concepts of basic time series analysis.
5. Compute and interpret trend values and seasonal indices for the given time series.
6. Describe the structure of official statistical agencies in India and estimate national income using standard approaches.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	1	0	2	2	2	3	2
CO2	3	3	2	2	2	1	1	1	0	2	2	2	3	2
CO3	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO4	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO5	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO6	3	2	2	2	3	2	1	2	2	3	3	2	2	3

Course content

Unit 1: Vital Statistics **8 Hours**

Demographic Methods: Introduction, measurement of population, rates and ratios of vital events. Measurement of mortality: CDR, SDR (w.r.t. Age and sex), IMR, Standardized death rates-problems; Life (mortality) tables: Introduction, components and uses. Measurement of fertility and reproduction: CBR, GFR, and TFR. Measurement of population growth: GRR, NRR-problems.

Unit 2: Index Numbers **8 Hours**

Meaning and Applications. Price and quantity relatives, link and chain relatives. Construction of Index

numbers: their computation and Interpretation-Simple aggregative and weighted average methods-Laspeyre's, Paasche's, Marshall – Edgeworth's, Drobish – Bowley and Fisher's Index numbers. Time and factor reversal tests, Consumer price Index. Problems involved in the construction of general and consumer price index numbers.

Unit 3: Time Series Analysis **8 Hours**

Introduction, meaning, objectives and components of time series. Decomposition of time series- additive and multiplicative model with their merits and demerits, illustrations of time series. Measurements of trend by moving averages and by least squares. Construction of seasonal indices by simple averages and ratio to moving averages-problems.

Unit 4: Official Statistics and National Income Estimation **8 Hours**

An outline of present official statistical system in India, Methods of collection of official statistics, their reliability and limitations. Role of Ministry of Statistics & Program Implementation (MoSPI), Central Statistical Office (CSO), National Sample Survey Office (NSSO), Directorate of Economics and Statistics(DES), Registered General Office and National Statistical Commission. Government of India's Principal publications containing data on the topics such as Agriculture, price, population, industry, finance and employment, Consumer price Index, Wholesale price index number and index of industrial production. National Income: Introduction, need and measures (GDP, GNP, NDP, NNP, per capita income), Estimation of national income: product approach, income approach, and expenditure approach.

Reference Books & Online Sources

1. Douglas C. Montgomery, George C. Runger, "**Applied Statistics and Probability for Engineers**", 8th Edition, Wiley, 2023.
2. Parimal Mukhopadhyay, "**Applied Statistics**", 4th Edition, Books & Allied (P) Ltd., Kolkata, 2022.
3. S.C. Gupta, V.K. Kapoor, "**Fundamentals of Applied Statistics**", Sultan Chand & Sons, New Delhi, 2023.
4. A.M. Goon, M.K. Gupta, B. Das Gupta, "**Fundamentals of Statistics, Volume II**", World Press Pvt. Ltd., Kolkata, Reprint Edition, 2020.
5. Arun Gupta, B. Kapoor, "**Applied Statistics for Social and Management Sciences**", 2nd Edition, Sage Publications India, 2019.
6. Marcello Pagano, Kimberlee Gauvreau, "**Principles of Biostatistics**", 2nd Edition, Cengage Learning, Reprint Edition, 2018.
7. Ministry of Statistics and Programme Implementation (MoSPI), Government of India, **"Guide to Official Statistics in India**", MoSPI Publications, New Delhi, 2023.
8. Richard De Veaux, Paul Velleman, David Bock, "**Intro Stats**", 6th Edition, Pearson Education, 2022.
9. Wayne W. Daniel, Chad L. Cross, "**Biostatistics: A Foundation for Analysis in the Health Sciences**", 11th Edition, Wiley, 2018.

Online Resources:

1. MoSPI Official Website
2. Economic Survey of India
3. Niti Aayog Reports
4. Census of India

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25STS312	Introduction to statistical learning	DSE	2	0	0	2	2

Prerequisite: Basic statistics and R programming , random variable and probability distributions.

Course objectives:

1. To introduce the fundamental concepts of statistical learning and its significance in the domains of machine learning and artificial intelligence.
2. To familiarize students with various learning paradigms including supervised, unsupervised, and reinforcement learning.
3. To provide a comprehensive understanding of regression techniques—both linear and logistic—and their practical applications.
4. To equip students with the skills to evaluate and interpret the performance of machine learning models using appropriate statistical metrics.

Course outcomes

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

1. Understand key concepts of statistical learning and AI.
2. Distinguish between classification and regression methods.
3. Evaluate classification models using performance metrics.
4. Apply linear regression and interpret its results.
5. Build and interpret logistic regression models.
6. Identify and address overfitting, underfitting and bias-variance trade-off.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	1	0	3	3	2	3	3
CO2	3	3	2	2	0	0	1	1	0	2	3	2	3	2
CO3	3	3	2	2	0	0	1	1	0	2	3	2	3	2
CO4	3	3	2	3	0	0	1	1	0	3	3	3	3	2
CO5	3	3	2	3	0	0	1	1	0	3	3	3	3	2
CO6	3	3	2	2	0	1	1	1	0	3	3	2	3	3

Course content

Unit1: Introduction to Statistical learning **8 Hours**

Meaning of Machine learning and Artificial intelligence (AI), Role of Statistics in Machine Learning and AI, Statistical learning, Types of Learning: Supervised, Unsupervised, Reinforcement (overview). Classification vs. Regression. Structure of a Learning Process: Features (independent variables) and response

(dependent variable), Training and testing datasets, Importance of random sampling. Applications in Bioinformatics.

Unit2: Evaluation metrics **8 Hours**

Performance Metrics: Confusion Matrix, Accuracy, Precision, Recall, F1-score, Specificity, Sensitivity. ROC and AUC. Bias-Variance Trade-off, Overfitting and Underfitting. Introduction to Cross-validation and Dimensionality reduction. Applications in Bioinformatics.

Unit 3: Linear Regression **8 Hours**

Linear regression: Simple linear regression—Basic concepts, meaning, model, Assumptions-Linearity, normality, homoscedasticity, independence. Least Squares Estimation and interpretation of coefficients, Residual analysis and diagnostic plots, Model evaluation -MAE, MSE, RMSE, R^2, Adjusted R^2. Application problems.

Unit4: Multiple and Logistic regressions **8 Hours**

Multiple linear regression: meaning and concepts, Model fitting and interpretation. Logistic regression: Introduction, Logistic Model, Assumptions, Model Fitting and Estimation, Model Interpretation and Inference, Model Evaluation- Confusion Matrix, Specificity, Sensitivity, Accuracy, Precision, Recall, F1-score. Application problems.

Reference Books:

1. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani (2021): *An Introduction to Statistical Learning with applications in R*, 2nd edition, Springer.
2. Gareth James, Daniela Witten, Trevor Hastie, Robert Tibshirani, Jonathan Taylor (2023): *An Introduction to Statistical Learning with applications in Python*, 2nd edition, Springer.
3. Trevor Hastie, Robert Tibshirani, Jerome Friedman(2009):The Elements of Statistical Learning, 2nd edition, Springer.
4. Gupta S.C., V.K. Kapoor.(2014) *Fundamentals of Applied Statistics*, Sultan Chand and Sons, New Delhi, India.
5. C. Radhakrishna Rao(2020): Statistical Learning and Data Science, World Scientific Publishing.
6. B.L. S. Prakasa Rao(2013): Introduction to Statistical Machine Learning, Springer India.
7. A.K. Vashishth & Neha Vashishth(2021): Data Science and Machine Learning using R, BPB Publications.
8. Pratap Dangeti(2017): Statistics for Machine Learning, Packt Publishing.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0302	Lab: Scripting for Bioinformatics: BioPerl and BioPython	DSC	0	0	2	2	3

Prerequisite: Basic knowledge of bioinformatics and programming experience in any language (preferably Python or Perl)

Course objectives

1. To understand scripting fundamentals and their application in bioinformatics data manipulation.
2. To develop proficiency in using Bioperl for sequence data analysis and automation.
3. To build competency in using BioPython libraries for accessing and analysing biological databases.
4. To apply scripting techniques in real-time bioinformatics problem-solving, such as BLAST parsing, sequence alignment, and data retrieval.

Course Outcomes

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

1. Understand the syntax and structure of Perl and Python programming languages.
2. Write Bioperl scripts for reading, writing, and manipulating sequence data.
3. Access and parse biological data from databases like NCBI using Bioperl modules.
4. Use BioPython libraries to retrieve and analyse nucleotide, protein, and structure data.
5. Develop scripts for automation of common tasks like BLAST result parsing and sequence alignment.
6. Apply scripting skills to develop mini projects in genomics and proteomics workflows.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	0	0	0	0	2	3	0	0
CO2	3	3	2	3	3	0	0	0	0	0	2	3	2	0
CO3	3	3	3	3	3	0	0	0	0	0	2	3	3	2
CO4	3	3	2	3	3	0	0	0	0	0	2	3	3	3
CO5	3	3	3	3	3	2	0	0	2	2	3	3	3	3
CO6	3	2	0	0	2	0	0	0	0	0	2	3	0	0

Course content

1. **DNA Sequence Storage and Manipulation (Perl)**
   - Store a DNA sequence in a scalar/array/hash
   - Compute reverse complement
   - Perform GC content analysis
2. **Transcription and Translation (Perl & BioPython)**
   - Convert DNA to RNA
   - Translate RNA to Protein using codon table
3. **Reading and Writing Sequence Files (FASTA & GenBank)**
   - Parse sequence data using Perl (Bio::SeqIO) and Biopython (Bio.SeqIO)
   - Store sequences and write to new files
4. **Motif Search in DNA/Protein Sequences**
   - Use regular expressions in Perl
   - Use motif pattern matching in Biopython
5. **BLAST Automation and Parsing (Biopython)**
   - Perform BLAST search using Bio.Blast
   - Parse and interpret BLAST XML/HTML output
6. **Subroutines and Function-Based Scripts in Perl**

- Create reusable subroutines
- Demonstrate pass-by-value and pass-by-reference

7. **Retrieving and Parsing NCBI Records using Entrez**
   - Automate sequence retrieval via Bio.Entrez
   - Extract metadata, organism name, and gene info
8. **Restriction Site Mapping and Feature Extraction**
   - Use BioPerl modules to detect restriction sites
   - Extract annotated features from GenBank/EMBL
9. **Multiple Sequence Alignment Parsing and Phylogenetic Analysis**
   - Read Clustal/Phylip alignments using Bio.AlignIO
   - Visualize trees using Bio.Phylo
10. **Develop a Mini Pipeline Tool (Perl or Python)**
    - Combine sequence reading, motif search, and BLAST in one script
    - Demonstrate integration of multiple modules

Recommended Textbooks and References

1. James, D. Tisdall (2003). **Mastering Perl for Bioinformatics.** O'Reilly Media.
2. Chapman, B., & Chang, J. T. (2000). **Biopython Tutorial and Cookbook.** Available online.
3. Hetland, M. L. (2017). **Beginning Python: From Novice to Professional.** Apress.
4. Mitchell, T. (2018). **Python for Data Science and Bioinformatics.** Independently published.
5. Mungall, C. & Batchelor, C. (2021). **Practical Bioinformatics with Perl.** CRC Press.
6. Cock, P. J. A. et al. (2020). **Biopython Tutorial and Cookbook.** Biopython Project.
7. Tisdall, J. (2022). **Beginning Perl for Bioinformatics.** O'Reilly Media.
8. Mitchell, R. (2019). **Bioinformatics Programming Using Python**. O'Reilly Media.
9. Rashidi, H. & Buehler, L. K. (2018). **Bioinformatics Basics: Applications in Biological Science and Medicine** (3rd ed.). CRC Press.
10. Baxevanis, A. D. & Ouellette, B. F. F. (2020). **Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins** (4th ed.). Wiley-Blackwell.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0302	Lab: Random variables and probability distributions	DSC	0	0	2	2	3

Prerequisites: Basic understanding of Elementary probability theory and Basic statistics.

Course Objectives

1. To develop an ability to compute and interpret key probability functions and statistical measures for discrete and continuous random variables.
2. To apply various discrete and continuous probability distributions to solve practical problems in life sciences.
3. To learn the methods for fitting probability distributions to observed data.

4. To use R programming to compute, simulate and visualize probability distributions and statistical measures.

Course outcomes

After completion of this course students will be able to:

1. Compute and interpret p.m.f, p.d.f, expectation, variance, and moments for discrete and continuous random variables.
2. Apply binomial, Poisson, geometric, negative binomial, and hypergeometric distributions to solve practical problems in life sciences.
3. Fit binomial, Poisson, and normal distributions to observed data and find expected frequencies.
4. Compute and interpret probabilities, mean, and variance for uniform, exponential, and normal distributions.
5. Analyze bivariate distributions including joint, marginal, and conditional distributions, covariance, and correlation.
6. Use R programming to perform statistical computations, simulate distributions, and visualize results for interpretation.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	0	0	1	1	0	2	2	2	3	2
CO2	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO3	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO4	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO5	3	3	3	2	1	0	1	1	0	2	2	2	3	2
CO6	3	3	2	3	1	1	1	2	0	3	3	3	3	2

Course content

S. No	Title of the Experiment
1	Compute and interpret the probability mass function (p.m.f), expectation, variance, moments, skewness, and kurtosis for discrete random variables.
2	Compute and interpret the probability mass function (p.m.f), expectation, variance, moments, skewness, and kurtosis for continuous random variables.
3	Solve the application problems based on binomial distribution.
4	Solve the application problems based on Poisson distribution.
5	Fit binomial and Poisson distribution and compute the expected frequencies.
6	Solve the application problems based on geometric, negative binomial and hyper geometric distributions.
7	Compute and interpret probabilities, mean and variance for uniform and exponential distribution.
8	Solve the application problems based on normal distribution.
9	Fit normal distribution and compute the expected frequencies.
10	Evaluate joint, marginal, conditional distributions, covariance and correlation of bivariate variables.

Suggested Software/Tools

1. R Programming (Recommended for statistical analysis, visualization)
2. Python (Libraries: NumPy, SciPy, Matplotlib, Pandas)
3. MS Excel / LibreOffice Calc (For basic visualization and tabulation)
4. GraphPad Prism/ SPSS / PSPP (For statistical modeling, if available)

Reference Books & Online Sources

1. Douglas C. Montgomery, George C. Runger, "**Applied Statistics and Probability for Engineers**", 8th Edition, Wiley, 2023.
2. Parimal Mukhopadhyay, "**Applied Statistics**", 4th Edition, Books & Allied (P) Ltd., Kolkata, 2022.
3. S.C. Gupta, V.K. Kapoor, "**Fundamentals of Applied Statistics**", Sultan Chand & Sons, New Delhi, 2023.
4. A.M. Goon, M.K. Gupta, B. Das Gupta, "**Fundamentals of Statistics, Volume II**", World Press Pvt. Ltd., Kolkata, Reprint Edition, 2020.
5. Arun Gupta, B. Kapoor, "**Applied Statistics for Social and Management Sciences**", 2nd Edition, Sage Publications India, 2019.
6. Marcello Pagano, Kimberlee Gauvreau, "**Principles of Biostatistics**", 2nd Edition, Cengage Learning, Reprint Edition, 2018.
7. Ministry of Statistics and Programme Implementation (MoSPI), Government of India, **"Guide to Official Statistics in India**", MoSPI Publications, New Delhi, 2023.
8. Richard De Veaux, Paul Velleman, David Bock, "**Intro Stats**", 6th Edition, Pearson Education, 2022.
9. Wayne W. Daniel, Chad L. Cross, "**Biostatistics: A Foundation for Analysis in the Health Sciences**", 11th Edition, Wiley, 2018.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0302	Lab: Advanced RDBMS	DSC	0	0	2	2	3

Prerequisite:

- Basic understanding of DBMS concepts (from introductory DBMS course)
- Familiarity with SQL syntax and relational algebra
- Exposure to computer programming logic

Course Objectives

1. Understand and implement database architecture and data modeling techniques.
2. Develop normalized database schemas using functional dependencies and ER diagrams.
3. Execute advanced SQL and PL/SQL operations for effective data management.
4. Explore modern database systems like distributed, mobile, and multimedia databases.

Course Outcomes

After successful completion of this lab, students will be able to:

1. Demonstrate the use of database environment and architecture in practical scenarios.
2. Design ER diagrams and normalize relational schemas using various normal forms.

3. Implement and test SQL queries for data definition, manipulation, and control.
4. Create PL/SQL programs including triggers, cursors, and exception handling.
5. Apply concepts of distributed, mobile, spatial, and multimedia databases in real-world applications.
6. Analyze and implement web-based database applications using multi-tier architecture.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	0	0	0	1	1	3	2	1	2
CO2	3	3	3	2	2	0	0	0	1	1	3	2	2	3
CO3	3	2	3	1	3	0	0	0	2	1	3	3	2	3
CO4	2	3	3	2	3	0	0	0	1	2	3	3	3	3
CO5	3	3	3	3	3	1	2	1	2	2	3	3	3	3
CO6	3	3	3	2	3	1	2	0	2	3	3	3	3	3

Course content

1. Design ER Diagram and Convert to Relational Schema for two domains (e.g., College, Tropical Disease DB)
2. SQL Schema Modifications on GENE Table – Add, Drop, Modify columns & constraints
3. Data Retrieval Using SQL – Filtering, Sorting, Aggregate Functions on EMPLOYEE Table
4. Advanced SQL Queries on SALARY Table – Grouping, Aggregate, Conditional logic
5. SQL Joins (LEFT, RIGHT, FULL) using GENE and EXPRESSION Tables
6. PL/SQL Program for DML Operations (INSERT, UPDATE, DELETE)
7. PL/SQL Cursor Example – Inventory Management / Iterative Query Handling
8. PL/SQL Program to Calculate Total Salary per Department
9. Data Analysis on Tropical Disease DB – Filtering by multiple fields across tables
10. [NEW] NoSQL Experiment (MongoDB) – Create collection, insert docs, query with filters

11. Write complex SQL queries using JOIN, NESTED QUERIES, GROUP BY, HAVING, ORDER BY, and SET OPERATIONS.
12. Perform operations across multiple tables with filtering and sorting.
13. Create and manipulate Views for data abstraction.
14. Implement Indexing to improve query performance.
15. Analyze execution plans to understand optimization.
16. **Advanced SQL Queries**

Write complex SQL queries using JOIN, NESTED QUERIES, GROUP BY, HAVING, ORDER BY, and SET OPERATIONS.

Perform operations across multiple tables with filtering and sorting.

Views and Indexing

Create and manipulate Views for data abstraction.

Implement Indexing to improve query performance.

Analyze execution plans to understand optimization.

Stored Procedures and Functions

Write Stored Procedures using parameters (IN, OUT, INOUT).

Create User-defined Functions (UDFs) for modular and reusable code.

Test and debug stored programs.

Triggers Implementation

Create BEFORE and AFTER triggers on INSERT, UPDATE, DELETE.

Implement row-level and statement-level triggers.

Use triggers for logging and enforcing business rules.

Cursors and Exception Handling in PL/SQL

Use Explicit and Implicit Cursors to process result sets.

Implement robust Exception Handling in PL/SQL blocks.

Transactions and Concurrency Control

Demonstrate ACID properties with transaction control statements (COMMIT, ROLLBACK, SAVEPOINT).

Test Concurrent Transactions and observe outcomes under isolation levels.

Normalization and Schema Design

Normalize a sample database up to 3NF or BCNF.

Create ERD and implement normalized schema in RDBMS.

Compare space and performance between unnormalized and normalized schemas.

Performance Tuning and Query Optimization

Analyze slow-running queries.

Apply indexing and rewriting techniques.

Use EXPLAIN PLAN to monitor performance impact.

Backup, Recovery and User Privileges

Perform database backup and recovery using SQL commands or admin tools.

Grant and revoke user privileges, roles, and implement access control.

Introduction to NoSQL and MongoDB

Compare RDBMS vs. NoSQL systems.

Perform basic CRUD operations using MongoDB shell or Compass.

Insert, update, and query JSON documents.

Recent Textbooks and Reference Books

1. Raghu Ramakrishnan and Johannes Gehrke (2020), ***Database Management Systems*****,** 3rd Ed., McGraw-Hill Education.
2. Elmasri, R., and Navathe, S. B. (2020), ***Fundamentals of Database Systems*****,** 7th Ed., Pearson.
3. Silberschatz, A., Korth, H. F., and Sudarshan, S. (2020), ***Database System Concepts*****,** 7th Ed., McGraw-Hill Education.
4. Date, C. J. (2019), ***An Introduction to Database Systems*****,** 8th Ed., Addison Wesley.
5. Coronel, C., and Morris, S. (2019), ***Database Systems: Design, Implementation, & Management*****,** 13th Ed., Cengage Learning.
6. Tamer Özsu and Patrick Valduriez (2011), ***Principles of Distributed Database Systems*****,** Springer.
7. Vikram Vaswani (2009), ***MySQL: The Complete Reference*****,** McGraw-Hill Education.
8. J.A. Hoffer, V. Rames & H. Topi, ***"Modern Database Management"*** Pearson, 2011.

9. Krishna P. Radha, Das Gupta Pranab Kumar, ***"Database Management System Oracle SQL and PL/SQL"*** Prentice-Hall of India Pvt. Ltd, 2013.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0303	Skill Enhancement Course-II (Statistics)	SEC	0	0	3	3	3

Prerequisite:

Basic understanding of mathematics at the higher secondary level

Familiarity with MS Excel or basic computational tools

Logical reasoning and data interpretation skills

Course Objectives

1. To build foundational knowledge in statistical concepts and methods.
2. To develop practical skills in data collection, visualization, and analysis.
3. To introduce basic tools for statistical inference and hypothesis testing.
4. To enable learners to apply statistics in real-world problem-solving across domains like life sciences, business, and social sciences.

Course Outcomes

1. Demonstrate an understanding of key statistical concepts relevant to the analysis of biological data.
2. Organize and preprocess biological datasets for statistical analysis using appropriate data handling techniques.
3. Apply statistical tools and techniques such as descriptive statistics, probability distributions, inferential techniques and statistical models to analyze biological data.
4. Interpret and explain the results of statistical analyses to derive meaningful biological insights.
5. Generate clear and informative visualizations to support the analysis and communication of bioinformatics data.
6. Utilize statistical software tools to perform data analysis, visualization, and reporting in bioinformatics applications.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	1	1	2	0	2	3	2	3	2
CO2	3	3	2	2	1	1	1	2	0	2	2	2	3	3
CO3	3	3	3	3	1	1	1	2	0	3	3	3	3	3
CO4	3	3	2	2	1	1	1	3	0	3	3	2	3	3
CO5	3	2	2	3	1	1	1	3	0	3	3	2	3	3
CO6	3	3	2	3	1	1	1	2	0	3	3	3	3	3

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25SB0301	Health and Wellness	VAC	1	0	0	1	1

Prerequisites

The student should have prior understanding of basic biology.

Course Objectives

1. To acquire basic understanding about public health and importance in day to day life.
2. To understand the human dietary requirements and the nutritional diseases management.
3. To understand about various yogasanas.
4. To understand stress relief through exercise and yoga.

Course Outcomes

After completing the course students should be able to:

1. Describe about the concept of public health importance.
2. Understand objectives of health education and wellness.
3. Understand dietary requirements.
4. Apply knowledge about role of nutrition and health for disease prevention.
5. Learn the concept of stress management.
6. Conceptualize the process of exercise and yoga.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	3	3	3	3	3	1	3	3	3	1	1	3	3
CO2	2	2	3	3	3	2	1	3	2	2	2	3	3	3
CO3	2	1	3	3	3	3	2	3	2	2	2	2	3	2
CO4	2	3	3	3	3	3	2	3	2	2	2	3	3	3
CO5	2	3	3	3	3	2	3	3	2	2	3	2	3	3
CO6	2	3	3	3	2	3	2	3	2	3	3	3	2	1

Course content

UNIT- I: Introduction and Methods to Maintain Health and Wellness 12 Hours

Meaning, Definition and dimensions of Health and Wellness (WHO/Yoga, Factors affecting Fitness and Wellness, Role of Fitness in maintaining Health and Wellness, Importance of Health Education and Wellness, Role of Physical Activities and Recreational Games for Health and Wellness, Role of Yogasanas and Meditation in maintaining Health and Wellness, Nutrition for Health & Wellness

Unit-II: Anxiety, Stress and Aging 12 Hours

Meaning of Anxiety, Stress and Aging, Types and Causes of Stress, Stress relief through Exercise and Yoga, Future challenges in public health, Role of nutrition and health for prevention of disease caused by stress and anxiety. Public Health Challenges Related to Stress and Aging, Community-Based Stress Management Strategies, Technological Tools for Stress Monitoring and Management, Future Challenges and Research Directions in Stress and Aging.

Reference Books:

1. Gordon Edlin & Eric Golanty (2009). **Health & Wellness** (10th ed.). Jones & Bartlett Publishers.
2. Mary-Jane Schneider (2013). **Introduction to Public Health** (4th ed.). Jones & Bartlett Learning.
3. M. R. Adams & M. O. Moss (2007). **Food Microbiology** (3rd ed.). Royal Society of Chemistry.
4. Geoffrey Campbell-Platt (Ed.) (2017). **Food Science and Technology** (2nd ed.). Wiley-Blackwell.
5. N. F. Lightfoot & E. A. Maier (1998). **Microbiological Analysis of Food and Water**. Elsevier.

6. Brooks, G. F., Carroll, K. C., Butel, J. S., Morse, S. A., & Mietzner, T. A. (2010). Jawetz, Melnick & Adelberg's **Medical Microbiology** (25th ed.). McGraw-Hill.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25NS0108	NSS	VAC	1	0	0	1	1

Prerequisites: Basic understanding of civic responsibility and social service orientation.

Course Objectives

1. To expose the students to the importance of NSS activities and awareness of resources.
2. To bring awareness to the students about Health first aid programs and administrative skills for 7 days special Camp.
3. To be aware of and contribute to the Unity in Diversity and Nation building activities.
4. To develop the skills to learn disaster management skills.

Course Outcomes

After completing the course students should be able to:

1. Discussion to understand the importance of NSS activities
2. Practicing and acquire knowledge on Health first aid programs
3. Summarize the Unity in Diversity and Nation building activities
4. Classify to learn disaster management skills, develop skills of social awareness
5. Demonstrate themselves to involve in NSS Programme activities Volunteer
6. Apply the skill to identify and solve societal problems

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	3	0	0	0	2	3	3	0	0
CO2	2	0	3	0	0	3	3	0	0	2	3	0	3	3
CO3	3	2	0	2	0	2	0	2	0	2	3	3	0	0
CO4	0	0	3	3	0	3	3	0	0	0	3	0	3	3
CO5	3	2	0	0	2	3	0	0	3	3	3	0	3	0
CO6	2	0	0	2	0	3	2	2	2	3	3	3	3	3

Course content

Unit: I-NSS

NSS : Introduction –Origin and growth of NSS – Objectives – Motto – Symbol – NSS – Import National Days – NSS Song, Environmental Awareness : Natural Resources – Conservation and Management – Water conservation and Rainwater harvesting – Solid waste management – Pollution control: Water, Air, Noise and Soil – Energy conservation – Wildlife Conservation Global warming.

Unit: II- Special Programme

Legal Awareness – Health awareness –Blood Donation Camp, First –Aid –Career Guidance – Leadership. Training cum –Cultural Programme –Globalization ant its Economic Social and Cultural Impacts. Planning and Preparation of special Camping Programme. Planning at institutions level – Guidelines for the success

of camp- Importance of successful camping programme – Guiding principles – organization of camp – Administration of camp.

Unit: III- Social Awareness

Basics and Social Service, Weaker Section of our society and their needs – NGOs : Role and Contribution – Civic responsibility – causes and Prevention; role of youth –Drug Abuse and Trafficking –awareness of IV / AIDS. National Integration : Importance and Necessity – Freedom Struggle and Nationalistic movement in India – National interests, Objectives, Threats and Opportunities – Unity in Diversity – Contribution of Youth in Nation Building.

Unit: IV- First Aid

Artificial Respiration – Control of Bleeding – Fractures – Burns – Shock – Wounds – Eye Injures – Heat Stroke – Snake Bite – Dog Bites – Poisoning., Disaster Management : Characteristics and types of Disasters (Geological and Mountain Area Disaster , Wind and Water Related natural Disaster, Man made Disaster) , Causes and effects, Assistance during Natural / Other Calamities Flood / Cyclone / Earthquake / Accident.

