SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY
PESHAWAR

DEPARTMENT OF BIOINFORMATICS

CURRICULUM 2018 & ONWARDS

DEPARTMENT OF BIOINFORMATICS

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

Title:

"REVISED BIO-INFORMATICS CURRICULUM 2018"

Approved from Statutory Bodies:

4th Meeting of the Board of Studies held on Tuesday, 26th December, 2017
4th Meeting of the Board of Faculty held on Friday, 9th March, 2018
9th Meeting of the Academic Council held on Thursday, 29th March, 2018
24th Meeting of the Syndicate held on Wednesday, 4th April, 2018.

Compiled By:

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SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DEPARTMENT OF BIOINFORMATICS

INTRODUCTION TO DEPARTMENT OF BIOINFORMATICS

Momentum for development of bioinformatics at the Shaheed Benazir Bhutto Women University Peshawar can be traced to the establishment of the Department of Bioinformatics.
Bioinformatics, by its nature, is multidisciplinary. At the University, we have built a core set of bioinformatics faculty, staff and students from Pre-Medical & Pre-Engineering background.
In the Bioinformatics discipline, faculty members are involved in the acquisition, representation, modeling, integration, interpretation, and transformation of biomedical data.
Their work spans a range of activities including biochemical systems theory, biological
process modeling, biomarker identification, machine learning, analysis and interpretation of genomic and proteomic data, text data mining, identification of gene regulatory networks, ontology development, and design and implementation of clinical decision aids. They combine multidisciplinary research and collaborative arrangements with basic and clinical sciences to provide an integrated approach to the development of new ontological approaches and synthesis of new and existing knowledge in medicine and the biological sciences.
The Department of Bioinformatics is dedicated to advancing the application of computational methods to cutting-edge problems in biology. The new field of Bioinformatics and Computational Biology is making critical contributions to diverse areas such as disease detection, drug design, forensics, agriculture and environmental sciences through the combination of biological analysis and high-performance computing. The Department offers a variety of undergraduate courses in Bioinformatics.
The Department of Bioinformatics engages in education and research activities in the biological sciences. Methodological and applied research activities provide students with unique opportunities to participate in quantitative research in all aspects of public health sciences, including such areas medicine, dentistry, nursing and cancer research.

BACKGROUND

The past 50 years have witnessed a scientific revolution of the first magnitude, a revolution which has transformed our knowledge of the cell from next to nothing, to nearly everything. With the complete sequence of the human and other genomes now elucidated, we will soon a have a complete parts list of the human cell—the precise location and base sequence of every gene in a reference genome. The reference allows us to rapidly characterize polymorphisms across the human population, and it also enables molecular fingerprinting technologies that permit identification of the precursors and consequences of normal and pathological changes in gene expression. These changes are driving, and coupled to, advance in monitoring and understanding the collective properties of proteins and metabolites, and their modifications under various forms of stress. The full armamentarium of tools and information is profoundly altering biomedical research and the culture of science, and it is destined—during the next 10–20 years—stimulates an explosive growth in diagnostics, prognostics and therapeutics, profoundly altering the practice of medicine. But with this bewildering explosion of information and tools, comes subtle and complex dilemmas of choice, which must be faced collectively by society, and individually by patients and health care professionals. The need for

clinically trained leaders, who understand these changes, their origin and their course, and who will play a proactive role in guiding their development, is crucial if the world's population is to benefit by these remarkable scientific advances.

MISSION

The mission of the department of bioinformatics is to apply our knowledge and expertise to the cost effective development, implementation, support and improvement of the Bioinformatics infrastructure to meet the present and future requirements of life sciences & to educate and produce graduate students in the field of bioinformatics and computational biology who are skilled & able to integrate research and education on the use of information technologies in molecular biology by developing / using bioinformatics tools.

VISION

Department of Bioinformatics wants to be a leading department of the country to provide educational background that blends biology with computer science and mathematics to develop Bioinformatics professionals and researchers with interdisciplinary approaches who are able to meet international challenges and to explore different areas of life sciences.