Unit: V- Basic Concepts and Components

NSS Programme Officer – NSS Volunteer – Community – Aims of NSS Programme /Activities – Classification of NSS Programme – Adoption of Villages – Contacting Villages / Area Leaders – Survey of the Villages / Area Identification of Problem(s) Completion of Projects – Evaluation of Project – Adoption of Slums – Survey of the Slum – Services in Slums - Coordination with Voluntary – Organizations.

Reference Books:

1. National Service Scheme Manual (Revised) 2006, Government of India, Ministry of Youth Affairs and Sports, New Delhi.
2. University of Mumbai National Service Scheme Manual 2009.
3. Avhan Chancellor's Brigade-NSS Wing, Training camp on Disaster Preparedness Guidelines, March 2012.
4. Rashtriya Seva Yojana Sankalpana- Prof. Dr. Saskatchewan, Dr. Pramod Pabrekar, Diamond Publication, Pune.
5. National Service Scheme Manual for NSS District Coordinators, National Service Scheme Cell, Dept. of Higher and Technical Education, Mantralayam,
6. Annual report of National Service Scheme (NSS) published by Dept. of Higher and Technical Education, Mantralayam.
7. NSS Cell, Dept. of Higher and Technical Education, Mantralayam, UTKARSHA- Socio and cultural guidelines.
8. Case material as a Training Aid for Field Workers, Gurmeet Hans.
9. Social service opportunities in hospital’s, Kapil K. Krishnan, TISS
10. New Trends in NSS, Research papers published by University of Pune.
11. ANOOGUNJ Research Journal, published by NSS Unit C. K. Thakur college

12. Training Manual for Field Work published by RGNIYD, Sriperumbudur
13. Prof. Ghatole R.N. Rural Social Science and Community Development.
14. Purushottam Sheth, Dr. Shailaja Mane, National Service Scheme

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25NC0109	NCC	VAC	1	0	0	1	1

Prerequisites: The students should have interest in NCC

Course Objectives

1. To develop character, comradeship, discipline, secular outlook, spirit of adventure and the ideals of selfless service amongst the youth of the country.
2. To create a human resource of organized, trained and motivated youth, to provide leadership in all walks of life and always available for the service of the nation.
3. To provide a suitable environment to motivate the youth to take up a career in the Armed Forces

Course Outcomes

After completing the course students should be able to:

1. Developing character, comradeship, discipline, a secular outlook, the spirit of adventure and ideals of selfless service amongst young citizens
2. Creating a pool of organized, trained and motivated youth with leadership qualities in all walks of life, who will serve the Nation regardless of which career they choose
3. Summarize the Unity in Diversity and Nation building activities.
4. Provide a Suitable Environment to Motivate the Youth to Take Up a Career in the Armed Forces
5. Develop Character, Comradeship, Discipline, Leadership, Secular Outlook, Spirit of Adventure, and Ideals of Selfless Service amongst the Youth of the Country.
6. Apply the Leadership in all Walks of life and be Always Available for the Service of the Nation.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	3	2	2	2	0	0	0	0	3	3	2	2
CO2	0	0	2	3	3	2	0	0	0	0	3	3	2	1
CO3	0	0	2	3	3	2	0	0	0	0	3	3	1	1
CO4	0	0	2	3	3	1	0	0	0	0	3	3	1	1
CO5	0	0	1	2	3	1	0	0	0	0	3	3	2	1
CO6	0	0	1	2	3	1	0	0	0	0	3	3	2	1

Course content

Unit: I- NCC

NCC : Introduction –Origin and growth of NCC – Objectives – Motto, Duties of NCC cadets, NCC Song ,NCC camps- types and Conduct ,Unity in Diversity and role of NCC in nation building, Threats to national security, Freedom struggle and nationalist movement in India , Drill, Weapon Training.

Unit: II- Personality Development and Leadership

Group Discussion - Stress and emotions, change your mindset, interpersonal relations and team work, Time management , civic sense ,Carrier counselling, SSB procedure and interview skills, Public speaking, Case

Studies - Mahatma Gandhi, Shivaji, APJ Abdul Kalam, Deepa Malik, Maharana Pratap, Ratan Tata, Jhansi ki Rani, Narayan Murti, Prakash Padukone, Tipu Sultan, Rabindra Nath Tagore, Fire Service and firefighting, Civil defence and NDMA, Initiative training, organising skills, do's and don'ts, natural disasters, manmade disasters.

Unit: III- Social Awareness and Community Development

Road/Rail travel safety, Cyber and mobile safety awareness, Civic responsibilities, Causes and preventions of HIV/AIDS, Drug awareness, traffic awareness, first aid in common medical emergencies, treatment and care of wounds, Infectious and contagious diseases and its prevention, Introduction to yoga and exercises, Water conservation and rainwater harvesting.

Unit: IV- Armed Forces

Armed Forces, Army, CAPF, Police, Basic organization of Armed Forces, Conduct to MR, Google & Tourist Maps and Apps, Prismatic compass and its use and GPS, Military History -Biographies of Renowned Generals, Study of Battles - Indo Pak war 1965, 1971, & Kargil, Basic Communication Procedure, Types of Communication, Characteristics of Wireless technology (mobile, Wi-Fi etc.)

Unit: V- Basics of Weapon Training

Stripping, assembling, loading, unloading of rifle, Light Machine Gun and Stern machine carbine, characteristics of weapons, (Rifle, LMG & Stern), safety procedures, loading, cocking and unloading of weapons, positions in shooting and its advantages, trigger control and firing a shot, theory of group and snap shooting, short range firing and aiming.

Reference Books

1. NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examinations, R.K. Gupta,2025
2. NCC: Handbook of NCC Cadets for 'A', 'B' and 'C' Certificate Examination, RPH Editorial Board,2016
3. NCC Army Wing, RPH Editorial Board,2023

FOURTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHK403	Language-II: Kannada-IV	AEC	3	0	0	3	3

Course Overview

ರಾಷ್ಟ್ರೀಯ ಶಿಕ್ಷಣ ನೀತಿಯ ಪ್ರಕಾರವಾಗಿ ಭಾಷೆಯನ್ನು ಮಾತನಾಡುವ ಬರೆಯುವ ಕೌಶಲ್ಯ, ಸಾಹಿತ್ಯದ ಬಗ್ಗೆ ಸ್ಥೂಲವಾಗಿ ಪರಿಚಯಿಸುವ ಮೂಲಕ ವಿದ್ಯಾರ್ಥಿಗಳ ವ್ಯಕ್ತಿತ್ವ ವಿಕಾಸ ಹಾಗು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು, ಪ್ರಸ್ತುತ ಸಂದರ್ಭಕ್ಕೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸಲು ಪಠ್ಯವನ್ನು ರೂಪಿಸಲಾಗಿದೆ. ಸಾಹಿತ್ಯ, ಕಲೆ, ವಾಣಿಜ್ಯ, ಆಡಳಿತಾತ್ಮಕ ಮತ್ತು ವಿಜ್ಞಾನದ ವಿಚಾರಗಳಿಗೆ ಒತ್ತನ್ನು ನೀಡಲಾಗಿದೆ. ಇದು ನಾಲ್ಕು ಸೆಮಿಸ್ಟರ್‌ಗಳಲ್ಲಿ ಮೂರು ಕ್ರೆಡಿಟ್‌ಗಳನ್ನು ಹೊಂದಿದೆ.

Prerequisite / Pre reading for the course

- ಕನ್ನಡ ಭಾಷೆಯ ಬಗೆಗೆ ಪ್ರಾಥಮಿಕ ತಿಳುವಳಿಕೆ ಅಗತ್ಯ.
- ಭಾಷೆಯನ್ನು ಓದಲು ಮತ್ತು ಬರೆಯಲು ತಿಳಿದಿರಬೇಕು.
- ಪದವಿ ಪೂರ್ವ ಶಿಕ್ಷಣದಲ್ಲಿ ಕನ್ನಡ ಭಾಷೆಯನ್ನು ಓದಿರಬೇಕು.

Course Objectives:

ನಾಲ್ಕು ಸೆಮಿಸ್ಟರ್‌ಗಳಲ್ಲಿ ಕನ್ನಡ ಸಾಹಿತ್ಯವನ್ನು ಒಳಗೊಂಡಂತೆ ವಿಷಯವಾರು ಪಠ್ಯಗಳನ್ನು ನೀಡಲಾಗಿದ್ದು, ಆ ಮೂಲಕ ಕನ್ನಡ ಭಾಷೆ, ಸಂಸ್ಕೃತಿಯ ಜೊತೆಗೆ ಮಾನವೀಯ ಗುಣಗಳನ್ನು ಪರಿಚಯಿಸುವ ಹಾಗೂ ಅಳವಡಿಸಿಕೊಳ್ಳಲು ಪ್ರೇರೇಪಿಸುವ ಉದ್ದೇಶವನ್ನು ಹೊಂದಿದೆ. ಅದರಂತೆ ನಾಲ್ಕನೇ ಸೆಮಿಸ್ಟರ್‌ನಲ್ಲಿ ದಮನಿತ ಲೋಕ, ಸಹಿಷ್ಣುತೆ, ಶ್ರೀಸಾಮನ್ಯನ ಬದುಕು ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂದಿಸಿದಂತೆ ವಿಷಯಗಳನ್ನು ನೀಡಿದ್ದು, ಅದಕ್ಕೆ ಪೂರಕವಾಗಿ ಸಾಹಿತ್ಯಿಕ ಪಠ್ಯವನ್ನಾಗಿ ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ. ಈ ಮೂಲಕ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಸಾಹಿತ್ಯದ ಬಗ್ಗೆ ಸದಭಿರುಚಿಯನ್ನು ಮೂಡಿಸಲಾಗುತ್ತದೆ. ಸಾಂಸ್ಕೃತಿಕ ತಿಳುವಳಿಕೆಯ ಜೊತೆಗೆ ವ್ಯಕ್ತಿತ್ವ ವಿಕಸನದ ಕಡೆಗೆ ಗಮನ ನೀಡಲಾಗುತ್ತದೆ.

1. ಭಾಷೆ, ಸಾಹಿತ್ಯ, ಇತಿಹಾಸ ಮತ್ತು ಸಂಸ್ಕೃತಿಗಳನ್ನು ಕನ್ನಡ, ಕರ್ನಾಟಕಕ್ಕೆ ಸಂಬಂಧಿಸಿದಂತೆ ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ. ಹಾಗೂ ವೈವಿಧ್ಯಮಯ ಭಾರತದ ಸಾಂಸ್ಕೃತಿಕ ನೆಲೆಗಳನ್ನು ಪರಿಚಯಿಸಲಾಗುತ್ತದೆ
2. ವಿದ್ಯಾರ್ಥಿಗಳ ಸರ್ವತೋಮುಖ ಬೆಳವಣಿಗೆಗೆ ಅನುವಾಗುವಂತೆ ಹಾಗೂ ಅವರಲ್ಲಿ ಮಾನವ ಸಂಬಂಧಗಳ ಬಗ್ಗೆ ಗೌರವ, ಸಮಾನತೆ ಮೂಡಿಸಿ, ಬೆಳೆಸುವ ನಿಟ್ಟಿನಲ್ಲಿ ಪಠ್ಯಗಳ ಆಯ್ಕೆಯಾಗಿದೆ.
3. ಅವರಲ್ಲಿ ಸೃಜನಶೀಲತೆ, ಶುದ್ಧ ಭಾಷೆ, ಉತ್ತಮ ವಿಮರ್ಶಾ ಗುಣ, ನಿರರ್ಗಳ ಸಂಭಾಷಣೆ, ಭಾಷಣ ಕಲೆ ಬರಹ, ವೃತ್ತಿ ಪೂರ್ವಕ ಕೌಶಲ್ಯಗಳನ್ನು ಬೆಳೆಸುವುದು ಗುರಿಯಾಗಿದೆ
4. ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ಅನುಕೂಲವಾಗುವಂತಹ ವಿಷಯಗಳನ್ನು ಗಮನದಲ್ಲಿಟ್ಟುಕೊಂಡು ಸೂಕ್ತ ಪಠ್ಯಗಳನ್ನು ಆಯ್ಕೆ ಮಾಡಿಕೊಳ್ಳಲಾಗಿದೆ.

Course Outcomes:

ದಮನಿತ ಲೋಕ, ಸಹಿಷ್ಣುತೆ, ಶ್ರೀಸಾಮನ್ಯನ ಬದುಕು ಮತ್ತು ಸಂಕೀರ್ಣ ವಿಷಯಕ್ಕೆ ಸಂಬಂಧಿಸಿದ ಸಾಹಿತ್ಯ ಪಠ್ಯಗಳ ಕಲಿಕೆಯ ಮೂಲಕ ಅವುಗಳ ಒಳನೋಟಗಳನ್ನು ಬೆಳೆಸುತ್ತದೆ.

1. ಸಾಮಾಜಿಕ, ರಾಜಕೀಯ, ಧಾರ್ಮಿಕ, ಸಾಂಸ್ಕೃತಿಕ, ಪರಿಸರ ಹಾಗೂ ಲಿಂಗಸಂಬಂಧಿ ಸೂಕ್ಷ್ಮತೆಯ ವಿಚಾರಗಳೆಡೆ ಗಮನ ಹರಿಸುವುದರೊಂದಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳಲ್ಲಿ ಚರ್ಚಾ ಮನೋಭಾವವು ಬೆಳೆಸುತ್ತದೆ.
2. ಜೀವನದಲ್ಲಿ ಬರುವ ಅಭಿಪ್ರಾಯ ಬೇಧಗಳ ವಿವಿಧ ಆಯಾಮಗಳೊಂದಿಗೆ ಆಧುನಿಕ ಸಂದರ್ಭದಲ್ಲಿ ಮಾನವೀಯತೆಯೊಂದಿಗೆ ನಿರ್ವಹಿಸುವಂತೆ ಪ್ರೇರೇಪಿಸುತ್ತದೆ.
3. ಉತ್ತಮ ಸಂವಹನ ಕಲೆಯನ್ನು ಬೆಳೆಸುವ ಉದ್ದೇಶವನ್ನು ಈಡೇರಿಸುತ್ತದೆ.
4. ಸಂಶೋದನಾ ಮನೋಭಾವ ಮತ್ತು ಸ್ಪರ್ಧಾತ್ಮಕ ಪರೀಕ್ಷೆಗಳಿಗೆ ವಿದ್ಯಾರ್ಥಿಗಳನ್ನು ಸಜ್ಜುಗೊಳಿಸುತ್ತದೆ.
5. ಭಾಷೆ ಮತ್ತು ಸಾಹಿತ್ಯದ ಶ್ರೀಮಂತಿಕೆ ಜೊತೆಗೆ ಮಾನವೀಯ ಮೌಲ್ಯಗಳನ್ನು ಕಲಿಯುವಿರಿ.
6. ಸದೃಢ ಬೌದ್ಧಿಕ ಮತ್ತು ಮಾನಸಿಕ ವನುನ ವಿಕಾಸಿಸುತುದೆ.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	T	1	1	1	1	1	0	1	0	0	0	1	1	0

CO2	1	1	1	0	1	1	0	0	0	0	0	1	0	0
CO3	0	0	1	0	0	0	1	1	0	0	0	0	1	1
CO4	0	0	1	1	0	0	1	0	1	0	0	1	1	1
CO5	0	0	1	1	0	0	1	0	1	0	1	1	1	1
CO6	0	0	1	1	0	0	1	0	1	0	1	1	1	1

COURSE CONTENT/ SYLLABUS

Unit I: ದಮನಿತ ಲೋಕ **10 Hours**

1.1 ಶಿಲುಬೆ ಏರಿದ್ದಾನೆ — ಕೆ. ಎಸ್. ನಿಸಾರ್ ಅಹಮದ್
1.2 ಮಿಟ್ಟಿಸಿಕೊಂಡವನು — ಪಿ. ಲಂಕೇಶ್
1.3 ಏಕಲವ್ಯ ನಾಟಕ ದೃಶ್ಯ 3 ರಿಂದ 8 — ಡಾ. ಸಿದ್ಧಲಿಂಗಯ್ಯ

Unit II: ಸಹಿಷ್ಣುತೆ **10 Hours**

2.1 ಬಿದಿರು ನಾನಾರಿಗಲ್ಲದವಳು — ಶಿಶುನಾಳ ಶರೀಫ
2.2 ಮಾಟೆಂಗೊ ಮೇರಿ ಬಸ್ ಬಹಿಸ್ಕಾರ — ಎಂ. ಆರ್. ಕಮಲ
2.3 ಬೆಂಕಿ ಮಳೆ — ಬಾನು ಮುಷ್ತಾಕ್

Unit III: ಶ್ರೀಸಾಮಾನ್ಯನ ಬದುಕು **10 Hours**

3.1 ಮನೆಯಿಂದ ಮನೆಗೆ — ಕೆ. ಎಸ್. ನರಸಿಂಹಸ್ವಾಮಿ
3.2 ಮೊಸರಿನ ಮೊಂಗಮ್ಮ — ಮಾಸ್ತಿ
3.3 ಜಾಗತೀಕರಣದ ಜಾರುಬಂಡೆ — ಬರಗೂರು ರಾಮಚಂದ್ರಪ್ಪ

Unit IV: ಸಂಕೀರ್ಣ **9 Hours**

4.1 ಕೃಷಿ ಸಂಸ್ಕೃತಿ ಮತ್ತು ಜಾಗತೀಕರಣ — ಸಿ. ಹೆಚ್ ಹನುಮಂತರಾಯ
4.2 ಮನುಕುಲದ ಕಥೆ — ಶಶಿಕಲಾ ವೀರಯ್ಯಸ್ವಾಮಿ
4.3 ಕಲೆ ಮತ್ತು ಅಸ್ತಿತ್ವ — ಡಾ. ಹೆಚ್. ಎಸ್. ರಾಘವೇಂದ್ರರಾವ್

TextBooks:

ಸಂಯೋಜಿತ ಕನ್ನಡ ಪಠ್ಯಪುಸ್ತಕ **'ಗಣಕ-ವಿಜ್ಞಾನ ಸೌರಭ – ನಾಲ್ಕನೇ ಸೆಮಿಸ್ಟರ್ ಬಿಸಿಎ ಮತ್ತು ಬಿಎಸ್ಸಿ (ಎಎಸ್)**

ಪರಾಮರ್ಶನ ಗ್ರಂಥಗಳು:

1. ಸಾಹಿತ್ಯ ಸಲ್ಲಾಪ-1 – ಸಂ. ಡಾ. ಬಿ ಗಂಗಾವರ, ಪ್ರಸಾರಾಂಗ ಬೆಂಗಳೂರು ವಿ.ವಿ, 2011
2. ವಿಸ್ಮಯ (ಪರಿಸರ ವಿಶ್ವರೂಪ), ಪುಸ್ತಕ ಪ್ರಕಾಶನ, ಮೈಸೂರು, 2013
3. ಬಂಡಾಯ- ವ್ಯಾಸರಾಯ ಬಲ್ಲಳ, ವಸಂತ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು, 2006
4. ಜಾಗತಿಕ ವಿಚಾರ ಸಾಹಿತ್ಯ- ಸಂ. ದಂಡಪ್ಪ, ಕುವೆಂಪು ಭಾಷಾ ಭಾರತಿ ಪ್ರಾಧಿಕಾರ, 2017
5. ದಕ್ಷಿಣ ಕರ್ನಾಟಕದ ಕಾವ್ಯ ಪ್ರಕಾರಗಳು- ಜಿ.ಶಂ.ಪ, ಅಭಿನವ ಪ್ರಕಾಶನ, ಬೆಂಗಳೂರು, 2016

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHA401	Language-II: Additional English-IV	AEC	3	0	0	3	3

Course Description:

This is a 3-credit course designed to help the learners gain competence in language and literature by exposing them to a larger variety of literary genres and themes to encourage their interests in critical social and cultural issues within literary as well as non-literary domains.

Course Objectives

1. To introduce the students to the multiplicity of literature from all over the world.
2. To contribute in the emotional and social development of the students.
3. To develop in the students an ability to appreciate cultural and social diversity.
4. To develop in the students an ability of reading different genres of texts adopting various reading strategies

Course Outcomes

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

1. Demonstrate a visible understanding of the significant issues of the society.
2. Analyze the basic as well as the latent concepts of the texts provided in the syllabus and do justice to them.
3. Explain the major and minor themes of the select texts and their significance in the broader context of real life.
4. Interpret audio files and comprehend different spoken discourses/ excerpts in different accents.
5. Discuss the impact and relevance of Education in society.
6. Design work of art represents the cultural and social multiplicity.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0

Course content

Unit-I: Myths & Mythology **10 Hours**

John W. May – Narcissus

W.B. Yeats – No Second Troy

Devdutt Pattanaik - Shikhandi and the Other Stories They Don't Tell you (Extracts)

Iravati Karve – Yuganta (Extract)

Unit-II: Family & Relationships **10 Hours**

Robert Hayden – Those Winter Sundays

Elizabeth Jennings – Father to son

Kushwant Singh – The Portrait Of a Lady

Kate Chopin – The Story of an Hour

Unit-III: Horror & Suspense **10 Hours**

Robert Browning – My Last Duchess

Edgar Allen Poe – The Haunted Palace

Bram Stoker – A Dream of Red Hands

Stephen King - Gramma

Unit-IV: Education **10 Hours**

Abraham Lincoln – A letter from Abraham Lincoln to his Teacher.

Oliver GoldSmith – A Village School Master

Francis Bacon – Of Studies

Frigyes Karinthy – Refund

References:

1. Finneran, Richard J. The Collected Works of W.B. Yeats **(Volume I: The Poems: Revised Second Edition**). Simon & Schuster, 1996.
2. Pattanaik, Devdutt. **Shikhandi: Ánd Other 'Queer' Tales They Don't Tell You**. Penguin Books, 2014.
3. Karve, Irawati. **Yuganta: The End of an Epoch.** Orient Blackswan, 2007.
4. Ezekiel, Nissim. **Collected Poems (With A New Introduction By John Thieme).** OUP, 2005.
5. Hughes, Langston. **The Collected Poems of Langston Hughes**. Vintage, 1995.
6. Chopin, Kate. **The Awakening and Selected Stories of Kate Chopin.** Simon & Schuster, 2004.
7. Ibsen, Henrik. **A Doll's House**. Maple Press, 2011.
8. Poe, Edgar Allan. **The Complete Poetry of Edgar Allan Poe**. Penguin USA, 2008.
9. Stoker, Bram. **Dracula**. Fingerprint Publishing, 2013.
10. Ray, Satyajit. **The Complete Adventures of Feluda (**Vol. 2). Penguin Books Ltd., 2015.
11. Lama, Dalai. **Freedom In Exile: The Autobiography of the Dalai Lama of Tibet.** Little, Brown Book Group, 1998.
12. Murthy, Sudha. **Wise and Otherwise: A Salute to Life.** Penguin India, 2006.
13. Wsahington, Booker T. **Up from Slavery**. Infinity, 2015.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AHH403	Language-II: Hindi-IV	AEC	3	0	0	3	3

Course Overview: अध्ययन संक्षिप्त विवरण :

यह पाठ्यक्रम नौसिखिया, अपनी भाषा की क्षमता का विकास करने हेतु तथा विभिन्न साहित्यिक प्रक्रियाओं द्वारा समाज, संस्कृति एवं जीवन के मूल्यों को समझने हेतु अभिकल्पित है |

Prerequisites/Pre reading for the course: पूर्वापेक्षा:

- अध्येता को, हिन्दी खंडकाव्य का संक्षिप्त ज्ञान आवश्यक है |
- हिन्दी साहित्य के इतिहास का संक्षिप्त ज्ञान की आवश्यकता है |
- हिन्दी व्याकरण का अवबोधन आवश्यक है |

Course Objectives: पाठ्यक्रम उद्देश्य :

- संदर्भानुसार उचित भाषा का प्रयोग करने की दक्षता को छात्रों में उत्पन्न करना |
- साहित्य के माध्यम से समाज एवं मानवीय मूल्यों को समझाकर, उन मूल्यों की रक्षा हेतु प्रेरित करना |

- छात्रों में पुस्तक पठन एवं लेखन की अकृतिम प्रवृत्ति स्थापित करना |
- अध्येताओं में साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास करना |

Course Outcomes अधिगम परिणाम :

अध्ययन की समाप्ति पर अध्येता –

1. हिंदी साहित्य की विविध विधाओं का परिचय प्राप्त कर सकता है |
2. सामाजिक मूल्य एवं नैतिक जवाबदेही को स्वीकार कर सकता है |
3. साहित्य की प्रासंगिकता को जीवन में समझने की दक्षता रखता है |
4. समाज में अंतर्निहित पद्धतियाँ एवं विचारधाराओं का व्याख्यान करने में सक्षम बन सकता है |
5. साहित्य के माध्यम से प्रभावी एवं कुशल संचार का विकास कर सकता है |
6. अनुवाद एवं व्यावहारिक ज्ञान से अवगत हो सकता है |

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	0	0	1	0	1	1	1	1	1	2	0	2	2	0
CO2	0	0	1	0	1	1	1	3	3	3	0	2	2	0
CO3	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO4	0	0	0	1	0	1	1	3	3	3	0	2	2	0
CO5	0	0	0	1	0	1	1	3	3	3	1	2	2	0
CO6	0	0	0	1	0	1	1	3	3	3	1	2	2	0

Course content

इकाई – 1: उपन्यास – सपनों की होम डिलिवरी – ममता कालिया **10 Hours**

- लेखक परिचय
- प्रथम खंड
- द्वितीय खंड

इकाई – 2: **10 Hours**

- तृतीय खंड
- चतुर्थ खंड

इकाई – 3: **10 Hours**

- पंचम खंड
- छठा खंड

इकाई – 4: योजनामूलक हिंदी **09 Hours**

- विज्ञापन लेखन
- दूरदर्शन और मोबाइल
- विभिन्न मोबाइल ऐप और रोजगार के अवसर

Textbook:

- **उपन्यास – सपनों की होम डिलिवरी** – ममता कालिया

References:

1. हिंदी साहित्य का इतिहास – डॉ. नागे
2. आधुनिक हिंदी साहित्य का इतिहास – डॉ. बृजनाथ सिंह
3. हिंदी साहित्य का नवीन इतिहास – डॉ. लाल साहब सिंह
4. हिंदी साहित्य का इतिहास – डॉ. सूर्यनारायण राणासुभे
5. हिंदी उपन्यास और यथार्थवाद – डॉ. विभुवन सिंह
6. योजनामूलक हिंदी – डॉ. अन्नादास देशमुख
7. योजनामूलक हिंदी – डॉ. माया सगरे-लता
8. योजनामूलक हिंदी के आधुनिक आयाम – महेन्द्र सिंह राणा

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0401	Genomics and Transcriptomics	DSC	3	0	0	3	4

Prerequisite:

- Fundamentals of Molecular Biology and Genetics,
- Familiarity with DNA, RNA structure, and Central Dogma
- Basic bioinformatics tools and databases

Course objectives

1. Understand the concepts and methodologies of genome and transcriptome analysis.
2. Explore high-throughput sequencing technologies and their application in genomics.
3. Gain insights into gene structure, annotation, and comparative genomics.
4. Learn transcriptome profiling techniques and differential gene expression analysis.

Course outcomes

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

1. Explain the fundamental concepts of genomics and transcriptomics.
2. Illustrate various sequencing technologies and their applications.
3. Analyze genome organization, annotation, and functional genomics.
4. Apply transcriptome analysis tools to study gene expression.
5. Interpret data from microarrays and RNA-Seq experiments.
6. Evaluate applications of genomics and transcriptomics in disease research, agriculture, and evolutionary biology.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	2	1	1	3	3	2	2
CO2	3	3	3	3	2	1	1	2	1	2	3	3	3	2
CO3	3	3	3	3	3	2	2	2	2	2	3	3	3	3
CO4	3	3	3	3	3	2	2	2	2	3	3	3	3	3
CO5	3	3	3	3	3	2	2	2	2	3	3	3	3	3
CO6	3	3	3	3	3	3	2	3	2	3	3	3	3	3

Course content

Unit I: Introduction to Genomics **12 Hours**

Definition and Scope of Genomics: Structural, Functional, and Comparative Genomics; Historical development and significance in life sciences; Genome Architecture: Prokaryotic vs. Eukaryotic genome organization; Gene density, coding and non-coding regions, repetitive DNA (microsatellites, minisatellites, transposons); Model organisms in genomics: E. coli, Saccharomyces cerevisiae, Drosophila melanogaster, Arabidopsis thaliana, Mus musculus, Homo sapiens; Reference genomes and their significance; Introduction to genome browsers: NCBI, Ensembl, UCSC; Human Genome Project (HGP): Objectives, strategies, milestones, key outcomes; Applications in medicine, agriculture, and biotechnology; Ethical, Legal, and Social Implications (ELSI).

Unit-II: Transcriptomics and Genome Sequencing Technologies **12 Hours**

Introduction to Transcriptomics: Definition and comparison with genomics; Types of RNAs: mRNA, rRNA, tRNA, ncRNA, miRNA, lncRNA; DNA Sequencing Technologies: First-generation sequencing (Sanger), Second-generation (NGS): principles and platforms, Third-generation sequencing (single molecule real-time); Transcriptome profiling techniques: **Microarrays:** principle, design, limitations; **RNA-Seq:** overview, library preparation, sequencing platforms (Illumina, Nanopore, PacBio), Gene expression quantification and normalization; Genome Analysis Techniques: Sequence assembly (de novo and reference-guided), Variant calling and annotation, Expression data repositories: GEO, ArrayExpress, Applications: Disease diagnosis, transcriptome-based biomarker discovery.

Unit III: Functional Annotation and Genome Analysis Tools **12 Hours**

Gene prediction approaches: ab initio and homology-based methods, Functional annotation tools: BLAST, InterProScan, Pfam, SMART; Gene Ontology (GO) classification and enrichment analysis; Pathway databases: KEGG, Reactome, BioCyc; Comparative genomics and synteny analysis; Ortholog and paralog identification; Introduction to genome annotation pipelines (e.g., Prokka, MAKER); Genome browsers and visualization tools; Tools and resources: GenBank, RefSeq, UniProt, Ensembl; Practical applications in annotating new genomes.

Unit IV: Applications and Emerging Trends in Genomics & Transcriptomics **12 Hours**

Clinical Genomics and Personalized Medicine; Genome-Wide Association Studies (GWAS); CRISPR-Cas9 and genome editing technologies; Single-cell transcriptomics: platforms, analysis, and applications; Epigenomics: DNA methylation, histone modification (introductory); Metagenomics and microbiome profiling; Synthetic biology and systems biology; Transcriptomics in disease mechanisms and therapeutic targets; Case studies: Cancer genomics, plant genomics, rare diseases; Ethical considerations in clinical genomics, data privacy, and sharing.

Reference Books

1. Brown, T. A. (2016). ***Genomes 4*****.** Garland Science.

2. Campbell, A. M., & Heyer, L. J. (2021). ***Discovering Genomics, Proteomics, and Bioinformatics*** (2nd Ed.). Pearson Education.
3. Lesk, A. M. (2022). ***Introduction to Genomics*** (3rd Ed.). Oxford University Press.
4. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2020). ***Bioinformatics: Methods and Applications*** (5th Ed.). PHI Learning.
5. Snyder, M. P., & Gerstein, M. (2019). ***Genomics and Personalized Medicine: What Everyone Needs to Know*.** Oxford University Press.
6. Lowe, R., & Rakyan, V. K. (2017). ***Transcriptomics: Methods and Applications***. Springer.
7. Ghosh, Z., & Mallick, B. (2021). ***Transcriptome Data Analysis: A Practical Guide*.** Springer Nature.
8. Griffiths, A. J. F., et al. (2020). ***Introduction to Genetic Analysis*** (12th Ed.). W.H. Freeman & Co.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0401	Statistical Inference	DSC	3	0	0	3	4

Prerequisites

Basic statistics and R programming, Mathematical Foundations for Bioinformatics, **random** variable and probability distributions

Course objectives:

1. To introduce the fundamental concepts of statistical inference, sampling distributions, and related distributions (Chi-square, t, F).
2. To equip students with theoretical knowledge of point estimation and interval estimation techniques including criteria for good estimators.
3. To develop understanding of maximum likelihood and method of moments for parameter estimation and their properties.
4. To provide knowledge on hypothesis testing for both large and small samples with applications in real-world biological data analysis.

Course outcomes

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

1. Describe the key concepts of statistical inference and explain the properties and applications of Chi-square, t, and F distributions.
2. Analyze sampling distributions and compute standard errors for various statistics under normality assumptions.
3. Evaluate estimators based on statistical properties such as unbiasedness, consistency, efficiency, and sufficiency.
4. Apply Maximum Likelihood and Method of Moments to estimate population parameters.
5. Construct and interpret confidence intervals for means, proportions and variances.
6. Formulate and test statistical hypotheses using appropriate large and small sample tests, and interpret the results.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3

CO1	3	3	2	2	0	1	1	2	0	2	2	2	3	2
CO2	3	3	2	2	0	1	1	2	0	2	2	2	3	2
CO3	3	3	3	2	0	1	1	2	0	3	2	2	3	2
CO4	3	3	3	2	0	1	1	2	0	3	2	2	3	2
CO5	3	3	2	2	0	1	1	2	0	2	2	2	3	2
CO6	3	3	3	2	0	1	1	2	0	3	2	2	3	2

Course content

Unit 1: Basics of statistical inference and sampling distributions 12 Hours

Concept and definition of: Population, Sample, Random Sample, Parameter, and Statistic; Statistical Inference: Definition and branches (Estimation and Hypothesis Testing); Sampling Distribution: Definition, Standard error of a statistic; Sampling distribution of sample mean and sample variance; Independence of sample mean and sample variance under normality (Statement only); Special Distributions: Chi-square, t, and F distributions – Definitions, Properties, and Applications

Unit 2: Estimation-I 12 Hours

Concepts of Estimator and Estimate; Estimation: Definition and branches, Properties of Estimators: Unbiasedness, Consistency (and its criteria), Efficiency, Relative Efficiency, Minimum Variance Unbiased Estimator (MVUE), Invariance property of consistent estimators, Mean Square Error (MSE) as a comparison criterion, Sufficient Statistic, Neyman–Factorization Theorem (Statement only), Fisher Information Function, Cramer–Rao Inequality (Statement and Applications)

Unit 3: Estimation-II 12 Hours

Maximum Likelihood Estimation (MLE): Definition, Properties, Problems, Non-uniqueness, Invariance property; Method of Moments – Definition and examples; Interval Estimation: Confidence interval, Confidence coefficient, Shortest confidence interval, Method of constructing confidence intervals using pivotal quantities, Construction of confidence intervals for: Mean, Difference of two means, Variance, Proportion, Difference of two proportions.

Unit 4: Testing of hypothesis 12 Hours

Basic Concepts: Null and Alternative Hypotheses, Simple and Composite Hypotheses, Type-I and Type-II errors, Test functions (Randomized and Non-randomized), Size of a test, Level of significance, Power function and Power of a test, Best critical region, One-tailed and Two-tailed tests, p-value and its interpretation; Steps in Hypothesis Testing; Large Sample Tests: Test for single mean, equality of two means; Test for single proportion, equality of two proportions; Small Sample Tests: Test for single mean, equality of two means, Paired t-test, Tests for variance and equality of variances

Reference Books:

1. Sundar Rao P.S.S, Richard J. (2012**). Introduction to Biostatistics and research methods**, 5th edition, PHI Learning Pvt. Ltd. India.
2. Arora P.N., Malhan P.K.(2020). **Biostatistics,** Himalaya Publishing House, India.

3. Gupta S.C. and Kapoor V.K.(2020) **Fundamentals of Mathematical Statistics**, 11th Edn., (Reprint), Sultan Chand and Sons.
4. Mood, A.M. Graybill, F. Boes, D. (2017). **Introduction to Theory of Statistics**, 3rdEdn.,Mc-Graw Hill Series.
5. Goon A.M., Gupta, M.K., Das Gupta, B. (2013).**An outline of statistical theory-Vol-I and II**, World Press, Calcutta.
6. Veer Bala Rastogi,(2015). **Biostatistics**, 3rd edition. Medtech ,New Delhi.
7. Dalgaard P(2008).**Introductory Statistics with R**, Springer
8. Shahbaba B.(2011) **Biostatistics with R: An Introduction to Statistics Through Biological Data,** Springer-Verlag New York Inc.
9. Wayne W. Daniel , Chad L. Cross.(2014) **Biostatistics: Basic Concepts And Methodology For The Health Sciences**, Tenth edition, Wiley
10. Casella, G. and Berger, R.L. (2007). **Statistical Inference**, Duxbury Press, Belmont, California, USA. (2nd Edition).
11. Zar J.H.(2014). **Biostatistical Analysis,**5th edition, Pearson Education India.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0401	Linux, and Operating Systems	DSC	3	0	0	3	4

Prerequisites: Basic computer literacy and understanding of programming logic

Course Objectives

1. To introduce the fundamental concepts of operating systems and their role in system performance and resource management.
2. To provide in-depth knowledge of Linux operating systems, including command-line usage and shell scripting.
3. To understand the architecture, kernel, file system, and process management of Linux.
4. To enable students to work in a multi-user environment and perform administrative tasks on Linux systems.

Course Outcomes (CO):

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

1. Describe the basic functions and types of operating systems.
2. Compare architecture and features of Linux systems.
3. Use essential Linux commands for file handling, process management, and system administration.
4. Write basic shell scripts for automating tasks in Linux.
5. Understand process synchronization, memory management, and scheduling.
6. Manage users, permissions, file systems, and services in a Linux environment.

Mapping of course outcomes with program outcomes

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

CO3	3	2	3	2	3	2	1	2	2	2	2	3	3	2
CO4	3	3	3	2	3	2	1	2	3	3	3	3	3	3
CO5	3	3	3	3	2	2	1	2	3	3	3	3	3	3
CO6	3	2	3	3	2	3	2	3	2	3	3	3	3	3

Course content

Unit 1: Introduction to Operating Systems **12 Hours**

Introduction to Operating Systems: Definition, Objectives; Types of Operating Systems: Batch, Time-Sharing, Distributed, Real-Time; Functions of Operating Systems: Process, Memory, File, Device, and Security Management; System Architecture: Kernel, Shell, User Space; OS Architectures: Monolithic vs. Microkernel; System Calls and Boot Process; Device Drivers: Concept and Role; Process Management: Process States, PCB; CPU Scheduling Algorithms: FCFS, SJF, Round Robin, Priority Scheduling; Memory Management: Paging, Segmentation, Virtual Memory; Introduction to File Systems: Types and Access Methods; Overview of Linux Operating Systems.

Unit 2: Linux/UNIX Basics and File System Management **12 Hours**

Linux File System Architecture: Directory Hierarchy and Standard Paths *(/bin, /etc, /home, /var, etc.*); File Types: Regular Files, Directories, Symbolic & Hard Links, Device Files; File and Directory Operations: *touch, mkdir, rmdir, cd, ls, pwd;* File Permission Management: *chmod, chown, umask*; Filters and Wildcards: *grep, sort, cut, uniq, tee, awk*; Input/Output Redirection and Pipelines: >, <, >>, Mounting and Unmounting File Systems: *mount, umount*; Disk Partitioning and Space Monitoring: *df, du, fdisk*; User and Group Management: *useradd, usermod, groupadd, passwd;* File Handling in Programming: *open, read, write, close, lseek, stat, chmod, unlink;* Directory Handling APIs: *opendir, readdir, closedir, mkdir, rmdir*; File Locking & Security: Locking Mechanisms, Access Control; File Comparison Utilities: *cmp, diff, comm, join.*

Unit 3: Shell Scripting and Automation **12 Hours**

Introduction to Shells: *Bourne Shell (sh), Bash, C Shell*; Writing Shell Scripts: Syntax, Variables, Operators; Control Structures: *if, case, for, while, until, break, continue*; Functions in Shell Scripts; Script Execution and Debugging; Input/Output in Scripts: Reading from Keyboard, Command Line Arguments; File Handling in Scripts: Reading, Writing, Appending; Job Scheduling: *cron, crontab, at, batch*; Automating System Tasks and Maintenance; Use of sed, awk, and Regular Expressions in Scripts; Shell Script Examples: Backup Scripts, User Account Management, Log File Analysis

Unit 4: Advanced Operating System Concepts **12 Hours**

Interprocess Communication (IPC): Pipes, Shared Memory, Semaphores, Message Queues; Concurrency and Synchronization: Critical Section Problem, Race Conditions, Mutex, Monitors; Deadlocks: Detection, Prevention, Avoidance, and Recovery; Disk Scheduling Algorithms: FCFS, SSTF, SCAN, C-SCAN; File System Implementation: Allocation Methods (Contiguous, Linked, Indexed), Directory Implementation; Introduction to Virtualization and Containers; Basics of System Performance Monitoring: *top, htop, iotop, vmstat*; Security in Operating Systems: User Authentication,

File System Security, SELinux; Introduction to Open Source OS Development and Community Contributions; Trends in Modern OS: Mobile OS, Cloud-based OS, Real-Time OS.

Reference Books

1. Silberschatz A., Galvin P.B., Gagne G. (2018). **Operating System Concepts**, 10th Edition, Wiley India.
2. Stallings W. (2018). **Operating Systems: Internals and Design Principles,** 9th Edition, Pearson Education.
3. Tanenbaum A.S., Bos H. (2015). **Modern Operating Systems**, 4th Edition, Pearson Education.
4. Sobell M.G. (2017). **A Practical Guide to Linux Commands, Editors, and Shell Programming**, 4th Edition, Pearson Education.
5. Matthew N., Stones R. (2007). Beginning Linux Programming, 4th Edition, Wrox Press.
6. Kanetkar Y.P. (2009). Let Us Linux, 1st Edition, BPB Publications.
7. Das S. (2007). Unix: Concepts and Applications, 4th Edition, McGraw-Hill Education.
8. Menezes A. (2012). Linux Kernel Development, 3rd Edition, Addison-Wesley.
9. Love R. (2010). Linux Kernel Development, 3rd Edition, Addison-Wesley Professional.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0402	Lab: Genomics and Transcriptomics	DSC	0	0	2	2	3

Prerequisite:

- Fundamentals of Molecular Biology and Genetics,
- Familiarity with DNA, RNA structure, and Central Dogma
- Basic bioinformatics tools and databases

Course objectives

1. Understand the concepts and methodologies of genome and transcriptome analysis.
2. Explore high-throughput sequencing technologies and their application in genomics.
3. Gain insights into gene structure, annotation, and comparative genomics.
4. Learn transcriptome profiling techniques and differential gene expression analysis.

Course outcomes

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

1. Explain the fundamental concepts of genomics and Transcriptomics.
2. Illustrate various sequencing technologies and their applications.
3. Analyze genome organization, annotation, and functional genomics.
4. Apply transcriptome analysis tools to study gene expression.
5. Interpret data from microarrays and RNA-Seq experiments.
6. Evaluate applications of genomics and Transcriptomics in disease research, agriculture, and evolutionary biology.

Mapping of Course Outcomes with Programme Outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	3	2	1	1	2	2	3	3	3	2

CO2	3	3	3	3	3	2	1	1	2	2	3	3	3	3
CO3	3	3	3	3	3	2	2	1	2	2	3	3	3	3
CO4	3	3	3	3	3	2	2	1	2	2	3	3	3	3
CO5	3	3	2	2	3	2	2	1	2	2	3	2	3	3
CO6	3	3	3	3	3	2	2	2	3	3	3	3	3	3

Course content

S.No	**List of experiments**	Remarks
1	Genome Browser Exploration (NCBI, Ensembl, UCSC)	Understand genome organization, gene structure, and gene annotation in model organisms and humans.
2	RNA-Seq Data Retrieval and Quality Control	Download RNA-Seq datasets (GEO/SRA) and assess sequence quality using **FastQC**.
3	Reference-Based Transcriptome Assembly using HISAT2 +SAMTools	Perform alignment and assembly of RNA-Seq reads to quantify gene expression.
4	De novo Transcriptome Assembly using Trinity/ Velvet	Assemble transcripts without a reference genome and explore gene prediction.
5	Expression Profiling and Visualization	Normalize and visualize gene expression data using R (e.g., DESeq2, ggplot2, heatmaps, volcano plots).
6	Microarray Data Analysis using R (limma)	Analyze expression data, perform differential expression analysis, and visualize gene profiles.
7	Gene Ontology (GO) and Pathway Enrichment Analysis using DAVID or g:Profiler	Classify genes into biological functions and visualize associated pathways.
8	Gene Prediction using Augustus or Glimmer	Predict gene structure (exons/introns) in DNA sequences using ab initio methods.
9	GWAS Data Exploration and Visualization	Interpret genome-wide association data for trait/disease loci using UCSC GWAS tracks.
10	Pathway Mapping Using KEGG and Reactome	Map annotated genes to metabolic and signaling pathways using KEGG Mapper or Reactome Pathway Browser.

Reference Books

1. Brown, T. A. (2016). ***Genomes 4*.** Garland Science.
2. Campbell, A. M., & Heyer, L. J. (2021). ***Discovering Genomics, Proteomics, and Bioinformatics*** (2nd Ed.). Pearson Education.
3. Lesk, A. M. (2022). ***Introduction to Genomics*** (3rd Ed.). Oxford University Press.
4. Rastogi, S. C., Mendiratta, N., & Rastogi, P. (2020). ***Bioinformatics: Methods and Applications*** (5th Ed.). PHI Learning.
5. Snyder, M. P., & Gerstein, M. (2019). ***Genomics and Personalized Medicine: What Everyone Needs to Know*.** Oxford University Press.

6. Lowe, R., & Rakyan, V. K. (2017). ***Transcriptomics: Methods and Applications***. Springer.
7. Ghosh, Z., & Mallick, B. (2021). ***Transcriptome Data Analysis: A Practical Guide*****.** Springer Nature.
8. Griffiths, A. J. F., et al. (2020). ***Introduction to Genetic Analysis*** (12th Ed.). W.H. Freeman & Co.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0402	Lab: Statistical Inference	DSC	0	0	2	2	3

Prerequisites: Basic statistics and R programming, Mathematical Foundations for Bioinformatics**,** random variable and probability distributions

Course objectives

1. To provide hands-on experience in generating samples and computing estimators.
2. To develop analytical skills in constructing and interpreting confidence intervals and hypothesis tests.
3. To illustrate the application of estimation and testing techniques using real or simulated biological data.
4. To enable students to use R programming for statistical computation.

Course outcomes

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

1. Generate random samples and compute parameter estimates along with standard errors.
2. Compare statistical estimators using criteria like Mean Square Error through graphical methods.
3. Implement Maximum Likelihood and Method of Moments estimation techniques using R.
4. Construct confidence intervals for various population parameters using both large and small samples.
5. Apply appropriate hypothesis tests for means, proportions and variances based on sample size and distribution.
6. Use R programming to generate random samples, perform estimation and hypothesis testing, and visualize statistical results through appropriate plots.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	0	0	1	1	0	2	2	3	3	2
CO2	3	3	2	2	0	0	1	1	0	2	2	3	3	2
CO3	3	3	2	3	0	0	1	1	0	3	3	3	3	2
CO4	3	3	2	3	0	0	1	1	0	3	3	3	3	2
CO5	3	3	2	3	0	0	1	1	0	3	3	3	3	2
CO6	3	3	2	3	0	0	1	2	0	3	3	3	3	2

Course content

1. Generate random samples using random number tables and estimate parameters with standard errors.
2. Compare estimators using Mean Square Error (MSE) plots.
3. Estimate parameters using the Maximum Likelihood Estimation (MLE) Method.
4. Estimate parameters using the Method of Moments (MM) Method.
5. Construct confidence intervals for mean, difference of means, proportion and difference of proportions using large samples.

6. Construct confidence intervals for mean, difference of means and variance using small samples.
7. Conduct large sample tests for single mean and difference of means.
8. Conduct small sample tests (t-tests) for single mean, difference of means, and paired samples.
9. Perform proportion tests for single and two population proportions.
10. Perform variance tests for single variance and equality of two variances under normality.

Reference Books:

1. Sundar Rao P.S.S, Richard J. (2012). ***Introduction to Biostatistics and research methods****,* 5th edition, PHI Learning Pvt. Ltd. India.
2. Arora P.N., Malhan P.K.(2020**).** ***Biostatistics*****,** Himalaya Publishing House, India.
3. Gupta S.C. and Kapoor V.K.(2020) ***Fundamentals of Mathematical Statistics****, 11th Edn*., (Reprint), Sultan Chand and Sons.
4. Mood, A.M. Graybill, F.Boes, D. (2017). **Introduction to Theory of Statistics**, 3rdEdn.,Mc-Graw Hill Series.
5. Goon A.M., Gupta, M.K., Das Gupta, B. (2013). **An outline of statistical theory-**Vol-I and *II,* World Press, Calcutta.
6. Veer Bala Rastogi,(2015). ***Biostatistics,*** 3rd edition. Medtech ,New Delhi.
7. Dalgaard P(2008).***Introductory Statistics with R****,*Springer
8. Shahbaba B.(2011) **Biostatistics with R: An Introduction to Statistics Through Biological Data**, Springer-Verlag New York Inc.
9. Wayne W. Daniel , Chad L. Cross.(2014) ***Biostatistics: Basic Concepts And Methodology For The Health Sciences,*** Tenth edition, Wiley
10. Casella, G. and Berger, R.L. (2007). ***Statistical Inference,*** Duxbury Press, Belmont, California, USA. (2nd Edition).
11. Zar J.H.(2014). ***Biostatistical Analysis****,*5th edition, Pearson Education India.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0402	Lab: Linux, and Operating Systems	DSC	0	0	2	2	3

Prerequisites: Basic computer literacy and understanding of programming logic

Course Objectives

1. To introduce the fundamental concepts of operating systems and their role in system performance and resource management.
2. To provide in-depth knowledge of UNIX and Linux operating systems, including command-line usage and shell scripting.
3. To understand the architecture, kernel, file system, and process management of UNIX/Linux.
4. To enable students to work in a multi-user environment and perform administrative tasks on Linux systems.

Course Outcomes (CO):

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

1. Describe the basic functions and types of operating systems.
2. Compare architecture and features of UNIX and Linux systems.
3. Use essential Linux/UNIX commands for file handling, process management, and system administration.
4. Write basic shell scripts for automating tasks in Linux.
5. Understand process synchronization, memory management, and scheduling.
6. Manage users, permissions, file systems, and services in a Linux environment.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	1	2	2	3	2	1
CO2	3	2	2	2	2	1	1	1	1	2	2	3	3	2
CO3	3	2	3	2	3	2	1	2	2	2	2	3	3	2
CO4	3	3	3	2	3	2	1	2	3	3	3	3	3	3
CO5	3	3	3	3	2	2	1	2	3	3	3	3	3	3
CO6	3	2	3	3	2	3	2	3	2	3	3	3	3	3

Course content

1. CPU Scheduling Algorithm Implementation

Write programs to simulate FCFS, SJF, Round Robin, and Priority Scheduling.

Compare turnaround time, waiting time.

2. Linux File and Directory Operations

Use commands like *ls, cd, mkdir, chmod, chown, touch, find, locate*.

Practice wildcard usage and permission settings.

3. Disk Space and File System Monitoring

Use df, du, mount, umount, fdisk, blkid, and tune2fs.

Check usage and manage partitions.

4. User and Group Management

Create and modify users/groups with useradd, usermod, groupadd, passwd.

Assign file permissions and demonstrate access control.

5. Basic Shell Script Creation

Create scripts using variables, arithmetic, conditional statements (if, case).

6. Looping and File Handling in Shell Scripts

Use for, while, until loops and file read/write (read, echo, redirection)

7. Job Scheduling and Automation

Use cron, at, crontab, sleep to schedule tasks (Example: Daily backup, log cleanup automation)

8. System Monitoring using top, htop, vmstat, iotop and Log File Analysis

Monitor system performance and extract usage patterns from system logs.

9. Write a shell script to perform the following string operations.

a. To extract a sub string from a given string

b. To find the length of a given string

10. Write a Shell script program for Payroll system which calls following sub program.

a. Subprogram to create employee details and save them in a file.

b. Subprogram to display payroll details from file.

Reference Books

1. Silberschatz A., Galvin P.B., Gagne G. (2018). **Operating System Concepts**, 10th Edition, Wiley India.
2. Stallings W. (2018). **Operating Systems: Internals and Design Principles,** 9th Edition, Pearson Education.
3. Tanenbaum A.S., Bos H. (2015). **Modern Operating Systems**, 4th Edition, Pearson Education.
4. Sobell M.G. (2017). **A Practical Guide to Linux Commands, Editors, and Shell Programming**, 4th Edition, Pearson Education.
5. Matthew N., Stones R. (2007). **Beginning Linux Programming**, 4th Edition, Wrox Press.
6. Kanetkar Y.P. (2009). **Let Us Linux**, 1st Edition, BPB Publications.
7. Das S. (2007). **Unix: Concepts and Applications,** 4th Edition, McGraw-Hill Education.
8. Menezes A. (2012). **Linux Kernel Development**, 3rd Edition, Addison-Wesley.
9. Love R. (2010). **Linux Kernel Development**, 3rd Edition, Addison-Wesley Professional.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0403	Introduction to Disease Biology	IDC	2	0	0	2	2

Prerequisite: Basic knowledge of Cell Biology and Genetics

Course Objectives

1. To provide a molecular understanding of various human diseases.
2. To explore the genetic, molecular, and biochemical basis of disease mechanisms.
3. To introduce students to the biological pathways and omics data relevant to disease biology.
4. To integrate bioinformatics tools and databases in understanding disease-associated data.

Course outcomes

After completing the course, students will be able to:

1. Understand the molecular basis and classification of diseases
2. Explain mechanisms of infection and host-pathogen interactions
3. Analyze the genetic and metabolic basis of disease using genomic data
4. Apply systems biology approaches to study diseases
5. Utilize databases and tools to explore gene-disease associations
6. Interpret omics-based data for disease biomarker discovery

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	0	0	0	1	1	0	0	0	3	0	0
CO2	3	3	2	2	0	0	2	0	0	0	0	3	2	0
CO3	3	3	2	2	0	0	3	0	0	0	0	2	2	0
CO4	3	3	3	3	3	0	0	0	0	0	2	3	3	2
CO5	2	2	3	3	2	0	1	0	0	0	3	3	2	2
CO6	2	3	3	3	3	2	0	0	2	2	3	3	3	3

Course content

UNIT I: Introduction to Disease Biology **6 Hours**

Definition and classification of diseases: Infectious, non-infectious, genetic, and metabolic diseases; Concepts of pathophysiology, homeostasis, and disease progression; Overview of disease mechanisms: cell injury, inflammation, necrosis, apoptosis; Phenotype & Disease Ontologies: HPO, Disease Ontology (DOID); Case Study: A rare genetic disorder.

UNIT II: Infectious Diseases and Host-Pathogen Interactions 6 Hours

Overview of bacterial, viral, fungal, and parasitic infections; Molecular mechanisms of pathogenesis and immune evasion; Host-pathogen interactions and immune responses; Bioinformatics tools in infectious disease surveillance: Nextstrain, GISAID; Case study: COVID-19 and genomic surveillance

UNIT III: Genetic and Metabolic Disorders 6 Hours

Inherited disorders: single-gene (e.g., cystic fibrosis), multifactorial (e.g., diabetes); Chromosomal abnormalities (e.g., Down syndrome, Turner syndrome); Metabolic diseases: Inborn errors of metabolism (e.g., PKU); Genetic basis of diseases – GWAS, polygenic risk scores; Variant annotation and interpretation: ClinVar, ANNOVAR, SnpEff; Case study: Familial hypercholesterolemia.

UNIT IV: Systems Biology of Diseases and Translational Bioinformatics 6 Hours

Disease-associated molecular pathways: KEGG, Reactome; Construction and analysis of disease networks using Cytoscape; Gene-disease association databases: OMIM, DisGeNET, MalaCards; Biomarker discovery and disease classification using transcriptomics and proteomics; Role of AI/ML in disease diagnostics – brief overview. Case study: Cancer systems biology.