CURRICULUM

OF

BIOINFORMATICS
BS

(Session 2018 & Onwards)

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

DEAPRTMENT OF BIOINFORMATICS

UNDERGRADUATE PROGRAM IN BIOINFORMATICS:

One of the first programs of its kind, the Undergraduate Program in Bioinformatics offers
Unique interdisciplinary training in the science, engineering, medicine and ethics of twenty-first century cell biology. Our curriculum focuses on the molecular biology and the physics of the cell, and emphasizes the use of advanced mathematics and computation.
The research program includes state-of-the-art topics in systems biology, computational modeling of regulatory and metabolic networks, small-molecule and macromolecule docking, comparative genomics, protein design, genomic and proteomic biotechnology, microarray engineering and analysis, pharmacogenomics, structural biology, large-scale modeling of biological systems, RNA, computational studies of cancer and neurological disorders and functional genomics, synthetic gene networks and molecular computing and genetics.
Our dynamic environment is focused on students and helps them to gain experience in the field through academic and industrial rotations, internships, and a student seminar series. Our students regularly collaborate with faculty to produce publications.

MISSION STATEMENT OF THE PROGRAMME:

The mission of the program is to educate and prepare graduate students to understand advantages & limitations of molecular biology along with practical application of bioinformatics tools for the development of human resource in the discipline of Bioinformatics.

PROGRAMME OBJECTIVES:

The program objectives are:

1) To learn the scientific concepts and applications of computational methods in the biological sciences.
2) To adopt practical approaches to IT and computer applications in molecular biology and biotechnology with focus on major issues concerning representation and analysis of bimolecular sequences and structural information.
3) To learn investigative methods for research in biosciences with the help of tools of Bioinformatics.
4) To provide knowledge on development and application of computer software tools of bioinformatics.

OUTCOMES OF THE PROGRAMME:

The graduates of BS-Bioinformatics will be able to;

1. Find new and global perspectives into the organization and function of biological systems.
2. Develop software tools, algorithms, and databases for gene identification, protein structural prediction, clustering analysis, and data mining.
3. Apply the knowledge of bioinformatics to disease diagnosis and treatment.
4. Apply the knowledge of computer programming and languages to bioinformatics.
5. Research the new and novel targets for drug discovery and development; and Find the Genetic/proteomic profiling for pharmaco-genomics or personalized medicine.

ADMISSION REQUIREMENTS:

ELIGIBILITY

Higher Secondary School Certificate (2nd division with at least 50% marks) in Pre-Engineering/Pre-Medical / Intermediate in Computer Science/relevant subjects (deficiency courses to be completed if needed).

DURATION

- Four years programme spread over 8 semesters, two semesters per year.

COURSE AND CREDIT REQUIREMENTS:

A total of 123-148 credits are required to complete Bachelor of Science in Bioinformatics.

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR
DEAPRTMENT OF BIOINFORMATICS

FOUR-YEARS CURRICULA FOR BS BIOINFORMATICS

STRUCTURE

S.NO	Categories	No. of courses Min- Max	Credit Hours Min- Max
1	Compulsory Requirement (No Choice)	9– 10	28 – 31
2	General Courses to be chosen from other departments	7 – 8	21 – 25
3	Discipline Specific Foundation Courses	9 – 10	30 – 34
4	Major Courses including research project / Internship	10 – 13	36– 42
5	Electives within the major	4 – 4	12 – 16
	TOTAL	**39-45**	**127-148**

Total numbers of Credit Hours	127-148
Duration	4 years
Semester Duration	16-18 weeks
Semesters	08
Course Load Per Semester	16-18 credit hours
Number of Courses Per Semester	4-6 (not more than 3 lab /practical courses)