Recommended Books and References:

1. Strachan, T., & Read, A. (2018). Human Molecular Genetics, 5th ed., Garland Science.
2. Cooper, G.M. (2019). The Cell: A Molecular Approach, 8th ed., Oxford University Press.
3. Bell, J. (2022). Precision Medicine and the Reinvention of Human Disease, MIT Press.
4. Kumar, V., Abbas, A.K., & Aster, J.C. (2021). Robbins and Cotran Pathologic Basis of Disease, 10th ed., Elsevier.
5. Rang, H.P. et al. (2020). Pharmacology, 8th ed., Elsevier.
6. Bioinformatics Tools & Databases: OMIM, KEGG, DisGeNET, Nextstrain, MalaCards, ClinVar.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0412	Environmental Studies	AEC	2	0	0	2	2

Prerequisite: Basic knowledge about environmental studies

Course Objectives

1. Understand the importance of interdisciplinary aspects of environmental studies
2. Know various ecosystems and their energy flow
3. Realise the importance biodiversity
4. Understand the complexity of environment and its protections

Course Outcomes

1. Analyse the multidisciplinary nature of environmental studies
2. Present the significance of sustainable development
3. Assess the energy flow in different ecosystems
4. Understand the causes and impacts of deforestation
5. Recognise the levels of biological diversity
6. Analyse the biodiversity and threats to biodiversity in India

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	1	0	0	0	0	0	0	0	0	1	1	0
CO2	2	1	1	1	1	0	0	0	0	0	0	1	1	0
CO3	2	1	1	1	1	0	0	0	0	0	0	1	1	0
CO4	2	1	1	1	1	0	0	0	0	1	1	1	1	0
CO5	2	1	1	1	1	0	0	0	0	1	1	1	1	0
CO6	2	1	1	1	1	0	0	0	0	1	1	1	1	0

Course content

Unit-1: Introduction to Environmental Studies **12 Hours**

Multidisciplinary nature of environmental studies. Scope and importance; Concept of sustainability and sustainable development. What is an ecosystem? Structure and function of ecosystem; Energy flow in an ecosystem: food chains, food webs and ecological succession. Case studies of the following ecosystems:

a) Forest ecosystem

b) Grassland ecosystem

c) Desert ecosystem

d) Aquatic ecosystems (ponds, streams, lakes, rivers, oceans, estuaries)

Natural Resources: Renewable and Non-Renewable Resources

- Land resources and land-use change; Land degradation, soil erosion and desertification.
- Deforestation: Causes and impacts due to mining, dam building on environment, forests, biodiversity and tribal populations.
- Water: Use and over-exploitation of surface and ground water, floods, droughts, conflicts over water (International & Inter-state).
- Energy resources: Renewable and non-renewable energy sources, use of alternate energy sources, growing energy needs, case studies.

Unit-2: Biodiversity and Conservation **12 Hours**

Levels of biological diversity: Genetic, species and ecosystem diversity; Biogeographic zones of India; Biodiversity patterns and global biodiversity hotspots. India as a mega-biodiversity nation; Endangered and endemic species of India. Threats to biodiversity: Habitat loss, poaching of wildlife, man-wildlife conflicts, biological invasions; Conservation of biodiversity: In-situ and Ex-situ conservation of biodiversity. Ecosystem and biodiversity services: Ecological, economic, social, ethical, aesthetic and Informational value.

TEXTBOOK

1. Sivashanmugam P, **Text Book on Environmental Science**, New India Publishing Agency, 2018.
2. Mr. Sourav Khawas, Dr. Omveer Singh, Prof. (Dr.) Shailesh Sharma, Mr. Hansraj Bishnoi, Mrs. Priyanka Jaiswal, Mr. Jay Chandra, (2023) **A text book of Environmental Science,** 2023.

REFERENCE BOOKS

1. **Environmental Policy and Public Health: Air Pollution, Global Climate Change, and Wilderness**, William N Rom, 2011.
2. Rajit Sengupta and Kiran Pandey (2021), **State of India's Environment 2021: In Figures. Centre Science and Environment**.

FIFTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0501	Proteomics and Metabolomics	DSC	3	0	0	3	4

Prerequisite: Basic understanding of molecular biology, cell biology, and biochemistry.

Course objectives

1. To provide an in-depth understanding of protein structure, function, and post-translational modifications.
2. To familiarize students with biochemical concepts of macromolecules (proteins, carbohydrates, lipids, nucleic acids) and their relevance to omics studies.
3. To impart knowledge on metabolomics and its analytical platforms.
4. To train students in the interpretation of high-throughput proteomic and metabolomic data using bioinformatics tools.

Course outcomes

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

1. Explain the principles of protein structure, function, and protein chemistry.
2. Describe core concepts in metabolism and biochemical pathways, including carbohydrates, lipids, proteins, and nucleic acids.
3. Apply knowledge of analytical techniques used in proteomics and metabolomics.
4. Interpret proteomic and metabolomic data using bioinformatics tools.
5. Evaluate the biological relevance of metabolic and proteomic changes in disease and development.
6. Demonstrate awareness of recent advances and applications of omics technologies in systems biology and personalized medicine.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	2	1	1	2	1	2	2	3	2	2
CO2	3	3	2	2	2	1	1	1	2	1	2	3	2	2
CO3	3	2	3	3	3	1	1	2	2	2	3	3	3	2
CO4	3	3	3	3	3	2	2	2	2	2	3	3	3	3
CO5	3	3	3	2	3	2	2	3	3	2	3	3	3	3
CO6	2	3	3	2	3	3	3	3	3	3	3	3	3	3

Course content

Unit I: Introduction to Biochemistry and Proteomics **12 Hours**

Overview of biomolecules: carbohydrates, lipids, proteins, nucleic acids – structure and functions. Enzyme function and kinetics; coenzymes and cofactors. Protein structure (primary to quaternary), folding, and domains. Introduction to proteomics – definition, scope, and applications. Protein separation and purification techniques – SDS-PAGE, 2D-PAGE, chromatography.

Unit II: Analytical Methods in Proteomics **12 Hours**

Protein identification methods – Mass spectrometry (MALDI-TOF, ESI, LC-MS/MS). Quantitative proteomics: iTRAQ, SILAC, Label-free methods. Post-translational modifications and their analysis. Protein-protein interaction mapping – Yeast two-hybrid, Co-immunoprecipitation. Bioinformatics tools in proteomics: UniProt, InterPro, STRING, PANTHER.

Unit III: Fundamentals of Metabolism and Metabolomics **12 Hours**

Basic metabolism: Glycolysis, TCA cycle, lipid metabolism, amino acid metabolism. Introduction to metabolomics – scope and significance. Analytical platforms in metabolomics – NMR, GC-MS, LC-MS, FTIR. Metabolite extraction and sample preparation techniques. Data acquisition and normalization in metabolomics.

Unit IV: Data Integration and Applications **12 Hours**

Metabolomic and proteomic data analysis – multivariate statistics, clustering, and PCA. Functional enrichment, pathway mapping – KEGG, Reactome, MetaboAnalyst. Applications in biomarker discovery, disease diagnosis, pharmacometabolomics. Case studies in systems biology: cancer, neurological, metabolic diseases. Future trends: Single-cell proteomics, multi-omics integration, AI in omics.

Reference Books

1. Berg, J.M., Tymoczko, J.L., Stryer, L. (2015). **Biochemistry, 8th Edition,** W.H. Freeman and Company.
2. Rawn, D.J. (2018). **Biochemistry, Indian Edition,** Narosa Publishing House.
3. Pennington, S.R., Dunn, M.J. (2002). **Proteomics: From Protein Sequence to Function,** Viva Books.
4. Righetti, P.G. (2006). **Proteome Analysis,** Elsevier Academic Press.
5. Dunn, W.B., Ellis, D.I. (2005). **Metabolomics: Current Analytical Platforms and Methodologies**, TrAC Trends in Analytical Chemistry.
6. Weckwerth, W. (2007). **Metabolomics: Methods and Protocols,** Humana Press.
7. Nicholson, J.K., Lindon, J.C. (2008). **Systems Biology: Metabolomics**, Elsevier.
8. Karp, P.D. et al. (2023). **BioCyc Database Collection: Tools for Metabolomics and Omics Integration**, Nucleic Acids Research.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0501	Sampling Techniques and non-parametric tests	DSC	3	0	0	3	4

Prerequisites: Basic statistics and R programming, Mathematical Foundations for Bioinformatics, random variable and probability distributions, statistical inference

Course objectives

1. To introduce the fundamental principles of sampling theory and survey methodology.
2. To equip students with techniques for drawing and analyzing simple, stratified, and systematic random samples.
3. To provide an understanding of non-parametric statistical methods for hypothesis testing.
4. To develop an analytical and computational skills to apply sampling and non-parametric methods in biological and life science data analysis.

Course outcomes

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

1. Describe sampling techniques and steps involved in survey design.
2. Apply simple random sampling to estimate means, totals and proportions of the populations.
3. Implement stratified and systematic sampling and compute related estimates.
4. Evaluate and compare sampling methods based on precision.
5. Apply non-parametric tests for one-sample and two-sample problems.
6. Perform goodness-of-fit and independence tests using Chi-square and Kolmogorov–Smirnov methods.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO2	3	3	2	2	1	0	1	1	0	2	2	3	3	2
CO3	3	3	2	2	1	0	1	1	0	2	2	3	3	2
CO4	3	3	3	2	1	0	1	1	0	3	2	2	3	2
CO5	3	3	2	2	1	1	1	2	0	3	3	2	3	2
CO6	3	3	2	2	1	1	1	2	0	3	3	2	3	2

Course content

Unit 1: Basics of Sampling **12 Hours**

Introduction to sampling theory: concepts of population and sample; Need for sampling and comparison with complete enumeration; Survey methods: principal steps in a sample survey – planning, execution, analysis, and reporting; Characteristics of a good questionnaire; Drafting and pre-testing of questionnaires and schedules; Pilot surveys; Sampling and non-sampling errors; Types of sampling: non-probability and probability; Random sampling techniques: lottery method and use of random number tables

Unit 2: Simple Random Sampling (SRS) **12 Hours**

Sampling with and without replacement; Unbiased estimators of population mean and total; Variance and standard errors of the estimators; Confidence intervals; Sampling for proportions – variance estimation; Sample size determination for estimating population mean and proportion; Merits and limitations of SRS; Application-based problems.

Unit 3: Stratified and Systematic Random Sampling **12 Hours**

Stratified random sampling: need, estimators for mean and total; Estimation of variance and standard error; Sample allocation: proportional, optimal, and Neyman allocations; Comparison of V(ran), V(prop), and V(opt); Estimation of gain in precision; Permuted block randomization – concept and applications; Systematic sampling: linear and circular, estimators of mean and total; Comparison with SRSWOR; Practical problems and applications.

Unit 4: Non-Parametric Tests **12 Hours**

Concept and importance of non-parametric methods; Run test for randomness; Empirical distribution function; Kolmogorov–Smirnov test for one sample; Sign test and Wilcoxon signed-rank test (one sample and paired samples); Median test and Mann–Whitney–Wilcoxon test (two sample problems); Test for independence using Spearman's rank correlation; Chi-square tests: goodness of fit and independence; Application problems.

Reference Books

1. Cochran, W.G. (2007). **Sampling Techniques (3rd ed.).** John Wiley & Sons.
2. Gupta, S.C., & Kapoor, V.K. (2014). **Fundamentals of Applied Statistics.** Sultan Chand & Sons.
3. Mukhopadhyay, P. (2008). **Theory and Methods of Survey Sampling (2nd ed.).** Prentice Hall India.
4. Goon, A.M., Gupta, M.K., & Das Gupta, B. (2013). **An Outline of Statistical Theory**, Volumes I & II. World Press.
5. Wu, C., & Thompson, M.E. (2020). **Sampling Theory and Practice**. Springer Nature.
6. Gupta, S.C., & Kapoor, V.K. (2020). **Fundamentals of Mathematical Statistics (11th ed.).** Sultan Chand & Sons.
7. Mood, A.M., Graybill, F., & Boes, D. (2017). **Introduction to the Theory of Statistics (3rd ed.).** McGraw-Hill.
8. Verzani, J. (2014). **Using R for Introductory Statistics (2nd ed.).** Chapman and Hall/CRC.
9. Arnab, R. (2017). **Survey Sampling: Theory and Applications.** Academic Press, Elsevier.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0501	Fundaments of web technology	DSC	3	0	0	3	4

Prerequisite: Basic computer knowledge and internet usage, Familiarity with operating systems and file systems.

Course Objectives

1. To introduce the foundational concepts of the internet, web servers, and web standards.
2. To impart skills in web development using HTML, CSS, and JavaScript.
3. To equip students with knowledge of dynamic and responsive web technologies.
4. To introduce modern tools and deployment platforms for developing and hosting websites.

Course Outcomes

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

1. Understand the architecture and components of web applications.
2. Create static web pages using HTML and structure content effectively.
3. Design visually appealing websites using CSS and layout techniques.
4. Add interactivity using JavaScript and the Document Object Model (DOM).
5. Demonstrate client-side dynamic effects using Ajax.
6. Deploy basic websites using hosting services and understand responsive design.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	0	2	2	0	0
CO2	3	3	2	0	0	0	0	0	0	0	2	2	0	0
CO3	2	2	3	2	0	0	0	0	0	0	2	2	2	0
CO4	2	3	3	2	0	0	0	0	2	0	2	3	2	0
CO5	2	3	3	2	0	0	0	0	0	0	3	2	2	2
CO6	2	3	2	3	2	0	0	0	2	2	3	2	3	2

Course content

Unit 1: Fundamentals of Internet and Web Architecture **12 Hours**

Introduction to Internet and Web Technologies; Web Servers, Web Clients, URL and Domain Names; HTTP, HTTPS, FTP, SMTP, POP, IMAP Protocols; DNS, Dynamic IP, Web Hosting, Domain Registration; Overview of Web Architecture and Standards (W3C); Web Development Tools, Text Editors, IDEs; Web Design Principles and Planning; Website Navigation and User Experience (UX) Basics

Unit 2: HTML and XHTML **12 Hours**

Evolution of HTML to HTML5; HTML Document Structure; Text Formatting Tags, Links, Lists; Tables, Forms and Input Elements; Embedding Multimedia: Audio, Video, Iframes; Introduction to Semantic HTML; Accessibility Considerations.

Unit 3: Cascading Style Sheets (CSS) **12 Hours**

Need for CSS and Types (Inline, Internal, External); CSS Syntax, Selectors, Colors, Backgrounds; Box Model: Margins, Padding, Borders; Font and Text Styling; Layout Techniques: Flexbox, Grid; Responsive Design with Media Queries; CSS3 Features: Transitions, Animations, Shadows

Unit 4: JavaScript and Introduction to Ajax **12 Hours**

JavaScript Basics: Variables, Data Types, Operators, Functions; DOM Manipulation, Element Selection and Events; Dynamic Effects: Showing/Hiding, Changing Styles; Form Validation and Event Handling; JavaScript Loops, Conditions, Arrays, Objects; Ajax: Basics, Working, Advantages, Use Cases; Introduction to Fetch API and JSON.

Reference Books

1. Achyut Godbole & Atul Kahate (2013). **Web Technologies: TCP/IP to Internet Application Architectures**, McGraw Hill Education.
2. Jon Duckett (2014**). HTML and CSS: Design and Build Websites,** Wiley.
3. Jon Duckett (2014**). JavaScript and JQuery: Interactive Front-End Web Development,** Wiley.

4. Thomas A. Powell (2010). **HTML and CSS: The Complete Reference,** McGraw Hill.
5. Robin Nixon (2021). **Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5,** O'Reilly Media.
6. David Flanagan (2020). **JavaScript: The Definitive Guide,** O'Reilly Media.
7. Jennifer Niederst Robbins (2018). **Learning Web Design,** 5th Edition, O'Reilly.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS511	Microbial Informatics	DSE	2	0	0	2	2

Prerequisite: Basic understanding of microbiology, molecular biology, and computer fundamentals

Course objectives

1. To provide foundational knowledge in microbiology and microbial diversity.
2. To explore genome organization, evolution, and molecular biology of microbes.
3. To introduce computational tools and databases for microbial data analysis.
4. To understand the applications of informatics in microbial genomics, ecology, and biotechnology.

Course Outcomes

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

1. Explain the fundamentals of microbiology including microbial classification.
2. Understand microbial genome structure, evolution, and gene function.
3. Utilize microbial databases and tools for sequence retrieval and analysis.
4. Apply computational approaches to analyse microbial diversity and taxonomy.
5. Interpret microbial metabolic pathways using bioinformatics tools.
6. Explore the applications of microbial informatics in health and biotechnology.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	1	2	3	0	0
CO2	3	3	2	0	0	0	0	0	0	0	2	3	2	0
CO3	3	3	3	2	3	0	0	0	1	0	3	3	3	2
CO4	3	3	2	3	3	1	0	2	0	0	2	2	3	0
CO5	2	2	3	2	3	0	0	0	0	2	3	2	3	2
CO6	3	3	2	0	3	2	2	0	2	2	3	3	3	3

Course content

Unit 1: Basics of Microbiology and Microbial Taxonomy **8 hours**

Introduction to microbiology; Microbial classification and taxonomy (Bacteria, Archaea, Fungi, Viruses); Overview of microbial physiology and growth; Microbial ecology and interactions; Introduction to Bergey's Manual and 16S rRNA gene-based classification.

Unit 2: Microbial Genomics and Molecular Biology **8 hours**

Microbial genome structure and organization; Comparative microbial genomics and pan-genomes; Plasmids, transposons, and phages; Gene prediction and annotation techniques; Microbial evolution and horizontal gene transfer.

Unit 3: Tools and Databases in Microbial Informatics **8 hours**

NCBI, GOLD, IMG, SILVA, and MBGD databases; Sequence alignment tools: BLAST, MUSCLE, Clustal Omega, Phylogenetic tree construction and visualization, Metagenomics data analysis pipelines (e.g., QIIME, Mothur); Microbiome studies and 16S rRNA sequencing analysis

Unit 4: Applications of Microbial Informatics **8 hours**

Pathogen identification and antimicrobial resistance prediction, Microbial informatics in environmental monitoring, Metabolic pathway reconstruction (KEGG, MetaCyc), Microbial biotechnology and synthetic biology, Role of microbes in human health and probiotics.

Reference Books:

1. Pelczar, M.J., Chan, E.C.S., & Krieg, N.R. (2010). ***Microbiology*****,** 5th Edition, Tata McGraw-Hill.
2. Willey, J.M., Sherwood, L.M., & Woolverton, C.J. (2021). ***Prescott's Microbiology*****,** 11th Edition, McGraw-Hill Education.
3. Nelson, K.E., & Steffen, A. (2021). ***Microbial Genomics and Bioinformatics*****,** 2nd Edition, ASM Press.
4. Reddy, P., & Reddy, S.M. (2014). ***Microbial Bioinformatics*****,** Scientific Publishers.
5. Streit, W.R., & Daniel, R. (2010). ***Metagenomics: Methods and Protocols*****,** Humana Press.
6. Falkow, S. (2005). ***Prokaryotes: A Handbook on the Biology of Bacteria*****,** Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS512	AI Techniques in Biology	DSE	2	0	0	2	2

Prerequisite: Basic knowledge of biology, statistics, and programming (preferably Python)

Course Objectives (COs):

1. Understand the fundamental concepts of artificial intelligence and machine learning.
2. Explore how AI techniques can be applied in biological data analysis and interpretation.
3. Gain practical experience in developing and evaluating AI models for biological datasets.
4. Analyze case studies demonstrating real-world applications of AI in biology and healthcare.

Course Outcomes (COs):

Upon completion of this course, students will be able to:

1. Explain core AI/ML concepts and their relevance in biology.
2. Apply supervised and unsupervised learning techniques to biological datasets.
3. Implement and evaluate classification and clustering models in bioinformatics.
4. Use Python libraries such as scikit-learn, pandas, and matplotlib for biological data analysis.
5. Interpret the output of AI models to derive meaningful biological insights.
6. Assess ethical and practical considerations of using AI in biology and healthcare.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	2	0	0	0	0	1	1	3	2	0
CO2	2	3	2	0	0	0	0	0	0	0	0	3	3	1

CO3	3	3	3	3	2	0	0	0	0	0	1	3	3	2
CO4	2	2	2	3	3	0	0	0	0	0	0	3	3	2
CO5	2	3	3	3	3	0	0	0	0	2	2	3	3	3
CO6	3	3	2	3	3	1	1	1	2	2	3	3	3	3

Course content

Unit I: Machine Learning Applications in Biology **8 Hours**

Overview of ML applications in biology: Genomics, Proteomics, Precision Medicine; Biological Intelligence vs Artificial Intelligence; Data types in biology: Sequences, Images, Networks; Supervised and unsupervised learning for biological data; Feature engineering for omics datasets; Case studies using Scikit-learn and ML pipelines

Unit II: AI for Biological Sequences and Structures **8 Hours**

Neural networks for biological sequence modeling; CNNs and RNNs for DNA/RNA/protein sequence classification; Protein structure prediction (e.g., AlphaFold); Sequence-to-function mapping using AI; Hands-on tools: TensorFlow, Keras, BioPython.

Unit-III: AI for Systems Biology and Imaging **8 Hours**

AI for metabolic and regulatory network analysis, Image-based cell classification and tissue segmentation, Deep learning for medical and histopathology imaging, Case Study: Cancer classification from gene expression and histological images, Tools and frameworks: OpenCV, DeepBio, PyTorch.

Unit-IV: Integrative Case Studies and Future Trends **8 Hours**

AI in personalized medicine, vaccine design, and drug repurposing; NLP for biomedical literature and clinical text mining; AI in pandemic modeling and public health; Explainable AI (XAI) and ethical considerations in biological AI; Mini project: Building an end-to-end AI pipeline using a biological dataset.

Reference Books & Resources

1. Shanmugam, G. (2021). **Artificial Intelligence in Bioinformatics: Applications and Trends.** CRC Press.
2. Zou, J., Huss, M., Abid, A., Mohammadi, P., Torkamani, A., & Telenti, A. (2019). **A primer on deep learning in genomics.** Nature Genetics, 51(1), 12–18.
3. Libbrecht, M. W., & Noble, W. S. (2015**). Machine learning applications in genetics and genomics**. Nature Reviews Genetics, 16(6), 321–332.
4. Chicco, D., & Jurman, G. (2020). **Machine Learning Can Predict Survival of Patients with Heart Failure from Serum Creatinine and Ejection Fraction Alone.** BMC Medical Informatics and Decision Making.
5. Online Tutorials and Docs: **TensorFlow, Keras, PyTorch, Scikit-learn, DeepBio Toolkit**.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0502	Lab: Proteomics and Metabolomics	DSC	0	0	2	2	3

Prerequisite: Students should have prior knowledge of Basic biochemistry and molecular biology, and exposure to bioinformatics tools

Course objectives

1. To familiarize students with protein and metabolite extraction and separation techniques.
2. To introduce methods for protein quantification, separation, and identification.
3. To train students in chromatographic techniques for metabolite analysis.
4. To expose students to proteomics and metabolomics bioinformatics tools for data analysis.

Course outcomes

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

1. Perform protein extraction and quantification using standard biochemical techniques.
2. Demonstrate protein separation and profiling using electrophoresis and blotting methods.
3. Apply chromatographic techniques for analyzing plant-derived metabolites.
4. Access and utilize protein databases and annotation tools for functional studies.
5. Analyze protein interaction networks and interpret biological significance.
6. Perform pathway mapping and functional enrichment analysis using omics datasets.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	0	0	0	0	2	2	2	3	3	0
CO2	3	3	3	2	0	0	0	0	2	2	2	3	3	0
CO3	3	2	3	2	0	0	0	0	2	2	2	3	2	0
CO4	3	3	3	2	2	0	0	0	2	3	3	3	3	2
CO5	3	3	3	2	2	0	0	0	2	3	3	3	3	2
CO6	3	3	3	2	3	0	0	0	2	3	3	3	3	3

Course content

Sl. No	Experiment Title	Objective	Tools/Software/Databases
1	Protein Extraction from Biological Samples	Isolate total proteins from plant or microbial cells	Lab setup
2	Protein Quantification using Bradford/Lowry Assay	Quantify extracted protein concentration	Spectrophotometer
3	SDS-PAGE for Protein Separation	Separate proteins based on molecular weight	Gel electrophoresis unit, stains
4	Western Blotting (Demo)	Detect specific proteins using antibodies	Transfer unit, antibodies
5	2D-PAGE for Protein Profiling (Demo)	Separate proteins by isoelectric point and size	IEF unit, SDS-PAGE
6	Column Chromatography for Plant Metabolites	Purify proteins using size/charge-based separation	Column setup, buffers
7	Thin Layer Chromatography (TLC) of Plant Metabolites	Analyze small molecule separation from plant extract	TLC plates, solvent, UV chamber

8	Identification of Proteins Using UniProt and InterPro	Retrieve and annotate protein sequences	UniProt, InterPro, PANTHER
9	Protein-Protein Interaction Analysis	Visualize protein interaction networks	STRING, Cytoscape (optional)
10	Functional Enrichment and Biomarker Analysis	Link omics data to disease models or pathways	DAVID, Reactome, MetaboAnalyst

Reference Books

1. Lehninger, A.L., Nelson, D.L., & Cox, M.M. (2021). **Lehninger Principles of Biochemistry** (8th ed.). W.H. Freeman and Company.
2. Murray, R.K., et al. (2018). **Harper's Illustrated Biochemistry** (31st ed.). McGraw-Hill Education.
3. Righetti, P.G. (2005). **Proteomics: The New Frontier in Functional Genomics.** Springer.
4. Rodriguez-Suarez, E., et al. (2013). **Proteomics in Systems Biology: Methods and Protocols.** Humana Press.
5. Wishart, D.S. (2016). **Metabolomics for Investigating Physiological and Pathophysiological Processes**. Springer Nature.
6. Patti, G.J., Yanes, O., & Siuzdak, G. (2012). **Innovation: Metabolomics: the apogee of the omics trilogy**. Nature Reviews Molecular Cell Biology, 13(4), 263–269.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0502	Lab: Sampling Techniques and non-parametric tests	DSC	0	0	2	2	3

Prerequisite: Students should have prior knowledge of Basic statistics and R programming, Mathematical foundations, Random variable and probability distributions, Statistical inference.

Course objectives

1. To introduce the methods for drawing random samples from quantitative and qualitative populations using various sampling techniques.
2. To develop skills in estimating population parameters and assessing estimator precision via SRS, stratified and systematic sampling.
3. To familiarize students with non-parametric statistical tests for biological data analysis.
4. To provide hands-on experience in applying statistical methods using R programming for sampling and inference.

Course outcomes

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

1. Draw random samples using SRSWR, SRSWOR, stratified, and systematic sampling techniques.
2. Estimate population parameters such as mean, total, and proportion along with standard errors and confidence intervals.
3. Compare the efficiency of different sampling methods and estimate gains due to stratification.
4. Perform and interpret non-parametric tests including Run test, Sign test, Wilcoxon tests, and Median test.
5. Apply Spearman’s rank correlation and Chi-square tests to life science data.

6. Use R programming to simulate sampling procedures, compute estimators, conduct hypothesis tests and visualize results.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	1	0	1	1	0	2	2	3	3	2
CO2	3	3	2	3	1	0	1	1	0	2	2	3	3	2
CO3	3	3	3	2	1	0	1	1	0	3	2	2	3	2
CO4	3	3	2	3	1	1	1	2	0	3	3	2	3	2
CO5	3	3	2	3	1	1	1	2	0	3	3	2	3	2
CO6	3	3	2	3	1	1	1	3	0	3	3	3	3	3

Course content

Sl. No	Experiment Title
1	Draw random samples from quantitative population using SRSWR and SRSWOR methods, estimate the population mean and total along with the standard error, and construct confidence intervals.
2	Estimate the population proportion and total, along with the standard error, using samples drawn through SRSWR and SRSWOR from a qualitative population.
3	Estimate the population mean, population total and the standard error of the estimators using stratified random sampling.
4	Compare the precision of estimators under proportional and optimum allocation in stratified sampling with that of SRSWOR, and estimate the gain in precision.
5	List all possible systematic samples from a given population, compute the sample variance, and compare them with those obtained from SRSWOR and stratified sampling.
6	Conduct Run test for randomness and Kolmogorov Simonov test for one sample.
7	Perform Sign test and signed rank test.
8	Apply the Mann-Whitney-Wilcoxon test and Median test to compare two independent samples.
9	Perform Spearman's rank correlation coefficient test and Chi-square test for goodness of fit.
10	Conduct Chi-square test for independence of attributes.

All experiments will be implemented using R programming and life science-based datasets.

Reference Books

1. Cochran, W.G. (2007). ***Sampling Techniques*** (3rd ed.). John Wiley and Sons.
2. Gupta, S.C., & Kapoor, V.K. (2014). ***Fundamentals of Applied Statistics.*** Sultan Chand & Sons.
3. Mukhopadhyay, P. (2008). ***Theory and Methods of Survey Sampling*** (2nd ed.). Prentice Hall India.
4. Goon, A.M., Gupta, M.K., & Das Gupta, B. (2013). ***An Outline of Statistical Theory*** Volumes I & II. World Press.
5. Wu, C., & Thompson, M.E. (2020). ***Sampling Theory and Practice***. Springer Nature Switzerland.
6. Gupta, S.C., & Kapoor, V.K. (2020). ***Fundamentals of Mathematical Statistics*** (11th ed.). Sultan Chand & Sons.
7. Mood, A.M., Graybill, F., & Boes, D. (2017). ***Introduction to the Theory of Statistics*** (3rd ed.). McGraw-Hill.

8. Verzani, J. (2014). ***Using R for Introductory Statistics*** (2nd ed.). Chapman and Hall/CRC.
9. Arnab, R. (2017). ***Survey Sampling Theory and Applications***. Academic Press, Elsevier.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0502	Lab: Fundaments of web technology	DSC	0	0	2	2	3

Prerequisite: Basic computer knowledge and internet usage, Familiarity with operating systems and file systems.

Course Objectives

1. To introduce the foundational concepts of the internet, web servers, and web standards.
2. To impart skills in web development using HTML, CSS, and JavaScript.
3. To equip students with knowledge of dynamic and responsive web technologies.
4. To introduce modern tools and deployment platforms for developing and hosting websites.

Course Outcomes

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

1. Understand the architecture and components of web applications.
2. Create static web pages using HTML and structure content effectively.
3. Design visually appealing websites using CSS and layout techniques.
4. Add interactivity using JavaScript and the Document Object Model (DOM).
5. Demonstrate client-side dynamic effects using Ajax.
6. Deploy basic websites using hosting services and understand responsive design.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	3	2	1	1	2	1	2	2	3	1	3
CO2	3	2	3	3	3	1	2	2	1	2	2	3	1	3
CO3	3	3	3	3	3	1	2	2	1	2	2	3	3	3
CO4	3	3	3	3	3	1	2	2	1	2	2	2	3	3
CO5	3	3	3	3	3	1	1	2	1	3	3	3	2	3
CO6	3	3	3	3	3	1	2	2	2	3	3	2	3	3

Course content

Sl. No.	Title of the Experiment	Description	Tools/Software Used
1	HTML & CSS for Static Web Page Design	Create a basic multi-section web page using HTML5 and style it with external CSS.	Text Editor (VS Code/Notepad++), Browser
2	JavaScript Form Validation and Event Handling	Develop a form and apply client-side validation using JavaScript with events like onClick.	Text Editor, Browser, JavaScript
3	Fibonacci Series using JavaScript	Generate Fibonacci series for a user-entered number using JavaScript.	Text Editor, JavaScript, Browser
4	Responsive Web Design using Media Queries	Design a responsive web page that adapts to different screen sizes (mobile/tablet/desktop).	Text Editor, CSS Media Queries, Browser

5	AJAX Form Submission using PHP	Submit a form without reloading the page using AJAX and process data with PHP.	XAMPP/WAMP, PHP, Browser, AJAX
6	Session and Cookie Handling in PHP	Create a PHP application to store and display user session and cookie data.	XAMPP/WAMP, PHP, Browser
7	User Login System using PHP and MySQL	Implement login/logout with user authentication using PHP sessions and MySQL database.	XAMPP/WAMP, PHP, MySQL, phpMyAdmin, Browser
8	Form Data Insertion and Retrieval using PHP-MySQL	Design a form to insert and retrieve data from a MySQL database using PHP.	XAMPP/WAMP, PHP, MySQL, Browser
9	File Upload System using PHP	Develop a web form to allow users to upload files and display them after submission.	XAMPP/WAMP, PHP, Browser
10	Employee Salary Calculator using JavaScript	Build a web app to calculate employee salary components (DA, HRA, PF) based on user input.	Text Editor, JavaScript, Browser

Reference Books

1. Achyut Godbole & Atul Kahate (2013). **Web Technologies: TCP/IP to Internet Application Architectures**, McGraw Hill Education.
2. Jon Duckett (2014**). HTML and CSS: Design and Build Websites,** Wiley.
3. Jon Duckett (2014**). JavaScript and JQuery: Interactive Front-End Web Development,** Wiley.
4. Thomas A. Powell (2010). **HTML and CSS: The Complete Reference,** McGraw Hill.
5. Robin Nixon (2021). **Learning PHP, MySQL & JavaScript: With jQuery, CSS & HTML5,** O'Reilly Media.
6. David Flanagan (2020). **JavaScript: The Definitive Guide,** O'Reilly Media.
7. Jennifer Niederst Robbins (2018). **Learning Web Design,** 5th Edition, O'Reilly.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0502	Pharmaceutical biology	IDC	2	0	0	2	2

Prerequisite: Students should have prior knowledge of biology, organic chemistry, and physiology at the higher secondary level.

Course Objectives:

1. To understand the principles of antimicrobial agents and their mechanisms of action.
2. To explore the stages of drug discovery and development including regulatory perspectives.
3. To introduce students to medicinal chemistry concepts and the significance of natural products in drug discovery.
4. To provide knowledge on pharmacokinetics, pharmacodynamics, and the influence of genetics on drug response.

Course Outcomes (COs):

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

1. Understand and classify various antimicrobial agents, their modes of action, and methods to evaluate their efficacy.
2. Explain the stages of drug development including preclinical testing, clinical trials, and regulatory frameworks.
3. Apply basic concepts of medicinal chemistry and SAR in understanding drug design and natural product-based drug discovery.
4. Analyze pharmacokinetic processes such as absorption, distribution, metabolism, and excretion (ADME) of drugs.
5. Evaluate the pharmacodynamics of drugs including dose-response relationships and therapeutic indices.
6. Demonstrate awareness of the importance of personalized medicine and the influence of genetics on drug response.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	1	2	1	2	3	2	1
CO2	3	3	3	2	2	1	2	2	2	1	2	3	3	2
CO3	3	3	3	3	3	2	1	1	2	2	2	3	3	3
CO4	3	3	2	3	2	2	2	2	2	2	2	3	2	2
CO5	3	2	2	3	2	1	2	2	2	2	2	3	2	2
CO6	3	3	3	3	3	2	2	2	2	3	3	3	3	3

Course content

Unit-I: Principles of Antimicrobial Agents **8 Hours**

Introduction to pharmaceutical biology and antimicrobial agents; classification of antimicrobials and chemotherapeutics; disinfectants and antiseptics; static vs cidal action; Mechanism of action of key antibiotics – β-lactams, aminoglycosides, tetracyclines, macrolides; antibiotic resistance overview; evaluation of antimicrobial activity – MIC, MBC, zone of inhibition methods.

Unit-II: Drug Discovery, Development and Regulation **8 Hours**

Introduction to drug discovery pipeline; Preclinical studies – in vitro, in vivo models, safety pharmacology; Clinical trial phases I–IV; regulatory agencies (FDA, EMA, CDSCO), IND and NDA submission; drug approval process; Pharmacovigilance, ADR reporting systems; recent case studies in drug approval and post-market recall.

Unit-III: Medicinal Chemistry and Natural Products in Drug Discovery **8 Hours**

Basics of medicinal chemistry; drug-target interaction; structure-activity relationship (SAR); bioisosterism and drug optimization; role of natural products from plants, animals, and microbes in drug discovery (e.g., artemisinin, taxol, penicillin); introduction to combinatorial chemistry and high-throughput screening; examples of FDA-approved natural product-derived drugs.

Unit-IV: Pharmacokinetics, Pharmacodynamics and Personalized Medicine **8 Hours**

Pharmacokinetics – absorption, distribution, metabolism (CYP450), and excretion (ADME); bioavailability, half-life, clearance; Pharmacodynamics – drug-receptor interaction, dose-response curves, EC50, IC50,

therapeutic window; factors influencing drug response (age, gender, genetic polymorphism); introduction to pharmacogenomics and personalized therapy (case examples: warfarin, imatinib).

Reference Books

1. **Kokate, C.K., Purohit, A.P., Gokhale, S.B.** (2017). *Pharmacognosy* (50th Edition). Nirali Prakashan.
2. **Trease, G.E., Evans, W.C.** (2019). *Pharmacognosy* (17th Edition). Elsevier.
3. **Tyler, V.E., Brady, L.R., Robbers, J.E.** (2011). *Pharmacognosy*. Wolters Kluwer.
4. **Wallis, T.E.** (2005). *Textbook of Pharmacognosy*. CBS Publishers.
5. **Samuelsson, G.** (2004). *Drugs of Natural Origin: A Textbook of Pharmacognosy*. CRC Press.
6. **Heinrich, M., Barnes, J., Gibbons, S., Williamson, E.M.** (2018). *Fundamentals of Pharmacognosy and Phytotherapy* (3rd Edition). Elsevier.
7. **Mukherjee, P.K.** (2019). *Quality Control of Herbal Drugs* (2nd Edition). Business Horizons.
8. **Jain, S.K.** (2002). *Medicinal Plants*. National Book Trust, India.
9. **Reddy, K.N., Reddy, C.S.** (2008). *Traditional Knowledge of Medicinal Plants of Srikakulam District*. Andhra Pradesh Forest Department.
10. **Harborne, J.B.** (1998). *Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis*. Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25LS0501	Constitution of India and Professional Ethics	AEC	2	0	0	2	2

Course Objectives

1. To provide and gain knowledge on Constitution of India
2. To know and understand the background of Indian Constitution
3. To attain knowledge about ethics and ideology of political leaders
4. To explore the philosophy and features of Indian Constitution

Course Outcomes

After completion of this course the students will be able to:

1. Analyze the political foundation of India
2. Understand the colonial impact on Indian Constitution
3. Demonstrate the political views during freedom struggle
4. Understand the acts during constitutional development of India
5. Illustrate the working committees in Indian Constitution
6. Summarize ethical standards followed by different companies

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	1	0	1	1	1	0	0	0	1	0	2	2	1
CO2	1	1	1	0	1	1	0	0	1	1	0	2	2	1
CO3	2	2	2	1	1	1	1	0	1	1	0	2	2	1
CO4	2	1	1	1	3	1	0	0	1	1	0	2	2	0
CO5	2	2	0	1	2	1	0	0	1	1	1	2	2	0
CO6	2	2	1	1	3	1	1	0	2	1	1	2	2	0

Course content

Unit-I: Development and Philosophy of the Indian Constitution 12 Hours

1. Evolution and Making of the Indian Constitution 3 Hours

- Historical Background – Growth of Constitutionalism in India
- Key Constitutional Acts – Regulating Act, Charter Acts, Government of India Acts (brief overview)
- Constituent Assembly – Composition, Debates, and Role of Committees in Drafting the Constitution

2. Philosophy and Features of the Indian Constitution 4 Hours

- The Preamble and its Significance – Interpretation & Judicial Perspective
- Salient Features of the Constitution – Federalism, Secularism, Parliamentary System, Judicial Review, etc.
- Concept of Constitutionalism – Limited Government, Rule of Law, Separation of Powers

3. Functioning of the Constitution 5 Hours

- Fundamental Rights – Key Provisions, Landmark Judgments, and Limitations
- Contributions of Dr. B.R. Ambedkar and Jawaharlal Nehru in Constitution-making
- Union-State & Inter-State Relations – Article 263, Interstate Disputes, Trade and Commerce Provisions
- Major Constitutional Amendments – 42nd, 44th, 73rd, 74th, 101st, and re-cent amendments
- Parliamentary Committees – Standing, Ad hoc, and Departmental Commit-tees: Role & Importance

Unit II: Constitutional Institutions and the Role of Citizens 12 Hours

1. Parliamentary and Constitutional Institutions 5 Hours

- Legislature – Composition and Powers of Upper and Lower Houses
- Executive – Structure and Powers of the President, Prime Minister, and Coun-cil of Ministers
- Judiciary – High Courts and Supreme Court: Composition, Jurisdiction, and Landmark Cases
- Key Constitutional Bodies
  - Comptroller and Auditor General (CAG) – Functions & Role in Financial Oversight
  - Inter-State Council – Role in Federal Cooperation
  - Election Commission – Structure, Powers, and Electoral Re-forms

2. Citizenship and Responsibilities of Citizens 4 Hours

- Concept of Citizenship – Constitutional Provisions (Articles 5-11)
- Citizenship Amendment Act – Evolution and Key Changes
- Fundamental Duties – Constitutional Mandate and Significance
- Right to Information Act – Importance in Transparency and Governance
- Role of Civil Society – Social Movements, Public Participation, and Account-ability

3. National Development and Constitutional Vision 3 Hours

- Concept of National Development – Constitutional Directives and Policy Framework
- Unity and Integrity of the Nation – Federalism, Secularism, and Social Jus-tice
- Educational Policies and Nation-Building – Constitutional Goals, Role of Teachers and Students in Strengthening Democracy

Textbooks:

1. Desai, A R. 2016. Social Background of Indian Nationalism. Los Angeles: Popular Prakashan.
2. Harish Ramaswamy and S. S. Patagundi (Ed.) 2007. Karnataka- Government and Politics. Delhi: Concept Publishing Company.

SIXTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0601	Computational Drug Discovery	DSC	3	0	0	3	4

Prerequisite: Basic knowledge of molecular biology, biochemistry, bioinformatics, and computer programming fundamentals.

Course objectives

1. To understand the principles and applications of computer-aided drug discovery (CADD).
2. To explore bioinformatics tools and databases used in target identification and validation.
3. To gain practical skills in molecular modelling, docking, QSAR, and virtual screening.
4. To evaluate drug delivery systems and integrate computational methods into formulation strategies.

Course outcomes

After completing this course, students will be able to:

1. Explain the concepts and workflow of drug discovery and the role of CADD.
2. Apply bioinformatics tools for target identification, structure modeling, and validation.
3. Perform virtual screening, molecular docking, and QSAR-based lead optimization.
4. Interpret pharmacokinetic and pharmacodynamic parameters using computational tools.
5. Analyse and design drug delivery systems using computational methods.
6. Utilize drug design software and databases for real-world drug development applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	2	1	1	1	1	1	2	3	2	1
CO2	2	3	3	3	3	1	1	1	1	2	3	3	3	2
CO3	2	3	2	3	3	1	1	1	1	2	3	3	3	3
CO4	2	3	3	3	3	1	1	1	1	2	3	3	3	2
CO5	2	3	2	3	3	2	2	1	2	2	3	3	2	2
CO6	2	3	3	3	3	2	1	2	2	3	3	3	3	3

Course content

Unit-I: Introduction to Computer-Aided Drug Design **12 Hours**

Introduction to Drug Design and Development Pipeline; Causes of Drug Failure and Success Stories in CADD; Rational Drug Design Approaches; Drug Discovery Workflow: Target Identification, Hit-to-Lead, Lead Optimization; Key Concepts in Drug Discovery: Binding Affinity, Drug-Likeness, ADMET, Lipinski's and Veber's Rules; Role of Computers in Drug Discovery; Common Software Tools Used in CADD: AutoDock, AutoDock Vina, GOLD, Discovery Studio, Schrödinger Suite, MOE; Chemical and Bioactivity Databases: PDB, ChEMBL, PubChem, DrugBank, BindingDB, SwissADME.

Unit-II: Target Identification and Validation **12 Hours**

Disease Pathway Analysis and Target Identification Strategies; Gene Expression Profiling and Biomarker Discovery; Protein Structure Prediction and Homology Modelling; Tools and Platforms: SWISS-MODEL, I-TASSER, ModRefiner; Molecular Visualization and Structural Validation; Protein–Protein Interaction Networks (STRING, BioGRID); Drug–Target Interaction Prediction; Basic Concepts of Pharmacokinetics (ADME) and Pharmacodynamics: Absorption, Distribution, Metabolism, Excretion; Receptor Binding, Dose–Response Relationship, Toxicodynamics.

Unit-III: Lead Identification, Optimization and Virtual Screening **12 Hours**

Hit-to-Lead and Lead Optimization Approaches; Ligand-Based Drug Design: Pharmacophore Modelling and 3D Mapping, Database Searching, Genetic Algorithms; QSAR: 2D & 3D QSAR; Molecular Descriptors, Model Building and Validation Techniques; Structure-Based Drug Design: Molecular Docking: Theory, Scoring Functions, Flexible Docking; De Novo Drug Design; Molecular Dynamics Simulations (GROMACS, AMBER – Basic Principles); Virtual Screening Strategies: Ligand Libraries, Filtering Methods

Unit-IV: Computational Drug Delivery Systems **12 Hours**

Introduction to Drug Delivery Systems; Challenges in Oral, Transdermal, and Parenteral Delivery; Sustained and Controlled Release Mechanisms; Targeted Drug Delivery Strategies: Nanocarriers, Liposomes, Antibody–Drug Conjugates; Physicochemical and Biological Factors Influencing Drug Delivery; Transdermal Drug Delivery: Components, Optimization, and Kinetics; In Vitro Permeation and Irritation Modelling; Tools for Simulating Drug Release, Permeability, and Bioavailability; Regulatory and Safety Aspects in Computational Formulation.

Reference Books

1. Leach, A. R. (2001). **Molecular Modelling: Principles and Applications** (2nd ed.). Pearson Education.
2. Gasteiger, J., & Engel, T. (Eds.). (2003). **Chemoinformatics: A Textbook**. Wiley-VCH.
3. Ekins, S. (Ed.). (2023). **Artificial Intelligence in Drug Discovery: Applications and Practices**. CRC Press.
4. Cherkasov, A., & Tropsha, A. (Eds.). (2022). **QSAR in Drug Discovery: Applications and Advances.** Springer.
5. Sliwoski, G., & Karanicolas, J. (Eds.). (2021). **Computational Methods for Drug Discovery.** Springer.
6. Wójcikowski, M., & Siedlecki, P. (2023). **Computational Drug Discovery and Design: Theory and Applications.** Springer Protocols (Humana).
7. Goh, G. B., Haspel, N., & Vishveshwara, S. (2020). **Computational Approaches for Drug Discovery and Development.** Wiley.
8. Hassaneen, E., & Choudhary, M. I. (Eds.). (2024). **Modern Tools and Techniques for Computational Drug Discovery.** Elsevier.

9. Agius, R., & Brimblecombe, R. (2020). **Computational Toxicology: Methods and Applications.** Royal Society of Chemistry.
10. Kitchen, D. B., Decornez, H., Furr, J. R., & Bajorath, J. (2004). **Docking and Scoring in Virtual Screening for Drug Discovery: Methods and Applications.** Nature Reviews Drug Discovery, 3(11), 935–949.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0601	ANOVA and Design of experiments	DSC	3	0	0	3	4

Prerequisites:

Basic Statistics and R Programming

Mathematical Foundations for Bioinformatics

Random Variables and Probability Distributions

Statistical Inference

Course Objectives

1. Understand the principles, assumptions, and applications of Analysis of Variance (ANOVA).
2. Introduce the concepts and implementation of classical experimental designs such as Completely Randomized Design (CRD), Randomized Block Design (RBD), and Latin Square Design (LSD).
3. Equip students with the skills to design, analyze, and interpret results from factorial experiments.
4. Develop students' abilities to compare design efficiencies and effectively handle missing observations in agricultural and life science research.

Course outcomes

Upon successful completion of this course, students will be able to:

1. Explain the concepts, assumptions, and components of fixed, random, and mixed effect models in ANOVA.
2. Apply one-way and two-way ANOVA to real experimental datasets.
3. Design and analyse CRD, RBD, and LSD with appropriate interpretation of results.
4. Compare the relative efficiencies of CRD, RBD, and LSD under different experimental conditions.
5. Analyse 2^2 and 2^3 factorial experiments and interpret main and interaction effects.
6. Apply confounding techniques in factorial designs and interpret outcomes in biological and agricultural experiments.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	0	1	1	0	2	2	2	3	2
CO2	3	3	3	2	1	0	1	2	0	3	2	2	3	2
CO3	3	3	3	2	1	0	1	2	0	3	2	2	3	2
CO4	3	3	2	2	1	0	1	1	0	3	2	2	3	2
CO5	3	3	3	2	1	0	1	2	0	3	2	2	3	2
CO6	3	3	2	2	1	0	1	1	0	3	2	2	3	2

Course Content

Unit I: Analysis of Variance (ANOVA) 12 Hours

Analysis of Variance (ANOVA)- Meaning, definition, assumptions. Definitions of fixed effect, random effect and mixed effect models. Cochran's theorem (statement only).One-way ANOVA, two-way ANOVA with one observation per cell for fixed effect model -model, assumptions, least square estimates of parameters, sum of squares and their expectations, degrees of freedom, mean sum of squares, ANOVA table, critical difference.

Unit II: Experimental Designs – I **12 Hours**

Introduction, terminologies in experimental designs, principles of design of experiments. Completely randomized design(CRD) and randomized block design(RBD) –meaning, advantages and disadvantages, applications, model, assumptions, least square estimates of parameters, sum of squares and their expectations, degrees of freedom, mean sum of squares, ANOVA table.

Unit III: Experimental Designs – II **12 Hours**

Latin Square Design (LSD): meaning, advantages, disadvantages, model, assumptions, estimation, ANOVA table; Comparison of relative efficiencies: CRD vs. RBD vs. LSD; Estimation of a single missing observation in RBD; Introduction to Balanced Incomplete Block Design (BIBD): concept and definition.

Unit IV: Factorial Experiments **12 Hours**

Concepts of main effects, interactions, and orthogonal contrasts in 2^2 and 2^3 factorial experiments; Yates' method for computing factorial effects; Analysis and significance testing of effects in 2^2 and 2^3 designs in RBD; Confounding: need and application; Complete and partial confounding in a 2^3 factorial experiment in RBD: layout and analysis.

Reference Books

1. Gupta, S. C., & Kapoor, V. K. (2014). **Fundamentals of Applied Statistics** (4th ed.). Sultan Chand and Sons, New Delhi.
2. Montgomery, D. C. (2017). **Design and Analysis of Experiments** (9th ed.). John Wiley & Sons, New York.
3. Das, M. N., & Giri, N. C. (1986). **Design and Analysis of Experiments**. Wiley Eastern Ltd., New Delhi.
4. Goon, A. M., Gupta, M. K., & Das Gupta, B. (2016**). Fundamentals of Statistics**, Vol. II. The World Press, Kolkata.
5. Lawson, J. (2014). **Design and Analysis of Experiments with R.** Chapman & Hall/CRC Press.
6. Toutenburg, H., & Shalabh. (2009). **Statistical Analysis of Designed Experiments** (2nd ed.). Springer.
7. Joshi, D. D. (1987). **Linear Estimation and Design of Experiments.** New Age International Publishers, New Delhi.
8. Dean, A., Voss, D., & Draguljić, D. (2017). **Design and Analysis of Experiments.** Springer.
9. Bapat, R. B. (2023**). Linear Models and the Design of Experiments**. Springer.
10. Kuehl, R. O. (2000). **Design of Experiments: Statistical Principles of Research Design and Analysis** (2nd ed.). Duxbury Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0601	Data Mining and Warehousing	DSC	3	0	0	3	4

Prerequisites: Students should be familiar with basic concepts of statistics, probability, and mathematical models.

Course objectives

1. Understand the fundamental concepts and architecture of Data Warehousing and Data Mining.
2. Comprehend the role of Data Mining in real-world problem-solving and decision support systems.
3. Identify different types of data and apply suitable preprocessing methods.
4. Apply key data mining algorithms and use appropriate tools in practical scenarios.

Course Outcomes

Upon completion of this course, students will be able to:

1. Understand the functionality and architecture of Data Warehousing and Data Mining systems.
2. Evaluate the strengths and limitations of various Data Mining and Data Warehousing models.
3. Apply analytical techniques for various types of data.
4. Explain different methodologies used in Data Mining and Warehousing.
5. Compare different data warehousing and data mining technologies.
6. Solve real-world problems using appropriate data mining tools and techniques.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	2	1	2	3	2	2	2	2	3	2
CO2	3	3	3	2	1	1	3	2	2	2	2	2	3	2
CO3	3	2	3	1	1	1	2	1	1	3	2	2	3	2
CO4	3	3	2	3	1	2	3	2	1	2	2	2	3	2
CO5	2	1	2	1	1	1	0	1	0	1	2	2	3	2
CO6	3	1	3	1	1	0	3	2	1	2	2	2	3	2

Course content

Unit I: Introduction to Data Mining and Data Warehousing **12 Hours**

Introduction to Data Mining and Knowledge Discovery; Data Mining vs. Data Warehousing; Architecture of Data Warehousing; Data Warehousing Components: ETL, Metadata, OLAP; Multidimensional data model; Data preprocessing: data cleaning, integration, transformation, reduction; Introduction to Data Mining Functionalities: characterization, discrimination, classification, clustering, prediction.

Unit II: Data Warehousing Architecture and Implementation **12 Hours**

Data Warehouse Design Approaches (Top-down and Bottom-up); Star, Snowflake, and Fact Constellation Schemas; Data Marts; OLAP Operations: Roll-up, Drill-down, Slice, Dice, Pivot; Implementation and maintenance of a data warehouse; ETL tools and techniques.

Unit III: Classification and Prediction Techniques **12 Hours**

Classification: Issues and Metrics; Decision Tree Induction: ID3, C4.5; Naive Bayes Classification; k-Nearest Neighbour (k-NN); Model evaluation and performance metrics; Prediction: Linear and Non-linear regression; Tools for classification and prediction.

Unit IV: Clustering and Advanced Mining Techniques **12 Hours**

Clustering: Types and applications; Partitioning methods: k-means, k-medoids; Hierarchical clustering: Agglomerative and Divisive; Density-based clustering: DBSCAN; Outlier detection; Association rule mining: Apriori and FP-Growth algorithms; Introduction to mining complex data types: Text mining, Web mining, and Multimedia mining.

Reference Books

1. Han, J., Kamber, M., & Pei, J. (2012). **Data Mining: Concepts and Techniques** (3rd ed.). Morgan Kaufmann.
2. Inmon, W. H. (2005). **Building the Data Warehouse** (4th ed.). Wiley Publishing.
3. Pujari, A. K. (2013). **Data Mining Techniques** (3rd ed.). Universities Press.
4. Pang-Ning Tan, Steinbach, M., & Kumar, V. (2019). **Introduction to Data Mining** (2nd ed.). Pearson.
5. Paulraj Ponniah (2010). **Data Warehousing Fundamentals for IT Professionals**. Wiley.
6. Dunham, M. H. (2006). **Data Mining: Introductory and Advanced Topics.** Pearson Education.
7. Singh, S., & Singh, N. (2020). **Data Mining and Warehousing**. Vikas Publishing House.
8. Aggarwal, C. C. (2015). **Data Mining: The Textbook.** Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0602	Lab: Computational Drug Discovery	DSC	0	0	2	2	3

Prerequisite: Basic knowledge of molecular biology, bioinformatics, chemistry and Familiarity with tools like PyMOL, RCSB-PDB, and PubChem.

Course Objectives

1. Understand the principles and pipeline of computational drug discovery.
2. Apply structure-based and ligand-based drug design techniques using open-source tools.
3. Predict drug-likeness, ADMET properties, and perform molecular docking and screening.
4. Integrate bioinformatics and cheminformatics tools for early-phase drug discovery.