LAYOUT

S.No	Compulsory Requirements (the student has no choice)	
	10 Courses	
	31 Credit Hours	
	Subject	**Credit Hours**
1.	English Comprehension	3
2.	Communication Skills	3
3.	Technical Report Writing	3
4.	Pak Studies	2
5.	Islamic Studies	2
6.	Basic Mathematics	3
7.	Computer fundamentals	4
8.	Chemistry	4
9.	Basic Cell Biology	4
10.	Basic Calculus	3
	*Deficiency Courses	
	Total Credit Hours	**31**

*Deficiency courses to be completed if needed

S.No	General Courses to be chosen from other Departments	
	7-8 Courses	
	21-25 Credit Hours	
	Subject	**Credit Hours**
1.	Programming Fundamentals	4
2.	Data Structure and Algorithms	4
3.	Object oriented programming	4
4.	Discrete Structures	3
5.	Database Management System	4
6.	Ethical and legal issues in Bioinformatics	2
7.	Probability & Biostatistics	4
	Total Credit Hours	**25**

S.No	Discipline Specific Foundation Courses	
	9-10 Courses	
	30-34 Credit Hours	
	Subject	**Credit Hours**
1.	Linear Algebra and Differential Equations	3
2.	Essentials of Genetics	3
3.	Bioinformatics I	3
4.	Bioinformatics II	4
5.	Biochemistry I	4
6.	Biochemistry II	4
7.	Molecular Biology	4
8.	Research Methodology	2
9.	System Biology	3
	Total Credit Hours	**30**

S.No	Major Courses including Research Project/Internship	
	10-13 Courses	
	36-42 Credit Hours	
	Subject	**Credit Hours**
1.	Bioinformatics Computing I	4
2.	Genomics	3
3.	Proteomics	3
4.	Graphics and Visualization	4
5.	Bioinformatics Computing II	4
6.	Artificial Intelligence	3
7.	Bioinformatics software Engineering	3
8.	Special topics in Bioinformatics	3
9.	Modeling and Simulation	3
10.	Research Project	6
	Total Credit Hours	**36**

S.No	**Elective Courses within the major**	
	4 Courses	
	12-16 Credit Hours (Any four of the courses may be opted from the following elective courses)	
	Subjects	**Credit Hours**
1.	Elective I (Microbiology & Immunology)	4
2.	Elective II (Operating System)	4
3.	Elective III) (Modern Programming Languages)	4
4.	Elective IV (Molecular Phylogeny and Evolution)	3
	Total Credit Hours	**15**

S.No	**List of Elective Courses**
	(Any four of the courses may be opted from the following elective courses)
	Subjects
1.	Enzyme Kinetics
2.	Microarray Data Analysis
3.	Human Computer Interaction
4.	Nanotechnology
5.	Environmental Biotechnology
6.	Special Topics in Biochemistry
7.	Immuno-Informatics
8.	Microbial genomics and proteomics
9.	Protein-protein interaction
10.	Digital Image Processing
11.	Gene Mining
12.	Pattern recognition and matching
13.	Biophysics
14.	Modern programming languages
15.	Medical Image Processing
16.	Operating System
17.	Microbiology and Immunology
18.	Molecular Evolutionary Sequence Analysis
19.	Molecular Phylogeny and Evolution
20.	Drug Discovery and Development
21.	Computational Systems Biology
22.	Cheminformatics
23.	Biological Data Integration
24.	Whole Genome Expression Analysis and Biomarker Discovery
25.	Molecular Biology, Genetics, and Disease
26.	Structural and functional Bioinformatics

27.	R for Biomedical Informatics
28.	Bioinformatics Analysis
29.	Statistical Genetics
30.	Pharmacogenomics
31.	Advanced Computer Programming
32.	Advanced Database Systems
33.	Data Mining
34.	Bioinformatics Algorithms
35.	Bioinformatics Database Development.
36.	Network Biology
37.	Functional Genomics
38.	Methods in Protein Modeling
39.	Pharmacoinformatics
40.	Statistical Methods in Bioinformatics
41.	Designing & Analysis of algorithms.
42.	Epigenetics & Gene Regulation
43.	Protein Chemistry
44.	Microbial Genetics
45.	Molecular Oncology
46.	Introduction to Big Data