Course outcomes

Upon completion of this course, students will be able to:

1. Explain the phases of drug discovery and development pipeline.
2. Use databases and tools to retrieve and analyse protein and ligand structures.
3. Evaluate drug-likeness and ADMET profiles using online tools and models.
4. Perform molecular docking and interpret binding interactions.
5. Apply ligand-based methods like QSAR and pharmacophore modelling.
6. Demonstrate skills in virtual screening and molecular dynamics using free tools.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	1	1	1	2	3	2	2	1
CO2	3	3	2	2	3	1	1	1	2	2	3	3	3	2
CO3	3	3	3	2	3	2	2	1	2	2	3	3	3	2
CO4	3	3	3	3	3	2	2	1	2	2	3	3	3	2
CO5	3	3	3	3	3	2	2	1	2	3	3	3	3	3
CO6	3	3	3	3	3	2	2	2	2	3	3	3	3	3

Course content

Sl. No.	Title of the Experiment	Software/Tools Used	Learning Outcome
1	Installation and overview of drug discovery software and databases	PyRx, AutoDock Tools, SwissADME, PubChem, ChEMBL	Familiarize with basic tools, databases, and resources used in drug discovery
2	Retrieval and preparation of ligand molecules	PubChem, Open Babel	Learn to retrieve 2D structures and convert them to 3D formats
3	Protein structure retrieval and preparation for docking	RCSB PDB, UCSF Chimera, AutoDock Tools	Understand how to prepare receptor structures for docking
4	Prediction of drug-likeness and ADMET properties	SwissADME, pkCSM, admetSAR	Evaluate pharmacokinetic properties of compounds
5	Ligand-based virtual screening	SwissSimilarity, ChemMine Tools	Perform similarity-based screening to identify potential hits
6	Structure-based virtual screening	PyRx	Identify best binders from a compound library
7	Molecular docking of selected compounds with a target protein	AutoDock Vina, PyRx	Study binding affinity and interactions of ligand-receptor pairs
8	Visualization and analysis of docking results	Discovery Studio Visualizer, UCSF Chimera	Interpret docking poses and interaction profiles
9	Molecular dynamics simulation (basic introduction)	WebGRO, MDWeb, CHARMM-GUI	Understand basic steps and utility of MD simulations in refining docked complexes
10	QSAR modelling using physicochemical descriptors	OCHEM, PaDEL-Descriptor, KNIME	Predict biological activity of analogs using QSAR
11	Pharmacophore modelling and screening	PharmaGist, ZINCPharmer	Identify essential features responsible for biological activity
12	Target fishing and drug repositioning analysis	SwissTargetPrediction, DrugBank	Explore potential targets and reposition existing drugs for new uses

Reference Books

1. Leach, A. R. (2001). **Molecular Modelling: Principles and Applications** (2nd ed.). Pearson Education.
2. Gasteiger, J., & Engel, T. (2003). **Chemoinformatics: A Textbook**. Wiley-VCH.
3. Kitchen, D. B., Decornez, H., Furr, J. R., & Bajorath, J. (2004). **Docking and scoring in virtual screening for drug discovery: methods and applications.** Nature Reviews Drug Discovery, 3(11), 935–949.
4. De Clercq, E., & Li, G. (2016). **Approved antiviral drugs over the past 50 years.** Clinical Microbiology Reviews, 29(3), 695–747.
5. Andrade, C. H., & Martins, J. P. A. (Eds.). (2018). **Computational Drug Discovery and Design**. Springer.
6. Ferreira, L. G., dos Santos, R. N., Oliva, G., & Andricopulo, A. D. (2015). **Molecular docking and structure-based drug design strategies.** Molecules, 20(7), 13384–13421.
7. Trott, O., & Olson, A. J. (2010). **AutoDock Vina: improving the speed and accuracy of docking with a new scoring function, efficient optimization, and multithreading**. Journal of Computational Chemistry, 31(2), 455–461.
8. Bajorath, J. (2020). **Chemoinformatics and Computational Chemical Biology.** Humana Press.
9. Gu, J., Bourne, P. E., & Xie, L. (2017). **Data Mining for Systems Biology: Methods and Protocols** (2nd ed.). Humana Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25ST0602	Lab: ANOVA and Design of Experiments	DSC	0	0	2	2	3

Prerequisites:

- Basic Statistics and R Programming
- Mathematical Foundations for Bioinformatics
- Random Variables and Probability Distributions
- Statistical Inference

Course objectives

1. To equip students with the basic concepts, theory, and applications of ANOVA techniques.
2. To guide students in understanding the concepts, issues, and principles of various designs of experiments.
3. To train students to construct robust experimental designs and perform statistical analysis of experimental data.
4. To explain factorial experiments and the need for confounding in complex designs.

Course outcomes

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

1. Explain the concepts and analysis of ANOVA models with their applications.
2. Understand the basic concepts and principles of experimental design.
3. Apply CRD, RBD, and LSD techniques to analyse experimental data.

4. Compare the relative efficiencies of CRD, RBD, and LSD.
5. Describe the statistical analysis and importance of confounding in factorial experiments.
6. Use R and RStudio to perform statistical analysis of ANOVA models and experimental designs.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	1	0	1	2	0	2	2	2	3	2
CO2	3	3	2	2	1	0	1	2	0	2	2	2	3	2
CO3	3	3	3	3	1	0	1	2	0	3	2	3	3	2
CO4	3	3	2	2	1	0	1	1	0	3	2	2	3	2
CO5	3	3	2	2	1	0	1	2	0	3	2	2	3	2
CO6	3	3	2	3	1	0	1	3	0	3	3	3	3	3

Course content

1. Perform one-way ANOVA to compare group means
2. Perform two-way ANOVA to study two factors and their interaction
3. Conduct a Completely Randomized Design (CRD) experiment
4. Conduct a Randomized Block Design (RBD) experiment
5. Use Latin Square Design (LSD) to control two blocking factors
6. Analyse missing plots in a Randomized Block Design
7. Run 2^2 factorial experiment using RBD layout
8. Run 2^3 factorial experiment using RBD layout
9. Analyse 2^3 factorial experiment with complete confounding in RBD
10. Analyse 2^3 factorial experiment with partial confounding in RBD

Reference Books

1. Gupta S.C., V.K. Kapoor.(2014) **Fundamentals of Applied Statistics**, Sultan Chand and Sons, New Delhi, India.
2. Montgomery, D.C. (2014). **Design and Analysis of Experiments,** Wiley, New York.
3. Das M.N. and Giri N.C(1986) **Design and Analysis of Experiments,** Wiley, New York
4. Goon A.M., Gupta, M.K., Das Gupta, B. (2016). **Fundamentals of Statistics, Vol.II,** World Press, Calcutta.
5. Lawson J (2014). **Design and Analysis of Experiments with R,** Chapman and Hall/CRC.
6. Toutenburg H and Shalabh (2009) **Statistical Analysis of designed experiments**, Springer.
7. Joshi, D. D. (1987).**Linear Estimation and Design of Experiments,** New Age International (P) Limited, New Delhi.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25CP0602	Lab: Machine learning in Data Mining	DSC	0	0	2	2	3

Prerequisite:

Basic knowledge of programming (Python/SQL preferred)

Understanding of statistics and probability

Basic concepts in database management systems (DBMS)

Exposure to data structures and algorithms

Course objectives

1. To introduce fundamental concepts and techniques of data warehousing and data mining.
2. To develop skills to design and implement data warehouses using star/snowflake schemas and perform OLAP operations.
3. To apply data mining techniques for solving real-world problems such as classification, clustering, and association.
4. To enable learners to work with real datasets and extract meaningful patterns using open-source tools.

Course outcomes

After completing this course, students will be able to:

1. Understand the architecture and components of data warehousing systems.
2. Design data warehouse schemas (star, snowflake) and perform OLAP operations.
3. Apply data preprocessing techniques and exploratory data analysis.
4. Implement data mining techniques such as classification, clustering, and regression using open-source tools.
5. Discover patterns and associations in datasets using algorithms like Apriori and FP-growth.
6. Evaluate and interpret results from data mining models and recommend suitable solutions.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	0	0	0	0	1	2	2	0	0
CO2	3	2	3	2	2	0	0	0	0	1	2	2	1	0
CO3	3	2	2	2	3	0	0	0	0	2	2	2	2	1
CO4	3	3	3	3	3	0	0	0	0	2	2	3	3	2
CO5	3	3	2	3	2	0	0	0	0	2	3	3	3	2
CO6	3	3	3	3	3	0	0	0	0	2	3	3	3	2

Course content

1 Data Preprocessing and EDA using Python

Load a dataset and perform basic exploratory data analysis (EDA), including summary statistics, handling missing data, and data visualization.

2 Exploratory Data Analysis on Sports Dataset

Analyse FIFA/World Cup dataset to answer domain-specific questions involving cards, goals, fouls, and shooting accuracy using Python and Pandas.

3 Visualization Techniques for Sales Dataset

Plot line charts, bar charts, stacked/grouped bar plots, and scatter plots to analyse monthly trends in multi-product sales data.

4 Data Warehousing: Create a Star Schema

Design and create a star schema from a given transactional dataset using MySQL/PostgreSQL. Populate fact and dimension tables.

5 OLAP Operations

Perform OLAP operations such as Roll-up, Drill-down, Slice, Dice, and Pivot on a data cube using a warehousing tool or SQL-based OLAP queries.

6 Regression Error Metrics Implementation

Write Python code to calculate SSE, MSE, RMSE, and R^2 Score using actual and predicted values for any regression problem.

7 Regression Modelling using Python (e.g., Linear/Polynomial)

Build a regression model to predict numerical outcomes (e.g., insurance cost). Evaluate the model using error metrics.

8 Decision Tree using ID3 Algorithm

Manually build a decision tree from a small dataset using entropy/gini for splitting and identify the most significant feature.

9 Supervised Learning using Classification Models

Use scikit-learn to train and evaluate classification models (e.g., Decision Tree, Logistic Regression) on the Iris dataset.

10 K-Nearest Neighbours Classification

Implement the KNN algorithm for flower classification (Iris dataset), visualize results, and analyse with a confusion matrix.

11 Clustering using K-Means

Apply K-Means clustering to customer segmentation or product grouping data. Visualize the clusters using scatter plots.

12 Association Rule Mining using Apriori Algorithm

Use market basket data to find frequent item sets and generate strong association rules using the Apriori algorithm in Python.

Reference Books

1. Han, J., Kamber, M., & Pei, J. (2012). **Data Mining: Concepts and Techniques** (3rd ed.). Morgan Kaufmann.
2. Inmon, W. H. (2005). **Building the Data Warehouse** (4th ed.). Wiley Publishing.
3. Pujari, A. K. (2013). **Data Mining Techniques** (3rd ed.). Universities Press.
4. Pang-Ning Tan, Steinbach, M., & Kumar, V. (2019). **Introduction to Data Mining** (2nd ed.). Pearson.
5. Paulraj Ponniah (2010). **Data Warehousing Fundamentals for IT Professionals**. Wiley.
6. Dunham, M. H. (2006). **Data Mining: Introductory and Advanced Topics.** Pearson Education.
7. Singh, S., & Singh, N. (2020). **Data Mining and Warehousing**. Vikas Publishing House.
8. Aggarwal, C. C. (2015). **Data Mining: The Textbook.** Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0603	Scientific Writing and Research Ethics	IDC	2	0	0	2	2

Prerequisite: Basic understanding of research methodology, reading comprehension, and academic writing skills.

Course Objectives

1. To introduce the fundamentals of scientific communication and writing.
2. To enable students to structure and draft research papers, proposals, and thesis effectively.
3. To instil academic integrity and ethical practices in research.
4. To familiarize students with tools for plagiarism detection, referencing, and publishing protocols.

Course outcomes

By the end of the course, the students will be able to:

1. Understand the principles and structure of scientific writing
2. Draft scientific documents such as research papers, thesis, and project reports
3. Apply citation and referencing standards accurately
4. Recognize and follow ethical guidelines in research and publication
5. Avoid plagiarism using appropriate tools and techniques
6. Evaluate ethical considerations in research involving human/animal subjects

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	2	1	3	3	3	2	2	2	2	2	1
CO2	3	3	2	3	2	2	2	2	3	3	2	3	3	2
CO3	2	2	1	2	2	3	3	2	2	3	2	2	2	2
CO4	3	2	2	3	2	3	3	3	3	3	3	3	2	2
CO5	3	3	2	2	2	3	3	3	3	3	2	2	2	2
CO6	3	2	2	3	2	3	3	3	3	3	2	2	3	3

Course content

Unit I: Introduction to Scientific Writing **8 Hours**

Basics of scientific communication; Structure of scientific articles (IMRAD); Writing titles, abstracts, and keywords; Language precision, clarity, and grammar usage; Writing for target audiences and journals

Unit II: Technical Components of Scientific Documents **8 Hours**

Referencing styles (APA, MLA, IEEE, Vancouver), Use of reference managers (Zotero, Mendeley, EndNote); Data presentation: tables, figures, legends; Literature review writing techniques; Tools for spelling, grammar, and plagiarism checking (Grammarly, Turnitin, iThenticate)

Unit III: Research Ethics and Integrity **8 Hours**

Definition and importance of ethics in research; Types of research misconduct (plagiarism, fabrication, falsification); Conflict of interest, authorship issues; Ethical approval: IRB, IACUC, and consent protocols; Patents and copyright issues in publications

Unit IV: Publishing Process and Emerging Issues **8 Hours**

Journal selection and impact factor; Peer review process and editorial decision; Predatory journals and open access publishing; Research data management and reproducibility; Case studies on research fraud and ethical violations

Reference Books

1. Day, R. A., & Gastel, B. (2016). ***How to Write and Publish a Scientific Paper***, 8th Ed., Cambridge University Press.
2. Gopen, G. D., & Swan, J. A. (1990). ***The Science of Scientific Writing***, American Scientist.
3. Kumar, P. (2021). ***Scientific Writing: A Guide to the Art of Writing and Publishing in Peer-Reviewed Journals*****,** Springer.
4. Steneck, N. H. (2007). ***ORI Introduction to the Responsible Conduct of Research***, Office of Research Integrity, U.S. Department of Health & Human Services.
5. ICMR (2017). ***National Ethical Guidelines for Biomedical and Health Research Involving Human Participants***, Indian Council of Medical Research.
6. Resnik, D. B. (2018). ***The Ethics of Research with Human Subjects: Protecting People, Advancing Science, Promoting Trust*****,** Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25PT0601	Soft Skills Training	SEC	1	0	0	1	2

Course Objective

To carry out the academic training towards enhancing co-curricular knowledge

Course Outcomes

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

1. Understand the basic communication skills.
2. Upgrade their knowledge about the career development.
3. Implement the subject specific practical knowledge into career development.
4. Correlate the theoretical and practical understanding.
5. Develop critical thinking skills necessary to evaluate information, make decisions, and innovate within the field.
6. Analyse problems within the scope of the course and apply appropriate solutions.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	1	2	2	0	1	0	3
CO2	3	2	2	3	3	3	3	1	2	2	0	1	0	3
CO3	3	3	1	3	3	3	3	1	2	2	0	1	1	3
CO4	3	3	1	1	1	3	3	1	2	2	1	1	1	3
CO5	2	2	2	2	2	2	2	2	2	2	1	2	1	1
CO6	2	2	2	2	2	2	2	2	2	2	1	2	1	1

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0604	Research Project/ Internship	DSE	0	0	3	3	4

Course Objective

To carry out the academic research towards enhancing research based knowledge

Course outcomes

1. Apply fundamental and disciplinary concepts and methods in ways ap-propriate to their principal areas of study.

2. Demonstrate the skill sets acquired and employ the knowledge of current information in the domain.
3. Design experiment based on the area of research.
4. Apply technological tools and techniques specific to the professional field of study.
5. Acquire real time exposure to the systematic execution of research components and methodology.
6. Describe the statistical procedures in the interpretation of results.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	1	2	2	1	0	3	2
CO2	3	2	2	3	3	3	3	1	2	2	1	0	3	3
CO3	3	3	1	3	3	3	3	1	2	2	1	1	3	3
CO4	3	3	1	1	1	3	3	1	2	2	1	1	3	3
CO5	2	2	2	2	2	2	2	2	2	2	2	1	1	2
CO6	2	2	2	2	2	2	2	2	2	2	2	1	1	2

Bioinformatics Project: Minimum of 12 weeks duration internship / project should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the project programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted by the school.

SEVENTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0701	AI & Deep Learning in Bioinformatics	DSC	3	0	0	3	3

Prerequisite: Students should have prior knowledge of basic bioinformatics, python programming, Machine Learning and Statistics.

Course objectives

1. To introduce advanced concepts of deep learning architectures relevant to bioinformatics.
2. To train students in implementing AI-driven workflows for omics data, protein structures, and systems biology.
3. To develop skills in model interpretation, explainability, and performance optimization.
4. To familiarize students with emerging AI trends in precision medicine, single-cell omics, and biomedical imaging.

Course outcomes

After completing this course, students will be able to:

1. Understand and compare advanced DL architectures like autoencoders, transformers, and GANs for biological datasets.
2. Develop and deploy deep learning models for omics integration, spatial transcriptomics, or image-based phenotyping.
3. Utilize pre-trained models and transfer learning for low-sample-size bioinformatics problems.
4. Analyze, interpret, and visualize deep learning model outputs using explainable AI methods.

5. Solve complex biological problems (multi-omics, drug-target interaction, mutation effect prediction) using end-to-end AI pipelines.
6. Evaluate the ethical, regulatory, and reproducibility challenges associated with AI in biomedical applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	2	3	3	0	0
CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3

Course content

Unit I: Deep Learning Foundations for Bioinformatics **12 Hours**

Introduction to deep learning vs traditional ML; Deep Neural Networks (DNN): architecture, activation functions, optimizers; Regularization techniques: dropout, batch norm, early stopping; High-dimensionality in biological data (gene expression, SNPs); Encoding biological sequences: one-hot, k-mer, embeddings; Data pre-processing strategies for omics and imaging data.

Unit II: Specialized Architectures for Bioinformatics **12 Hours**

Autoencoders and Variational Autoencoders (VAEs) for noise reduction and feature learning; Convolutional Neural Networks (CNNs) for structural and image-based biological data; Recurrent Neural Networks (RNNs), LSTM, GRU for sequence-based data (DNA/RNA/proteins); Graph Neural Networks (GNNs) for PPI networks and pathways; Transformers in bioinformatics: sequence embeddings (e.g., ProtBERT, ESM) and structural prediction.

Unit III: Transfer Learning, Model Interpretation & Explainability **12 Hours**

Transfer learning for low-sample-size biological problems, Hyperparameter tuning and DL model selection, Evaluation metrics: ROC, AUC, F1-score, confusion matrix, specificity, sensitivity, Class imbalance handling in biomedical datasets, Applications: Disease classification, biomarker discovery, variant effect prediction, Integration of multi-omics data using DL

Unit IV: Advanced Applications and AI Ethics in Bioinformatics **12 Hours**

Deep learning in drug-target interaction prediction; DL models for rare variant prediction and single-cell omics; AI in biomarker discovery and personalized genomics; AI for synthetic biology and generative biology; Reproducibility, bias, fairness, and explainability in bioinformatics; AI regulatory guidelines and data privacy (GDPR, HIPAA).

Reference Books

1. Chicco, D. (2021). **Deep Learning in Bioinformatics.** Springer.
2. Goodfellow, I., Bengio, Y., Courville, A. (2016). **Deep Learning.** MIT Press.

3. Zou, J., Huss, M., Abid, A., Mohammadi, P., Torkamani, A., & Telenti, A. (2019). **A primer on deep learning in genomics.** Nature Genetics.
4. Eraslan, G., Avsec, Z., Gagneur, J., & Theis, F. J. (2019). **Deep learning: new computational modeling techniques for genomics.** Nature Reviews Genetics.
5. Witten, I. H., Frank, E., Hall, M. A. (2016). **Data Mining: Practical Machine Learning Tools and Techniques.** Morgan Kaufmann.
6. AlQuraishi, M. (2019). **End-to-End Differentiable Learning of Protein Structure.** Cell Systems.
7. Research articles from **Nature Biotechnology, Bioinformatics (Oxford), Briefings in Bioinformatics, and PLOS Computational Biology.**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0702	Clinical Genomics & Precision Medicine	DSC	3	0	0	3	3

Prerequisite: Students should have prior knowledge on molecular biology and genetics, Familiarity with genomic technologies and bioinformatics tools.

Course objectives

1. To introduce the principles and technologies used in clinical genomics.
2. To understand the role of genomic variation in disease diagnosis, prognosis, and therapy.
3. To explore the integration of genomics in personalized and precision medicine.
4. To interpret genomic data in clinical and translational research settings.

Course outcomes

1. Explain the principles of clinical genomics and their relevance in healthcare.
2. Interpret genomic data for disease association, risk prediction, and diagnosis.
3. Evaluate clinical case studies using genomic approaches in precision medicine.
4. Apply bioinformatics tools to analyse and interpret clinical genomic datasets.
5. Integrate ethical, regulatory, and societal aspects of clinical genomics in healthcare.
6. Communicate findings effectively for translational applications in genomic medicine.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	3	1	2	1	2	2	2	2	1
CO2	3	3	2	2	2	2	1	2	1	3	3	3	3	2
CO3	2	3	3	2	1	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	1	1	1	2	1	3	3	3	3	3
CO5	2	2	2	1	3	3	1	2	1	2	2	2	2	2
CO6	2	2	2	1	2	2	2	3	2	2	2	2	2	2

Course content

Unit I: Introduction to Clinical Genomics **12 Hours**

Overview of Human Genome & Genomic Variation; Role of Genomics in Clinical Practice; Techniques: Microarrays, Whole Genome, Exome, and Targeted Sequencing; Genomic Databases: ClinVar, dbSNP,

HGMD, gnomAD; Bioinformatics Pipelines for Clinical Sequencing; Introduction to Clinical Bioinformatics.

Unit II: Variant Analysis and Interpretation 12 Hours

Variant Calling and Filtering (GATK, bcftools, etc.), Annotation Tools: ANNOVAR, VEP, SnpEff, ACMG Guidelines for Variant Classification, Functional Prediction Tools: SIFT, PolyPhen-2, CADD, Interpretation of Copy Number Variants (CNVs) and Structural Variants; Data Visualization and Clinical Reporting Standards (e.g., VCF, HL7, FHIR).

Unit III: Precision and Personalized Medicine Applications 12 Hours

Introduction to Precision Medicine and its Paradigm Shift; Pharmacogenomics: CYP genes, Warfarin, Clopidogrel, TPMT; Cancer Genomics: Tumour Mutational Burden, MSI, Liquid Biopsy; Rare Disease Genomics and Mendelian Inheritance; Case Studies in Precision Oncology, Infectious Disease, and Inherited Disorders; Gene Panels vs Whole Genome/Exome Approaches.

Unit IV: Ethics, Regulations, and Future Trends (12 Hours)

Data Sharing & Repositories (GA4GH, EGA, dbGaP), Consent, Data Privacy, and Return of Results; Ethical, Legal, and Social Implications (ELSI); Implementation Challenges in Low-Resource Settings; Regulatory Perspectives: FDA, EMA, ICMR Guidelines; Future Directions: Polygenic Risk Scores, AI in Genomics, Multi-omics Integration.

Reference Books:

1. Ginsburg, G. S., & Willard, H. F. (2017). ***Genomic and Precision Medicine: Foundations, Translation, and Implementation*.** Academic Press.
2. Mardis, E. R., & McPherson, J. D. (2021). ***The Human Genome, 3rd Edition*.** Elsevier.
3. Lesko, L. J**.** (2014). ***Personalized and Precision Medicine: The Future of Individualized Healthcare***. CRC Press.
4. Shen, B. (2022). ***Clinical Bioinformatics*.** Springer.
5. Lio, P., & Di Cunto, F. (2019). ***Introduction to Genomics and Precision Medicine*.** Cambridge University Press.
6. Ashley, E. A. (2015). ***The Precision Medicine Revolution: How Genetic Testing and Digital Health Are Changing the Way We Treat Disease*.** Harper Business.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0703	Computational Systems Biology	DSC	3	0	0	3	3

Prerequisite: Students should have knowledge on Molecular Biology, Biochemistry, and Cell Biology, Basic Programming (Python/R)

Course objectives

1. Understand biological systems as integrated and interacting networks of genes, proteins, and biochemical reactions.

2. Apply mathematical modeling and computational tools to analyse biological systems.
3. Explore dynamic behaviours, network motifs, and emergent properties in cellular systems.
4. Use systems-level approaches to investigate diseases, drug response, and synthetic biology.

Course outcomes

After successful completion, students will be able to:

1. Describe key concepts and applications in systems biology.
2. Apply network-based methods to analyse biological interaction networks.
3. Build and simulate mathematical models of metabolic and signalling pathways.
4. Interpret omics data using integrative and systems-level approaches.
5. Use computational tools to analyse systems-level behaviour in biological systems.
6. Evaluate and critique published systems biology studies and models.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	2	1	2	2	2	2	2
CO2	3	3	3	3	1	1	1	2	1	2	3	3	3	2
CO3	3	3	3	3	2	1	2	2	2	2	2	3	3	3
CO4	3	3	2	3	2	1	1	2	2	3	3	3	3	3
CO5	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO6	3	2	3	2	1	2	2	3	2	3	3	2	3	2

Course content

Unit 1: Introduction to Systems Biology and Modeling Approaches 12 hours

Introduction to Systems Biology, Principles and goals of systems biology, Biological networks: metabolic, gene regulatory, and signalling networks, Data types: transcriptomics, proteomics, metabolomics, Deterministic vs stochastic modeling, Ordinary Differential Equations (ODEs) for biochemical systems, Case study: Lac operon and toggle switch

Unit 2: Network Biology and Topological Analysis 12 hours

Types of biological networks: PPI, gene regulatory, co-expression networks; Graph theory basics: nodes, edges, degree, centrality, clustering coefficient; Network motifs and modules; Tools: Cytoscape, STRING, Gephi; Pathway databases: KEGG, Reactome, BioCyc

Unit 3: Dynamic Modeling and Simulation 12 hours

Enzyme kinetics and Michaelis-Menten equations; Simulation techniques: time-course analysis, parameter sensitivity; Boolean and Bayesian network models; Agent-based modeling; Tools: COPASI, CellDesigner, SBML, MATLAB SimBiology

Unit 4: Applications and Integrative Omics 12 hours

Disease modeling (cancer, metabolic disorders); Drug target identification using systems approaches; Multi-omics integration strategies; Synthetic biology: gene circuits and pathway design; Personalized and precision medicine using systems biology; Case studies and project presentations

Textbooks / Reference Books

1. **Alon, U. (2007)**. *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman & Hall/CRC.
2. **Klipp, E. et al. (2016)**. *Systems Biology: A Textbook* (2nd Edition). Wiley-Blackwell.
3. **Kitano, H. (2002)**. *Foundations of Systems Biology*. MIT Press.
4. **Palsson, B. Ø. (2015)**. *Systems Biology: Constraint-Based Reconstruction and Analysis*. Cambridge University Press.
5. **Kriete, A. & Eils, R. (2006)**. *Computational Systems Biology*. Academic Press.
6. **David Fell (2000)**. *Understanding the Control of Metabolism*. Portland Press.
7. **Voit, E.O. (2012)**. *A First Course in Systems Biology*. Garland Science.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS711	Machine learning in Bioinformatics	DSE	3	0	0	3	3

Prerequisite:

Basic knowledge of biology and bioinformatics

Programming proficiency (Python/R recommended)

Fundamentals of statistics and probability

Introductory machine learning concepts

Course objectives

1. To understand the foundational principles of machine learning and its relevance to bioinformatics.
2. To explore supervised, unsupervised, and deep learning methods in biological data analysis.
3. To apply ML algorithms for genomics, proteomics, and systems biology.
4. To critically evaluate and validate machine learning models for biological predictions.

Course outcomes

By the end of this course, students will be able to:

1. Explain core machine learning concepts and algorithms used in bioinformatics.
2. Apply supervised and unsupervised learning methods to biological datasets.
3. Use deep learning tools to interpret omics data (DNA, RNA, proteins).
4. Evaluate the performance of predictive models in biomedical informatics.
5. Develop end-to-end ML pipelines for applications in precision medicine and biomarker discovery.
6. Interpret ML-driven outputs for biological insights and decision-making.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	3	1	1	1	2	1	2	3	3	2	2
CO2	3	3	2	3	1	1	1	2	1	2	3	3	3	2
CO3	2	2	3	3	1	1	1	2	1	2	3	3	3	3
CO4	2	3	3	3	1	2	1	3	2	3	3	2	3	3
CO5	3	3	2	3	2	2	2	3	3	3	3	3	3	3
CO6	2	2	3	3	2	2	2	3	2	3	3	2	3	3

Course content

Unit 1: Foundations of Machine Learning **12 Hours**

Introduction to ML in bioinformatics; Types of learning: Supervised, Unsupervised, Reinforcement; Biological data characteristics and preprocessing; Feature selection and dimensionality reduction techniques; Overfitting, bias-variance trade-off, cross-validation; Tools and platforms (Python scikit-learn, TensorFlow basics)

Unit 2: Supervised Learning Applications **12 Hours**

Regression models: Linear, Logistic, Ridge, Lasso; Classification: Decision Trees, Random Forest, SVM, Naive Bayes; Case studies: Gene expression classification, disease prediction; Model evaluation: ROC, AUC, Confusion matrix, F1-score

Unit 3: Unsupervised and Deep Learning **12 Hours**

Clustering: K-means, Hierarchical clustering, DBSCAN; Dimensionality reduction: PCA, t-SNE, UMAP; Deep learning introduction: ANN, CNN, RNN; Applications in NGS, proteomics, and biomedical imaging; Autoencoders and representation learning in genomics

Unit 4: Integrated ML Pipelines in Bioinformatics **12 Hours**

ML for biomarker discovery and drug response prediction; Applications in personalized medicine, metagenomics, and systems biology; Reproducibility and model interpretability in bioinformatics; ML in clinical bioinformatics: diagnostics and prognosis; Building end-to-end workflows using Python, Jupyter, and ML platforms; Ethical considerations and limitations of ML in life sciences.

Reference Books & Resources

1. Eraslan, G., et al. (2019). **Deep learning: new computational modelling techniques for genomics**. *Nature Reviews Genetics*.
2. Bishop, C. M. (2006). ***Pattern Recognition and Machine Learning***. Springer.
3. Kelleher, J., Mac Namee, B., & D'Arcy, A. (2020). ***Fundamentals of Machine Learning for Predictive Data Analytics*.** MIT Press.
4. Libbrecht, M. W., & Noble, W. S. (2015). **Machine learning applications in genetics and genomics**. *Nature Reviews Genetics*.
5. Leskovec, J., Rajaraman, A., & Ullman, J. D. (2020). ***Mining of Massive Datasets*.** Cambridge University Press.
6. **Practical Machine Learning for Genomics using Python/R Tutorials** – Bioinformatics-focused MOOCs (Coursera, edX)

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS712	Entrepreneurship in Life Sciences	DSE	3	0	0	3	3

Prerequisite:

Basic understanding of life sciences, biotechnology, and research methodology. Awareness of innovation and fundamental business concepts is recommended.

Course Objectives:

1. To introduce the concepts and significance of entrepreneurship in the context of life sciences and biotechnology.
2. To understand the lifecycle of life science startups from ideation to market.
3. To explore regulatory, ethical, IP, and funding landscapes relevant to life science ventures.
4. To develop skills in business planning, market analysis, and investor pitching for Bioentrepreneurship.

Course outcomes

Upon successful completion of this course, students will be able to:

1. Explain the fundamentals of entrepreneurship and its relevance in the life sciences sector.
2. Identify and evaluate business opportunities in biotechnology, healthcare, and diagnostics.
3. Develop a business model and prepare a business plan for a life science startup.
4. Demonstrate knowledge of funding mechanisms, IP protection, and regulatory frameworks.
5. Analyze successful case studies and challenges of Bioentrepreneurship in real-world contexts.
6. Exhibit the ability to work in teams and communicate effectively in a business context.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	3	1	2	2	2	3	1	2	2
CO2	2	3	3	2	2	3	2	2	3	2	3	3	2	3
CO3	3	2	3	3	2	2	3	2	3	3	2	3	2	3
CO4	2	2	3	3	3	3	1	2	2	2	3	2	3	2
CO5	2	3	3	2	3	2	2	2	3	2	3	2	2	3
CO6	1	1	2	2	1	2	3	3	3	3	3	1	2	2

Course content

Unit 1: Foundations of Entrepreneurship in Life Sciences **12 Hours**

Introduction to Entrepreneurship: Definitions, types, and myths; Role of entrepreneurship in biotechnology and healthcare; Bioentrepreneurship: Scope, trends, and global perspectives; Traits of successful entrepreneurs; ideation and innovation; Business models in life sciences: B2B, B2C, licensing, and spin-offs; Institutional support: DBT-BIRAC, Startup India, Atal Innovation Mission, DST, and incubators.

Unit 2: Market Research, Business Planning, and Financials **12 Hours**

Opportunity recognition in diagnostics, therapeutics, agri-biotech, and bioproducts; Market segmentation, customer discovery, and competitor analysis; Designing value propositions and MVPs (Minimum Viable Products); Components of a business plan: Executive summary to financial projections; Introduction to budgeting, costing, and revenue models; Risk analysis and contingency planning

Unit 3: Regulatory, Legal, and IP Frameworks **12 Hours**

Regulatory landscape: CDSCO, ICMR, DCGI, FDA, EMA basics; Ethics in biotechnology: Clinical trials, biosafety, data sharing; Intellectual Property Rights (IPR): Patents, copyrights, trademarks, and trade secrets;

IP protection in life sciences: Patent search and filing (national/international); Licensing models, technology transfer, and MoUs; Case study: IP strategy of a biotech startup

Unit 4: Funding, Incubation, and Startup Launch **12 Hours**

Funding lifecycle: Seed, angel, venture capital, and grants; Pitch deck essentials and elevator pitching techniques; Role of incubators, accelerators, and co-working spaces; Government schemes: BIRAC BIG, NIDHI PRAYAS, TIDE, SEED Fund; Scaling strategies, branding, and customer acquisition; Case studies of Indian and global life science startups

Reference Books / Resources:

1. Kuratko, D. F. (2016). ***Entrepreneurship: Theory, Process, Practice*.** Cengage Learning.
2. Hisrich, R. D., Peters, M. P., & Shepherd, D. A. (2019). ***Entrepreneurship*.** McGraw-Hill Education.
3. Timmons, J. A., & Spinelli, S. (2009). ***New Venture Creation: Entrepreneurship for the 21st Century***. McGraw-Hill.
4. BIRAC (2021). ***Bio-Entrepreneurship: Innovation and Commercialization Manual*.** Govt. of India.
5. Johnson, A. C. (2014). ***Life Science Ventures: The Science of Entrepreneurship*.** Elsevier.
6. Rao, C. A. (2018). ***Biotech Primer*.** BioTech Primer Inc.
7. OECD. (2009). ***Biotechnology Statistics*.** Organisation for Economic Co-operation and Development.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS713	Biomedical Text Mining & NLP	DSE	2	0	0	2	2

Prerequisite:

Basic understanding of molecular biology, biostatistics, and programming (preferably Python); foundational knowledge in bioinformatics.

Course Objectives

1. To introduce the fundamental concepts of biomedical text mining and NLP.
2. To familiarize students with biomedical ontologies, terminologies, and literature databases.
3. To apply NLP techniques to extract, annotate, and analyze biomedical literature and clinical narratives.
4. To explore real-world applications of NLP in biomedical research, drug discovery, and clinical decision support.

Course outcomes

At the end of the course, students will be able to:

1. Understand the structure and characteristics of biomedical text data.
2. Apply information retrieval and NLP tools for mining biomedical literature.
3. Design named entity recognition (NER) and relation extraction pipelines for biomedical data.
4. Utilize biomedical ontologies and controlled vocabularies (e.g., MeSH, UMLS).
5. Analyze and interpret biomedical datasets using NLP-based techniques.
6. Evaluate ethical and practical issues in clinical NLP applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	2	3	3	0	0
CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3

Course content

Unit 1: Introduction to Biomedical Text Mining **8 Hours**

Overview of Biomedical Text Mining & NLP; Biomedical literature databases (PubMed, PMC, Medline); Biomedical ontologies and controlled vocabularies: MeSH, SNOMED CT, UMLS, Gene Ontology; Document preprocessing: Tokenization, stemming, lemmatization; Part-of-speech tagging and parsing

Unit 2: Information Retrieval and Named Entity Recognition (NER) **8 Hours**

Information retrieval in biomedical domain; Indexing, TF-IDF, word embeddings (Word2Vec, BioWordVec); Named Entity Recognition (NER): genes, diseases, drugs, proteins; Biomedical-specific NER tools: MetaMap, cTAKES, SciSpacy, PubTator; Evaluation metrics: Precision, recall, F1-score

Unit 3: Relation Extraction and Semantic Analysis **8 Hours**

Relation extraction techniques: rule-based, machine learning, deep learning; Co-occurrence, dependency parsing, and syntactic pattern matching; Relation extraction tools and frameworks: BioBERT, BioNLP Shared Tasks; Semantic similarity and ontology-based text mining; Biomedical QA systems and text summarization

Unit 4: Applications and Challenges in Biomedical NLP **8 Hours**

Clinical text mining: EHR, discharge summaries, clinical notes; Biomedical knowledge graphs and entity linking; NLP in pharmacovigilance and drug repurposing; Challenges: ambiguity, abbreviations, multilingual data; Ethical concerns in clinical NLP (privacy, fairness, bias).

Reference Books

1. **Cohen, K. B., & Demner-Fushman, D.** (2014). *Biomedical Natural Language Processing*. John Benjamins Publishing.
2. **Zeng, Q. T.** (2020). *Text Mining for Biomedical Informatics*. World Scientific.
3. **Kulikowski, C. A.** (2021). *Clinical Natural Language Processing*. Springer.
4. **Jiang, M. et al.** (2022). *Deep Learning in Biomedical Natural Language Processing*. Springer.
5. **Hirschberg, J., & Manning, C. D.** (2015). *Advances in Natural Language Processing*. Science, 349(6245), 261-266.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS714	Immunoinformatics	DSE	2	0	0	2	2

Prerequisite: Basic knowledge of immunology, molecular biology, and bioinformatics tools.

Course Objectives:

1. To introduce the principles of Immunoinformatics and its role in computational immunology.
2. To explore databases, algorithms, and software tools used for epitope prediction and vaccine design.
3. To equip students with skills to analyse immunological data for applications like vaccine development and immune system modeling.
4. To understand immunogenomics and the use of machine learning in predicting immune responses.

Course Outcomes

1. Explain the fundamentals of Immunoinformatics and its relevance to immune system research.
2. Identify and retrieve immunological data from databases.
3. Predict B-cell and T-cell epitopes using computational tools.
4. Design peptide-based vaccines using immunoinformatics approaches.
5. Analyze MHC binding affinity and immunogenicity using predictive models.
6. Apply machine learning and structural bioinformatics to immune receptor modeling and interaction analysis.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	2	1	1	1	1	2	2	2	3	2	2
CO2	3	3	2	3	2	1	1	1	2	2	1	3	2	2
CO3	3	3	3	3	2	1	1	1	2	3	2	3	3	3
CO4	3	3	3	3	3	2	1	2	2	2	2	3	3	3
CO5	3	3	2	3	2	2	1	2	2	2	2	3	3	3
CO6	3	3	3	3	3	2	1	1	3	3	3	3	3	3

Course content

Unit I: Introduction to Immunoinformatics and Databases 8 Hours

Overview of immune system and molecular immunology; Role of bioinformatics in immunology; Introduction to major Immunoinformatics databases: IEDB (Immune Epitope Database), IMGT (International ImMunoGeneTics Information System), VDJdb, TCRdb, Epitope Atlas, Data formats and curation in immunological data

Unit II: Epitope Prediction and MHC Binding 8 hours

Antigenicity and immunogenicity; B-cell epitope prediction (linear and conformational); Tools: BepiPred, ABCPred; T-cell epitope prediction: MHC Class I and II binding prediction, Tools: NetMHCpan, NetCTL, MHCflurry; Cross-reactivity and allergenicity prediction

Unit III: Vaccine Design and Immune Simulation 8 Hours

Peptide and subunit vaccine design; Multi-epitope vaccine strategies; Population coverage analysis; Linker design and adjuvants; Immune response simulation using C-ImmSim; Reverse vaccinology approaches.

Unit IV: Structural Immunoinformatics and ML Applications 8 Hours

TCR-peptide-MHC structural modeling (Pymol, Chimera); Docking and binding affinity prediction (AutoDock, HADDOCK); Machine learning in Immunoinformatics: data preparation, model development; Deep learning for epitope discovery and immune repertoire analysis; Case studies: COVID-19, cancer immunotherapy, neoantigen discovery

Reference Books & Resources

1. **Flower, D.R.** (2008). *Bioinformatics for Vaccinology*. Wiley-Blackwell.
2. **Tomar, N. & De, R.K.** (2010). Immunoinformatics: *A Brief Review*. J. Proteomics & Bioinformatics.
3. **Kringelum, J.V. et al.** (2012). *Reliable B cell epitope predictions: impacts of method development and improved benchmarking*. Molecular Immunology.
4. **Brusic, V. et al.** (2007). *Computational Immunology: Current State and Future Challenges*. Briefings in Bioinformatics.
5. IEDB: https://www.iedb.org
6. IMGT: https://www.imgt.org

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0704	Lab: AI & Deep in Bioinformatics	DSC	0	0	2	2	3

Prerequisite: Basics of Python programming, molecular biology, and fundamentals of machine learning.

Course Objectives:

1. To provide hands-on training in applying AI and deep learning tools to biological datasets.
2. To enable implementation of supervised and unsupervised learning algorithms on omics data.
3. To build neural network models using real-life genomics, proteomics, and transcriptomics datasets.
4. To familiarize students with AI frameworks like TensorFlow, Keras, and scikit-learn in bioinformatics applications.

Course outcomes

After completing this course, students will be able to:

1. Understand and compare advanced DL architectures like autoencoders, transformers, and GANs for biological datasets.
2. Develop and deploy deep learning models for omics integration, spatial transcriptomics, or image-based phenotyping.
3. Utilize pre-trained models and transfer learning for low-sample-size bioinformatics problems.
4. Analyze, interpret, and visualize deep learning model outputs using explainable AI methods.
5. Solve complex biological problems (multi-omics, drug-target interaction, mutation effect prediction) using end-to-end AI pipelines.
6. Evaluate the ethical, regulatory, and reproducibility challenges associated with AI in biomedical applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	0	0	0	0	0	0	2	3	3	0	0

CO2	2	3	2	3	0	0	0	0	0	0	2	3	3	2
CO3	2	3		3	0	0	0	0	2	3	3	3	3	3
CO4	1	2	2	3	0	2	0	2	0	3	3	2	3	3
CO5	3	3	3	3	2	2	2	3	3	3	3	3	3	3
CO6	0	0	0	0	3	3	2	2	0	3	3	0	0	3

Course content

S. No.	List of Experiments	Objectives	Tools / Software / Databases
1	Biological Sequence Encoding and Visualization	Understand and apply encoding techniques for DNA/protein sequences and visualize them	Python, Biopython, Matplotlib, Seaborn, FASTA files, UniProt
2	Gene Expression Data Preprocessing	Normalize and preprocess gene expression data for downstream deep learning tasks	GEO datasets, Python (Pandas, NumPy), scikit-learn, R (optional)
3	Deep Neural Network (DNN) for Cancer Type Classification	Build a basic DNN model for classifying cancer types based on expression profiles	Keras/TensorFlow, TCGA datasets, Python
4	Autoencoders for Dimensionality Reduction	Implement autoencoders to reduce dimensions of high-throughput gene expression data	Keras, Python, GEO datasets
5	CNN for Microscopy or Histopathological Image Classification	Classify biomedical images using CNNs	Keras, OpenCV, BioImage Archive, Kaggle datasets (Histopathology)
6	RNN/LSTM for DNA Sequence Classification	Sequence modeling and classification of DNA/RNA using RNN or LSTM	TensorFlow/Keras, Biopython, NCBI datasets
7	Graph Neural Networks for Protein Interaction Networks	Model and predict PPI using GNNs	PyTorch Geometric, STRING, IntAct, NetworkX
8	Transfer Learning with Pretrained Models (ProtBERT/ESM)	Use pretrained transformer models for protein function prediction	HuggingFace Transformers, ProtTrans, UniProt
9	Deep Learning for Disease Biomarker Discovery	Identify candidate genes or proteins predictive of disease using deep learning	GEO, DESeq2 (R), TensorFlow/Keras, feature selection techniques
10	Model Explainability and Ethics Evaluation	Apply interpretability tools (SHAP/LIME) and discuss AI ethics in biomedical applications	SHAP, LIME, Python, Case studies on AI bias and biomedical ethics

Reference Books

1. Chicco, D. (2021). **Deep Learning in Bioinformatics.** Springer.
2. Goodfellow, I., Bengio, Y., Courville, A. (2016). **Deep Learning.** MIT Press.
3. Zou, J., Huss, M., Abid, A., Mohammadi, P., Torkamani, A., & Telenti, A. (2019). **A primer on deep learning in genomics.** Nature Genetics.
4. Eraslan, G., Avsec, Z., Gagneur, J., & Theis, F. J. (2019). **Deep learning: new computational modeling techniques for genomics.** Nature Reviews Genetics.
5. Witten, I. H., Frank, E., Hall, M. A. (2016). **Data Mining: Practical Machine Learning Tools and Techniques.** Morgan Kaufmann.
6. AlQuraishi, M. (2019). **End-to-End Differentiable Learning of Protein Structure.** Cell Systems.
7. Research articles from **Nature Biotechnology, Bioinformatics (Oxford), Briefings in Bioinformatics, and PLOS Computational Biology.**

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0705	Lab: Clinical Genomics & Precision Medicine	DSC	0	0	2	2	3

Prerequisite: Students should have prior knowledge on molecular biology and genetics, Familiarity with genomic technologies and bioinformatics tools.

Course objectives

1. To introduce the principles and technologies used in clinical genomics.
2. To understand the role of genomic variation in disease diagnosis, prognosis, and therapy.
3. To explore the integration of genomics in personalized and precision medicine.
4. To interpret genomic data in clinical and translational research settings.

Course outcomes

1. Explain the principles of clinical genomics and their relevance in healthcare.
2. Interpret genomic data for disease association, risk prediction, and diagnosis.
3. Evaluate clinical case studies using genomic approaches in precision medicine.
4. Apply bioinformatics tools to analyse and interpret clinical genomic datasets.
5. Integrate ethical, regulatory, and societal aspects of clinical genomics in healthcare.
6. Communicate findings effectively for translational applications in genomic medicine.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	2	3	1	2	1	2	2	2	2	1
CO2	3	3	2	2	2	2	1	2	1	3	3	3	3	2
CO3	2	3	3	2	1	2	2	2	2	3	3	3	3	3
CO4	3	3	3	3	1	1	1	2	1	3	3	3	3	3
CO5	2	2	2	1	3	3	1	2	1	2	2	2	2	2
CO6	2	2	2	1	2	2	2	3	2	2	2	2	2	2

Course content

S. No.	List of Experiments	Objectives	Tools / Software / Databases

1	Retrieval and Annotation of Disease-Associated Genes	Identify and annotate clinically relevant genes linked to a specific disease	OMIM, DisGeNET, Gene Cards, Ensembl, UCSC Genome Browser
2	Variant Calling from Whole Genome/Exome Sequencing Data	Perform variant detection from sequencing reads	NCBI SRA, BWA, SAMtools, GATK
3	Functional Annotation of Variants (SNPs/Indels)	Interpret functional effects of genetic variants	ANNOVAR, Ensembl VEP, SnpEff
4	Pathogenicity Prediction of Variants	Predict the clinical significance of mutations	PolyPhen-2, SIFT, ClinVar, CADD
5	Pharmacogenomics Analysis for Personalized Drug Response	Study gene-drug interactions and assess individual drug responses	PharmGKB, DrugBank, CPIC, DGIdb
6	HLA Typing and Immunogenomics Analysis	Perform HLA typing and its relevance in immunotherapy	OptiType, NetMHC, IMGT/HLA
7	Cancer Genomics: Mutation Analysis in TCGA Data	Analyze somatic mutations and gene expression in cancer patients	cBioPortal, Firebrowse, Xena Browser
8	RNA-Seq Data Analysis for Biomarker Discovery	Analyze differential expression and identify diagnostic/prognostic biomarkers	GEO, STAR, DESeq2, edgeR, Galaxy
9	Clinical Variant Interpretation using ACMG Guidelines	Classify variants according to ACMG standards	InterVar, VarSome, ClinGen
10	Multi-Omics Data Integration for Precision Medicine	Integrate genomics, transcriptomics, and proteomics to inform personalized therapies	iClusterPlus, TCGAbiolinks, Cytoscape

Reference Books:

1. Ginsburg, G. S., & Willard, H. F. (2017). ***Genomic and Precision Medicine: Foundations, Translation, and Implementation*.** Academic Press.
2. Mardis, E. R., & McPherson, J. D. (2021). ***The Human Genome, 3rd Edition*.** Elsevier.
3. Lesko, L. J**.** (2014). ***Personalized and Precision Medicine: The Future of Individualized Healthcare***. CRC Press.
4. Shen, B. (2022). ***Clinical Bioinformatics*.** Springer.
5. Lio, P., & Di Cunto, F. (2019). ***Introduction to Genomics and Precision Medicine*.** Cambridge University Press.
6. Ashley, E. A. (2015). ***The Precision Medicine Revolution: How Genetic Testing and Digital Health Are Changing the Way We Treat Disease*.** Harper Business.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.

B25BI0706	Lab: Computational Systems Biology	DSC	0	0	2	2	3

Prerequisite: Students should have knowledge on Molecular Biology, Biochemistry, and Cell Biology, Basic Programming (Python/R)

Course objectives

1. Understand biological systems as integrated and interacting networks of genes, proteins, and biochemical reactions.
2. Apply mathematical modeling and computational tools to analyse biological systems.
3. Explore dynamic behaviours, network motifs, and emergent properties in cellular systems.
4. Use systems-level approaches to investigate diseases, drug response, and synthetic biology.

Course outcomes

After successful completion, students will be able to:

1. Describe key concepts and applications in systems biology.
2. Apply network-based methods to analyse biological interaction networks.
3. Build and simulate mathematical models of metabolic and signalling pathways.
4. Interpret omics data using integrative and systems-level approaches.
5. Use computational tools to analyse systems-level behaviour in biological systems.
6. Evaluate and critique published systems biology studies and models.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	2	1	1	1	1	2	1	2	2	2	2	2
CO2	3	3	3	3	1	1	1	2	1	2	3	3	3	2
CO3	3	3	3	3	2	1	2	2	2	2	2	3	3	3
CO4	3	3	2	3	2	1	1	2	2	3	3	3	3	3
CO5	3	3	3	3	1	1	2	2	1	2	2	3	3	3
CO6	3	2	3	2	1	2	2	3	2	3	3	2	3	2

Course content

S. No.	List of Experiments	Objectives	Tools / Software / Databases
1	Network Construction from Protein-Protein Interaction (PPI) Data	Build and visualize interaction networks between proteins	STRING, Cytoscape, BioGRID
2	Gene Regulatory Network (GRN) Reconstruction	Model and analyze transcriptional regulation	ARACNe, GeNIE, GENIE3
3	Metabolic Pathway Reconstruction and Visualization	Map genes to pathways and simulate metabolic flux	KEGG Mapper, PathVisio, MetExplore
4	Boolean Modeling of Gene Regulatory Circuits	Understand binary gene regulation and attractor dynamics	GINsim, BoolNet (R), CellNetAnalyzer

5	Dynamic Simulation of Biological Systems (ODE-based)	Simulate time-course behavior of molecular species	COPASI, BioModels, MATLAB SimBiology
6	Pathway Enrichment and Impact Analysis	Analyze omics data for pathway enrichment	DAVID, Reactome, GSEA, Enrichr
7	Co-expression Network Analysis	Identify gene modules and hub genes from transcriptomic data	WGCNA (R), Cytoscape, GEO
8	Multi-Omics Data Integration and Network Construction	Integrate transcriptomics, proteomics, and metabolomics into networks	OmicsNet, NetworkAnalyst, Cytoscape
9	Constraint-Based Metabolic Modeling (Flux Balance Analysis)	Simulate and optimize metabolic fluxes under genetic or environmental constraints	COBRA Toolbox (MATLAB/Python), Escher, BIGG Models
10	In Silico Knockout Simulation and Target Identification	Predict essential genes/reactions for metabolic engineering or drug target identification	COBRApy, CellNetAnalyzer, OptFlux

Textbooks / Reference Books

1. **Alon, U. (2007)**. *An Introduction to Systems Biology: Design Principles of Biological Circuits*. Chapman & Hall/CRC.
2. **Klipp, E. et al. (2016)**. *Systems Biology: A Textbook* (2nd Edition). Wiley-Blackwell.
3. **Kitano, H. (2002)**. *Foundations of Systems Biology*. MIT Press.
4. **Palsson, B. Ø. (2015)**. *Systems Biology: Constraint-Based Reconstruction and Analysis*. Cambridge University Press.
5. **Kriete, A. & Eils, R. (2006)**. *Computational Systems Biology*. Academic Press.
6. **David Fell (2000)**. *Understanding the Control of Metabolism*. Portland Press.
7. **Voit, E.O. (2012)**. *A First Course in Systems Biology*. Garland Science.

EIGHTH SEMESTER

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0801	Comparative Genomics	DSC	2	0	0	2	3

Prerequisite:

Basic understanding of molecular biology, genomics, and bioinformatics. Familiarity with genome annotation, sequence alignment, and biological databases is recommended.

Course Objectives

1. To introduce the principles and methods used in comparing genomes across species.
2. To understand genome evolution and functional annotation through comparative approaches.
3. To apply computational tools for genome alignment, orthology detection, and phylogenetic analysis.

4. To explore applications of comparative genomics in disease gene identification, evolutionary biology, and functional genomics.

Course Outcomes

By the end of the course, students will be able to:

1. Understand the theoretical foundations of comparative genomics.
2. Perform genome alignments and identify conserved and divergent regions.
3. Analyze orthologs, paralogs, synteny, and gene families across species.
4. Use comparative genomics for functional annotation and evolutionary inference.
5. Apply comparative genomics in disease gene mapping and functional studies.
6. Utilize tools and databases such as Ensembl, UCSC Genome Browser, OrthoDB, and Genomicus.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	1	2	2	1	2	2	3	2	1
CO2	3	3	3	3	2	1	1	2	1	1	2	3	2	2
CO3	3	3	3	3	3	1	2	2	2	2	2	3	3	2
CO4	3	2	2	3	3	2	1	2	1	1	2	3	3	2
CO5	3	3	3	3	2	2	2	2	2	1	2	3	3	2
CO6	3	3	3	3	3	2	2	2	2	1	2	3	3	3

Course Content

Unit I: Introduction to Comparative Genomics **12 Hours**

Definition and scope of comparative genomics; Types of genome comparisons: pairwise, multiple species; Genome organization across domains of life; Synteny, gene order conservation; Overview of genome annotation and re-annotation strategies. **Tools/Databases**: Ensembl, NCBI Genome, OrthoDB

Unit II: Genome Alignment and Orthology **12 Hours**

Whole genome and local alignment strategies; Global vs local alignments; Genome alignment tools: Mauve, MUMmer, LASTZ; Orthology detection methods: Reciprocal BLAST, InParanoid, OrthoFinder; Clustering orthologs and paralogs; Evaluation of gene family evolution. **Tools/Databases**: MAUVE, OrthoFinder, OMA.

Unit III: Functional Inference and Evolution **12 Hours**

Functional annotation via comparative genomics; Conserved noncoding elements and regulatory regions; Evolution of gene structure and content; Gene duplication and loss; Horizontal gene transfer; Phylogenomic approaches and species tree reconstruction; **Tools/Databases**: UCSC Genome Browser, Genomicus, PhyloP, PhastCons

Unit IV: Applications in Biomedical Research **12 Hours**

Comparative genomics in disease gene identification; Pathogen genome comparison; Human-mouse and human-primates genome comparisons; Personalized medicine and genome variation; Comparative metagenomics; Case studies: ENCODE, 1000 Genomes Project, GTEx; **Tools/Databases**: Ensembl Compara, 1000 Genomes, ClinVar, PANTHER

Recommended Reference Books

1. Brown, T. A. (2016). *Genomes 4*. Garland Science.
2. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*, 3rd Ed. Wiley-Blackwell.
3. Apostolico, A., & Guerra, C. (2000). ***Computational Methods in Comparative Genomics.*** Springer.
4. Mount, D. W. (2004). ***Bioinformatics: Sequence and Genome Analysis.*** Cold Spring Harbor Laboratory Press.
5. Lesk, A. M. (2012). ***Introduction to Genomics*****,** 2nd Ed. Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0802	Molecular Diagnostics	DSC	2	0	0	2	3

Prerequisite: Basic knowledge of molecular biology, genetics, and microbiology

Understanding of nucleic acid structure and function

Fundamentals of biotechnology and laboratory techniques

Course Objectives

1. To provide fundamental and applied knowledge of molecular techniques used in disease diagnosis.
2. To familiarize students with nucleic acid-based diagnostics and probe-based detection systems.
3. To train students in the principles and applications of PCR, microarrays, and sequencing in clinical diagnostics.
4. To explore the regulatory, ethical, and quality control issues in molecular diagnostics.

Course outcomes

1. Understand the principles and scope of molecular diagnostics in healthcare.
2. Describe various nucleic acid-based detection methods including PCR and hybridization.
3. Apply molecular techniques for the diagnosis of infectious and genetic diseases.
4. Interpret results from real-time PCR, DNA microarrays, and sequencing platforms.
5. Analyze the use of molecular diagnostics in personalized medicine and cancer genomics.
6. Evaluate quality control, biosafety, and regulatory practices in molecular diagnostics labs.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	0	0	0	2	1	2	2	2	2	2
CO2	3	3	2	2	2	0	0	1	1	2	2	3	3	2
CO3	3	3	3	3	3	1	0	1	2	2	3	3	3	3
CO4	3	3	3	3	3	0	0	2	2	3	3	3	3	3
CO5	3	3	2	3	2	3	2	2	2	3	3	3	3	3
CO6	3	3	2	3	3	3	2	3	2	3	3	3	3	3

Course Content

Unit 1: Introduction to Molecular Diagnostics **12 Hours**

History and evolution of molecular diagnostics; Overview of infectious and genetic diseases; Advantages of molecular diagnostics over conventional diagnostics; Biomarkers: DNA, RNA, and protein markers; Basic tools in molecular diagnostics: electrophoresis, blotting, centrifugation

Unit 2: Nucleic Acid-Based Techniques **12 Hours**

DNA/RNA extraction and purification techniques; Probe-based detection: Southern, Northern blotting, FISH; Polymerase Chain Reaction (PCR): conventional, nested, multiplex; Real-Time PCR (qPCR), RT-PCR and droplet digital PCR (ddPCR); Isothermal amplification methods: LAMP, NASBA.

Unit 3: Advanced Diagnostic Technologies **12 Hours**

Microarrays and lab-on-chip technologies; CRISPR-based diagnostics (e.g., SHERLOCK, DETECTR); Next-Generation Sequencing (NGS) in diagnostics; Point-of-care diagnostics; Applications in prenatal screening, oncology, and infectious diseases

Unit 4: Quality Assurance and Clinical Applications **12 Hours**

Quality control in molecular diagnostic laboratories; Regulatory compliance: FDA, CE-IVD, CLIA; Biosafety levels and practices; Personalized medicine and pharmacogenomics; Ethical, legal, and social implications (ELSI) of molecular diagnostics.

Reference Books

1. Bruns, D. E., Ashwood, E. R., & Burtis, C. A. (2022). ***Fundamentals of Molecular Diagnostics*** (2nd Edition). Elsevier.
2. Coleman, W. B., & Tsongalis, G. J. (2016). ***Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*****.** Springer.
3. Patrinos, G. P., Ansorge, W., & Danielson, P. B. (2021). ***Molecular Diagnostics*** (2nd Edition). Academic Press (Elsevier).
4. Kim, Y. J., & Park, W. J. (2020). ***Clinical Molecular Medicine: Principles and Practice***. Academic Press.
5. Tietz, N. W. (2012). ***Tietz Textbook of Clinical Chemistry and Molecular Diagnostics*** (5th Edition). Saunders (Elsevier).
6. White, B. A., & Garcea, R. L. (2019). ***Diagnostic Molecular Biology*****.** CRC Press.
7. Patrinos, G. P. (2019). ***Applied Genomics and Public Health***. Elsevier.
8. **Online Resources:** Protocol tutorials and application guides from Thermo Fisher Scientific, QIAGEN, New England Biolabs (NEB), and other molecular biology tool providers.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0803	Biodiversity Informatics	DSC	2	0	0	2	3

Prerequisite: Basic understanding of biodiversity, ecology, and taxonomy

Introductory knowledge of computer science and databases

Familiarity with biological data types and statistics

Course Objectives

1. To introduce concepts and significance of biodiversity and its digital documentation.
2. To provide tools and techniques used in biodiversity data collection, storage, and analysis.
3. To familiarize students with global biodiversity databases and information systems.

4. To enable students to apply bioinformatics and GIS tools in biodiversity conservation and management.

Course outcomes

1. Define and explain the scope, goals, and applications of biodiversity informatics.
2. Demonstrate understanding of taxonomy, species identification, and metadata standards.
3. Utilize biodiversity databases and information systems for species-level data retrieval.
4. Apply data mining and GIS tools to analyse and visualize biodiversity distribution.
5. Evaluate biodiversity patterns using phylogenetics and statistical models.
6. Integrate biodiversity informatics tools in conservation planning and policymaking.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	0	2	1	2	1	2	2	2	1	0
CO2	3	3	2	1	1	0	1	2	1	2	2	3	2	0
CO3	3	3	2	2	2	0	0	2	1	2	3	3	3	2
CO4	3	3	3	3	3	0	0	2	2	2	3	3	3	3
CO5	3	3	3	3	3	2	2	3	2	3	3	3	3	3
CO6	3	3	2	3	2	3	2	3	2	3	3	3	3	3

Course content

Unit 1: Introduction to Biodiversity Informatics **12 Hours**

Definition, scope, and importance of biodiversity; Overview of biodiversity informatics; Global and Indian biodiversity policies and initiatives (CBD, NBAP, GBIF, BSI, ZSI); Data standards: Darwin Core, ABCD; Digital taxonomy and species concepts.

Unit 2: Data Sources and Biodiversity Databases **12 Hours**

Primary data types: occurrence data, ecological metadata, traits, and images; Major biodiversity databases: GBIF, ITIS, EOL, Catalogue of Life, India Biodiversity Portal; Metadata standards and data cleaning; Access and retrieval of biodiversity data using APIs and portals; Citizen science and participatory biodiversity platforms.

Unit 3: Tools and Techniques in Biodiversity Informatics **12 Hours**

Species distribution modeling (SDM): MaxEnt, BIOMOD; Phylogenetics and DNA barcoding tools (e.g., MEGA, BOLD); Geographical Information Systems (GIS) for mapping biodiversity; Open-source tools: QGIS, R (vegan, dismo packages); Data visualization using web platforms

Unit 4: Applications and Case Studies **12 Hours**

Conservation planning and protected area management; Biodiversity monitoring and climate change impact studies; Invasive species tracking and endangered species protection; Integrating genomics, ecology, and informatics; Case studies: Biodiversity hotspots, IUCN Red List, e-Flora and e-Fauna projects.

Reference Books

1. Bisby, F. A., et al. (2007). ***Taxonomy and Biodiversity: Home for Biodiversity Data*****.** Chapman & Hall.
2. Godfray, H. C. J. (2002). ***Challenges for taxonomy*****.** *Nature*, 417(6884), 17–19.

3. Krishtalka, L., & Humphrey, P. S. (2000). ***Can Natural History Museums Capture the Future?*** *BioScience*, 50(7), 611–617.
4. Joppa, L. N., et al. (2013). ***Biodiversity informatics: The challenge of integrating data.*** *Science*, 339(6117), 413–414.
5. Faith, D. P., & Zermoglio, M. F. (2017). ***Biodiversity informatics and climate change:*** *A report*. UN Environment Programme.
6. **National Biodiversity Authority (NBA), India.** *Reports and Portals* – https://nbaindia.org
7. **Global Biodiversity Information Facility (GBIF).** *User Documentation & Tools* – https://www.gbif.org

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS811	Agri-genomics	DSE	2	0	0	2	2

Prerequisite: Basic knowledge of genetics, genomics, and molecular biology

Familiarity with bioinformatics tools and databases

Introductory understanding of plant breeding and crop science

Course Objectives

1. To introduce the principles and applications of genomics in agriculture.
2. To understand modern sequencing technologies used in crop improvement.
3. To explore genome mapping, QTL analysis, and marker-assisted selection.
4. To provide knowledge on functional genomics and computational approaches for crop research.

Course outcomes

By the end of the course, students will be able to:

1. Describe fundamental concepts and technologies in Agri-genomics.
2. Interpret next-generation sequencing data relevant to crop genomes.
3. Apply genome-wide association studies (GWAS) and QTL mapping for trait discovery.
4. Evaluate the role of molecular markers in plant breeding.
5. Analyze transcriptomic and epigenomic datasets for functional trait analysis.
6. Demonstrate use of databases and tools for Agri-genomic applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	0	2	2	0	0	0	1	2	1	3	2	1
CO2	3	3	2	2	2	0	0	0	0	2	1	3	2	2
CO3	3	3	3	3	2	1	0	0	0	2	2	3	3	3
CO4	3	2	3	2	3	2	2	1	1	2	2	2	3	2
CO5	2	3	3	3	3	1	1	0	1	2	2	3	3	3
CO6	3	3	3	3	3	0	2	1	2	2	2	3	3	3

Course content

Unit 1: Introduction to Agri-Genomics **8 Hours**

Overview of agricultural genomics; Plant and animal genome organization; Historical perspectives and key milestones; Genome sequencing technologies (NGS, long-read sequencing); Applications in crop and livestock improvement**.**

Unit 2: Genome Mapping and Marker Technologies **8 Hours**

Linkage mapping and physical mapping; Molecular markers (SSR, SNP, AFLP, etc.); Genotyping by sequencing (GBS); Marker-assisted selection (MAS); Case studies: Rice, maize, and wheat

Unit 3: Functional Genomics in Agriculture **8 Hours**

Transcriptomics and RNA-seq applications; Proteomics and metabolomics; Epigenomics and regulatory genomics; CRISPR and genome editing in crops; Systems biology approaches

Unit 4: Computational Tools and Applications **8 Hours**

Databases: Gramene, EnsemblPlants, SoyBase, MaizeGDB; Tools for GWAS, QTL mapping, and gene annotation; Comparative genomics in crop species; Genomic selection and predictive breeding; Future trends: AI and ML in Agri-genomics

Reference Books

1. Varshney, R. K., Tuberosa, R., & Thudi, M. (2017). ***Genomics-Assisted Crop Improvement:*** *Volumes 1 & 2*. Springer.
2. Kole, C. (Ed.). (2013). ***Genomics and Breeding for Climate-Resilient Crops*****.** Springer.
3. Jain, H. K., & Kharkwal, M. C. (2012). ***Plant Breeding: Mendelian to Molecular Approaches*****.** Narosa Publishing House.
4. Henry, R. J. (2012). ***Molecular Markers in Plants***. Blackwell Publishing.
5. Chen, J., & Chen, G. (2022). ***Omics in Plant Breeding*****.** Wiley-Blackwell.
6. Online Databases and Resources:

- Gramene (www.gramene.org)
- EnsemblPlants (https://plants.ensembl.org)
- MaizeGDB, SoyBase

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BIS811	Medical Informatics	DSE	2	0	0	2	2

Prerequisite

Basic knowledge of human biology, computer applications, and healthcare systems. Familiarity with data management and introductory bioinformatics is desirable.

Course objectives

1. Understand the fundamental concepts of medical informatics and its applications in healthcare.
2. Explore various healthcare information systems and electronic medical records.
3. Learn data standards, interoperability, and ethical issues in medical informatics.
4. Analyze healthcare data for decision support and predictive analysis.

Course outcomes

At the end of the course, students will be able to:

1. Describe the principles and evolution of medical informatics.
2. Evaluate the structure and functionality of hospital information systems (HIS) and EMRs.
3. Apply knowledge of interoperability standards like HL7, DICOM, and SNOMED.
4. Analyze healthcare data using informatics tools for better clinical decision-making.
5. Understand the security, privacy, and ethical challenges in medical informatics.
6. Demonstrate practical understanding of health IT tools, telemedicine systems, and patient care applications.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	3	2	2	2	1	2	1	2	1	2	3	2	1
CO2	3	3	2	3	3	2	2	1	2	2	3	3	3	2
CO3	3	3	3	3	3	2	2	2	2	3	3	3	3	3
CO4	3	2	3	3	3	2	3	2	3	2	3	3	2	2
CO5	3	2	3	2	2	3	2	3	3	3	2	3	2	2
CO6	3	3	3	2	2	2	3	2	2	2	3	3	3	2

Course content

Unit I: Foundations of Medical Informatics **8 Hours**

Introduction to Medical Informatics and Healthcare Data Ecosystem; Data Science in Clinical Settings: Fundamentals and Relevance; EHR (Electronic Health Record) Systems and Interoperability Standards (e.g., HL7, FHIR); Clinical Data Repositories and Data Warehousing in Healthcare; Biomedical Ontologies and Terminologies (SNOMED CT, ICD, MeSH).

Unit II: Consumer Health Informatics and Digital Health **8 Hours**

Mobile Health (mHealth), E-health, and Telemedicine Platforms; Patient Portals, Health Literacy, and Consumer Engagement; Wearables and Remote Monitoring Devices; Tools for Health Communication: Social Media, Chatbots, and Web 3.0; Public Databases for Health Research: NCBI, CDC, WHO Resources

Unit III: Clinical Decision Support and Analytics **8 Hours**

Clinical Decision Support Systems (CDSS): Design and Use Cases; Machine Learning and NLP in Medical Data Analysis; Predictive Analytics in Population Health; Ethics in AI-based Clinical Decisions; Case Studies: AI-driven Diagnostics and Prognostics

Unit IV: Medical Network Design & Governance **8 Hours**

Medical Network Infrastructure: Basics and Cloud Integration; Cybersecurity in Healthcare: Threats, Protection, Blockchain; Data Privacy Laws (HIPAA, GDPR), IRB, and Ethics Committees; Human Factors in Medical UI/UX Design; Emerging Trends: Smart Hospitals, Digital Twins in Healthcare

Reference Books:

1. Ramona Nelson & Nancy Staggers (2017). ***Health Informatics: An Interprofessional Approach.*** 2nd Edition. Mosby.

2. Mervat Abdelhak, Sara Grostick & Mary Alice Hanken (2017). ***Health Information: Management of a Strategic Resource***. 5th Edition. Saunders.
3. Edward H. Shortliffe & James J. Cimino (2014). ***Biomedical Informatics: Computer Applications in Health Care and Biomedicine.*** Springer.
4. David J. Lubliner (2015). ***Medical Informatics: An Executive Primer.*** CRC Press.
5. R. A. Greenes (2014). ***Clinical Decision Support: The Road Ahead.*** **Academic** Press.
6. William R. Hersh (2020). ***Information Retrieval: A Health and Biomedical Perspective***. Springer.
7. Charles P. Friedman & Jeremy C. Wyatt (2010). ***Evaluation Methods in Biomedical Informatics***. Springer.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0804	Lab: Comparative Genomics III	DSC	0	0	2	2	3

Prerequisite:

Basic understanding of molecular biology, genomics, and bioinformatics. Familiarity with genome annotation, sequence alignment, and biological databases is recommended.

Course Objectives

1. To introduce the principles and methods used in comparing genomes across species.
2. To understand genome evolution and functional annotation through comparative approaches.
3. To apply computational tools for genome alignment, orthology detection, and phylogenetic analysis.
4. To explore applications of comparative genomics in disease gene identification, evolutionary biology, and functional genomics.

Course Outcomes

By the end of the course, students will be able to:

1. Understand the theoretical foundations of comparative genomics.
2. Perform genome alignments and identify conserved and divergent regions.
3. Analyze orthologs, paralogs, synteny, and gene families across species.
4. Use comparative genomics for functional annotation and evolutionary inference.
5. Apply comparative genomics in disease gene mapping and functional studies.
6. Utilize tools and databases such as Ensembl, UCSC Genome Browser, OrthoDB, and Genomicus.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	3	2	2	1	2	2	1	2	2	3	2	1
CO2	3	3	3	3	2	1	1	2	1	1	2	3	2	2
CO3	3	3	3	3	3	1	2	2	2	2	2	3	3	2
CO4	3	2	2	3	3	2	1	2	1	1	2	3	3	2
CO5	3	3	3	3	2	2	2	2	2	1	2	3	3	2
CO6	3	3	3	3	3	2	2	2	2	1	2	3	3	3

Course Content

S. No.	Title of the Experiment	Learning Outcome	Tools/Databases Used

1	Comparative analysis of genome structure across species	Understand gene order conservation and synteny across related organisms	Ensembl Genome Browser, NCBI Genome
2	Whole genome alignment of microbial genomes	Perform and interpret whole genome alignments to identify conserved regions	Mauve, MUMmer
3	Ortholog identification using Reciprocal BLAST and OrthoFinder	Identify orthologous genes and understand gene conservation	BLAST, OrthoFinder
4	Analysis of gene duplication and evolutionary divergence	Evaluate gene family evolution through duplication and divergence	OMA, OrthoDB
5	Phylogenomic reconstruction using conserved genes	Construct and interpret phylogenomic trees to understand evolutionary relationships	MEGA, PhyloP, PhastCons
6	Functional annotation of genes using Orthology and pathway databases	Predict gene function and metabolic roles from orthologous groups	PANTHER, KEGG, Ensembl Compara
7	Identification of conserved regulatory elements across species	Detect conserved noncoding elements potentially involved in regulation	UCSC Genome Browser, PhastCons
8	Comparative analysis of pathogen genomes to identify virulence genes	Identify key differences in pathogenic and non-pathogenic strains	Ensembl Genome Browser, NCBI Pathogen Genome DB
9	Human vs. Mouse ortholog comparison for disease gene identification	Link orthologous genes across species for translational disease research	Ensembl Compara, ClinVar
10	Case study analysis using GTEx and 1000 Genomes Project datasets	Interpret genome variation data for personalized medicine insights	GTEx Portal, 1000 Genomes, UCSC Genome Browser

Reference Books

1. Brown, T. A. (2016). *Genomes 4*. Garland Science.
2. Pevsner, J. (2015). *Bioinformatics and Functional Genomics*, 3rd Ed. Wiley-Blackwell.
3. Apostolico, A., & Guerra, C. (2000). ***Computational Methods in Comparative Genomics*.** Springer.
4. Mount, D. W. (2004). ***Bioinformatics: Sequence and Genome Analysis*.** Cold Spring Harbor Laboratory Press.
5. Lesk, A. M. (2012). ***Introduction to Genomics*,** 2nd Ed. Oxford University Press.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0805	Lab: Molecular Diagnostics	DSC	0	0	2	2	3

Prerequisite: Basic knowledge of molecular biology, genetics, and microbiology

Understanding of nucleic acid structure and function

Fundamentals of biotechnology and laboratory techniques

Course Objectives

1. To provide fundamental and applied knowledge of molecular techniques used in disease diagnosis.
2. To familiarize students with nucleic acid-based diagnostics and probe-based detection systems.
3. To train students in the principles and applications of PCR, microarrays, and sequencing in clinical diagnostics.
4. To explore the regulatory, ethical, and quality control issues in molecular diagnostics.

Course outcomes

1. Understand the principles and scope of molecular diagnostics in healthcare.
2. Describe various nucleic acid-based detection methods including PCR and hybridization.
3. Apply molecular techniques for the diagnosis of infectious and genetic diseases.
4. Interpret results from real-time PCR, DNA microarrays, and sequencing platforms.
5. Analyze the use of molecular diagnostics in personalized medicine and cancer genomics.
6. Evaluate quality control, biosafety, and regulatory practices in molecular diagnostics labs.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	0	0	0	2	1	2	2	2	2	2
CO2	3	3	2	2	2	0	0	1	1	2	2	3	3	2
CO3	3	3	3	3	3	1	0	1	2	2	3	3	3	3
CO4	3	3	3	3	3	0	0	2	2	3	3	3	3	3
CO5	3	3	2	3	2	3	2	2	2	3	3	3	3	3
CO6	3	3	2	3	3	3	2	3	2	3	3	3	3	3

Course Content

S. No.	Experiment Title	Purpose/Skills Developed
1	**Extraction and Purification of Nucleic Acids (DNA & RNA)** from clinical/biological samples	Learn sample preparation, purification principles, and quality assessment for diagnostics
2	**Reverse Transcription PCR (RT-PCR)**	Detection and quantification of RNA viruses or gene expression
3	**Quantitative PCR (qPCR)** for gene copy number or pathogen load estimation	Understand amplification efficiency, Ct values, and standard curves
4	**Droplet Digital PCR (ddPCR)** (Demo or simulation-based)	Advanced quantification and absolute measurement of nucleic acid targets
5	**LAMP (Loop-mediated isothermal amplification)** for rapid DNA detection	Explore point-of-care isothermal diagnostic tools
6	**FISH (Fluorescence In Situ Hybridization)** (virtual or image analysis if lab not equipped)	Visualization of genetic loci or chromosomal abnormalities in diagnostics

7	**CRISPR-based Diagnostics (e.g., SHERLOCK/DETECTR)** (demo/simulation-based)	Study emerging gene-editing-based detection methods for rapid disease diagnosis
8	**Microarray Data Analysis** using open-access databases (e.g., GEO)	Introduce data handling, biomarker profiling, and gene expression signatures
9	**Analysis of NGS Diagnostic Report** (case-based interpretation)	Understand variant calling, annotation, and clinical relevance of NGS in diagnostics
10	**Quality Control in Molecular Diagnostic Labs** (Lab visit/simulation/demo)	Understand lab practices, QC parameters, biosafety, and documentation in a diagnostic setup

Reference Books

1. Bruns, D. E., Ashwood, E. R., & Burtis, C. A. (2022). ***Fundamentals of Molecular Diagnostics*** (2nd Edition). Elsevier.
2. Coleman, W. B., & Tsongalis, G. J. (2016). ***Molecular Diagnostics: Fundamentals, Methods and Clinical Applications*****.** Springer.
3. Patrinos, G. P., Ansorge, W., & Danielson, P. B. (2021). ***Molecular Diagnostics*** (2nd Edition). Academic Press (Elsevier).
4. Kim, Y. J., & Park, W. J. (2020). ***Clinical Molecular Medicine: Principles and Practice***. Academic Press.
5. Tietz, N. W. (2012). ***Tietz Textbook of Clinical Chemistry and Molecular Diagnostics*** (5th Edition). Saunders (Elsevier).
6. White, B. A., & Garcea, R. L. (2019). ***Diagnostic Molecular Biology*****.** CRC Press.
7. Patrinos, G. P. (2019). ***Applied Genomics and Public Health***. Elsevier.
8. **Online Resources:** Protocol tutorials and application guides from Thermo Fisher Scientific, QIAGEN, New England Biolabs (NEB), and other molecular biology tool providers.

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25BI0806	Lab: Biodiversity Informatics	DSC	0	0	2	2	3

Prerequisite: Basic understanding of biodiversity, ecology, and taxonomy

Introductory knowledge of computer science and databases

Familiarity with biological data types and statistics

Course Objectives

1. To introduce concepts and significance of biodiversity and its digital documentation.
2. To provide tools and techniques used in biodiversity data collection, storage, and analysis.
3. To familiarize students with global biodiversity databases and information systems.
4. To enable students to apply bioinformatics and GIS tools in biodiversity conservation and management.

Course outcomes

1. Define and explain the scope, goals, and applications of biodiversity informatics.

2. Demonstrate understanding of taxonomy, species identification, and metadata standards.
3. Utilize biodiversity databases and information systems for species-level data retrieval.
4. Apply data mining and GIS tools to analyse and visualize biodiversity distribution.
5. Evaluate biodiversity patterns using phylogenetics and statistical models.
6. Integrate biodiversity informatics tools in conservation planning and policymaking.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	3	2	1	0	0	2	1	2	1	2	2	2	1	0
CO2	3	3	2	1	1	0	1	2	1	2	2	3	2	0
CO3	3	3	2	2	2	0	0	2	1	2	3	3	3	2
CO4	3	3	3	3	3	0	0	2	2	2	3	3	3	3
CO5	3	3	3	3	3	2	2	3	2	3	3	3	3	3
CO6	3	3	2	3	2	3	2	3	2	3	3	3	3	3

Course content

S. No.	Title of the Experiment	Learning Outcome
1	Exploring global biodiversity data using **GBIF portal**	Understand species occurrence data and access biodiversity datasets via GBIF
2	Retrieving and comparing taxonomic information using **ITIS and Catalogue of Life**	Gain familiarity with taxonomic hierarchies and digital species databases
3	**Metadata standardization** using Darwin Core and ABCD using sample biodiversity datasets	Learn to apply international metadata standards for biodiversity data
4	Data cleaning and validation using **OpenRefine**	Clean and standardize biodiversity data before analysis
5	Mapping species occurrence using **QGIS** and ecological layers	Visualize species distribution and analyze spatial patterns
6	**Species Distribution Modeling (SDM)** using MaxEnt or R-based dismo package	Predict potential species habitats using environmental data
7	**Phylogenetic analysis** and tree construction using MEGA software	Understand evolutionary relationships among species
8	**DNA Barcoding exploration** using BOLD Systems	Investigate species identification using genetic sequence data
9	Exploring **IUCN Red List** for conservation status and threat analysis	Analyze species vulnerability and conservation priorities
10	Case study analysis using **India Biodiversity Portal or e-Flora** data	Apply biodiversity informatics tools to real Indian case studies

Reference Books

1. Bisby, F. A., et al. (2007). ***Taxonomy and Biodiversity: Home for Biodiversity Data*****.** Chapman & Hall.

2. Godfray, H. C. J. (2002). ***Challenges for taxonomy.*** *Nature*, 417(6884), 17–19.
3. Krishtalka, L., & Humphrey, P. S. (2000). ***Can Natural History Museums Capture the Future?*** *BioScience*, 50(7), 611–617.
4. Joppa, L. N., et al. (2013). ***Biodiversity informatics: The challenge of integrating data.*** *Science*, 339(6117), 413–414.
5. Faith, D. P., & Zermoglio, M. F. (2017). ***Biodiversity informatics and climate change:*** *A report*. UN Environment Programme.
6. **National Biodiversity Authority (NBA), India.** *Reports and Portals* – https://nbaindia.org
7. **Global Biodiversity Information Facility (GBIF).** *User Documentation & Tools* – https://www.gbif.org

Course Code	Course Title	Course Type	L	T	P	C	Hrs./ Wk.
B25AS0808	Research Project/ Internship	DSE	0	0	6	6	12

Course Objective

To carry out the academic research towards enhancing research based knowledge

Course outcomes

1. Apply fundamental and disciplinary concepts and methods in ways ap-propriate to their principal areas of study.
2. Demonstrate the skill sets acquired and employ the knowledge of current information in the domain.
3. Design experiment based on the area of research.
4. Apply technological tools and techniques specific to the professional field of study.
5. Acquire real time exposure to the systematic execution of research components and methodology.
6. Describe the statistical procedures in the interpretation of results.

Mapping of course outcomes with program outcomes

PO/CO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11	PSO1	PSO2	PSO3
CO1	2	2	3	3	3	2	2	1	2	2	1	0	3	2
CO2	3	2	2	3	3	3	3	1	2	2	1	0	3	3
CO3	3	3	1	3	3	3	3	1	2	2	1	1	3	3
CO4	3	3	1	1	1	3	3	1	2	2	1	1	3	3
CO5	2	2	2	2	2	2	2	2	2	2	2	1	1	2
CO6	2	2	2	2	2	2	2	2	2	2	2	1	1	2

Bioinformatics Project: Minimum of 12 weeks duration internship / project should be carried out by the student either in industry or in an R&D organization, including educational institutes with excellent research culture. In case, if a student is unable to secure internship either in industry or in an R&D organization, a project may be carried out within the university. The student is expected to submit a formal report at the end of the project programme. The student shall be awarded the marks for internship based on the (a) presentation and (b) comprehensive viva by the panel of examiners constituted by the school.

CAREER OPPORTUNITIES

Having a degree will open doors to the world of opportunities for you. But Employers are looking for much more than just a degree. They want graduates who stand out from the crowd and exhibit real life skills that can be applied to their organizations. Examples of such popular skills employers look for include:

1. Willingness to learn
2. Self-motivation
3. Teamwork
4. Communication skills and application of these skills to real scenarios
5. Requirement of gathering, design and analysis, development, and testing skills
6. Analytical and Technical skills
7. Computer skills
8. Internet searching skills
9. Information consolidation and presentation skills
10. Role play
11. Group discussion, and so on

REVA University, therefore, has given utmost importance to develop these skills through variety of training programs and such other activities that induce the said skills among all students. A full-fledged Career Counselling and Placement division, namely Career Development Centre (CDC) headed by well experienced senior Professor and Dean and supported by dynamic trainers, counsellors and placement officers and other efficient supportive team does handle all aspects of Internships and placements for the students at REVA University. The prime objective of the CDC is to liaison between REVA graduating students and industries by providing a common platform where the prospective employer companies can identify suitable candidates for placement in their respective organization. The CDC organizes pre-placement training by professionals and also arranges expert talks to our students. It facilitates students to career guidance and improve their employability. In addition, CDC forms teams to perform mock interviews. It makes you to enjoy working with such teams and learn many things apart from working together in a team. It also makes you to participate in various student clubs which helps in developing team culture, variety of job skills and overall personality.

The need of the hour in the field of Biotechnology is not only knowledge in the subject, but also the skills to do the job proficiently, team spirit and a flavor of innovation. This kept in focus, the CDC has designed the training process, which will commence from second semester along with the curriculum. Special coaching in personality development, career building, English proficiency, reasoning, puzzles, and communication skills to every student at REVA University is given with utmost care. The process involves continuous training and monitoring the students to develop their soft skills including interpersonal skills that will fetch them a job of repute around his / her interest and march forward to make better career. The School of Chemical and Biological sciences also have emphasized subject based skill training through lab practice, internship, project work, industry interaction and many such skilling techniques. The students during their day-to-day studies are made to practice these skill techniques as these are inbuilt in the course curriculum. Concerned teachers also continuously guide and monitor the progress of students.

The University has also established University-Industry Interaction and Skill Development Centre headed by a Senior Professor & Director to facilitate skill related training to REVA students and other unemployed students around REVA campus. The center conducts variety of skill development programs to students to suite to their career opportunities. Through this skill development center, the students shall compulsorily complete at least two skill / certification-based programs before the completion of their degree. The University has collaborations with Industries, Corporate training organizations, research institutions and Government agencies like NSDC (National Skill Development Corporation) to conduct certification programs. REVA University has been recognized as a Centre of Skill Development and Training by NSDC (National Skill Development Corporation) under Pradhan Mantri Kaushal Vikas Yojana.

The University has also signed MOUs with Multi-National Companies, research institutions, and universities abroad to facilitate greater opportunities of employability, students' exchange programs for higher learning and for conducting certification programs.

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