Note: *In addition to the above, the university can offer any elective which they feel necessary subject to the availability of resources.*

SHAHEED BENAZIR BHUTTO WOMEN UNIVERSITY PESHAWAR

SCHEME OF STUDIES OF BIOINFORMATICS 4-YEAR PROGRAM (SESSION- 2018)

Semester I

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
ENG-321	English comprehension	3	0
ISL-320	Islamic studies	2	0
	Basic Mathematics	3	0
CSC-300	Computer Fundamentals	3	1
BI-301	Chemistry	3	1
Deficiency Courses*			
Total Credit Hours		14	2

Semester II

Course Code	Course Title	Credit Hrs.	
		Lectures	Lab
ENG-322	Communication skills	3	0
	Pak Studies	2	0
CSC-302	Programming Fundamentals	3	1
	Basic Calculus	3	0
	Basic Cell Biology	3	1
Total Credit Hours		14	2

Semester III

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
ENG-421	Technical Report writing	3	0
MTH-408	Linear Algebra and Differential Equation	3	0
	Biochemistry I	3	1
	Essential of Genetics	3	1
CSC-422	Data Structure and Algorithms	3	1
Total Credit Hours		15	3

Semester IV

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
BI-411	Bioinformatics I	3	1
	Biochemistry II	3	1
	Molecular Biology	3	1
BI-401	Probability & Biostatistics	3	1
CSC-412	Object Oriented programming	3	1
Total Credit Hours		14	4

Semester V

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
CSC-304	Discrete Structures	3	0
BI-501	Research Methodology	2	0
CSC-524	Database Management System	3	1
BI-521	Bioinformatics II	3	1
BI-502	Ethical and Legal issues in Bioinformatics	2	0
	Genomics	3	0
Total Credit Hours		16	2

Semester VI

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
BI-522	Bioinformatics Computing I	3	1
CSC-637	Modeling and Simulation	2	1
	Proteomics	3	0
CSC-525	Graphics and Visualization	3	1
BI-523	Special Topic in Bioinformatics	3	0
Total Credit Hours		14	3

Semester VII

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
BI-621	Bioinformatics Computing II	3	0
BI-622	Bioinformatics Software Engineering	2	1
	Elective-I (Microbiology and immunology)	3	1
	Elective-II (Operating System)	3	1
	System Biology	3	0
Total Credit Hours		14	3

Semester VIII

Course Code	Course Title	Credit Hrs	
		Lectures	Lab
CSC-543	Artificial Intelligence	3	1
	Elective-III (Modern Programming Languages)	3	0
	Elective-IV (Modern Phylogeny and Evolution)	3	0
BI-689	*Research Project	0	6
Total Credit Hours		09	7

*Research Project, worth of 06 credit hours is mandatory for all students.

The department is following the rules of HEC pertaining to the semester system, in content of courses, credit hours and examination.

Department of Bioinformatics is deviating from HEC in scheme of studies as follows.

S. No.	Deviation	Justification
1.	Revised the Course codes accordance with accreditation and SBBWU approved policy.	Advised by the Accreditation council to revise the course codes and use the same course codes for the courses chosen from the other departments.
2.	Communication Skills is shifted from 3rd Semester to 2nd Semester	In HEC scheme both subjects of English were selected in the same semester.
2.	Probability and Biostatistics is shifted from 2nd semester to 4th Semester.	This said course is a difficult at this stage of 2nd semester.
3.	Biochemistry I is shifted from 2nd semester to 3rd semester	This said course is a difficult at this stage of 2nd semester and is correlated with the courses of 3th semester being taught. It should be in continuation with the Biochemistry II as the concepts of both subjects are correlated.
4.	The Credit Hrs. of Bioinformatics I is	As Bioinformatics I is the discipline foundation

	changed from 2+1 to 3+1.	course and provided the basic knowledge of Bioinformatics so the course content of the said subject could not be covered in the HEC prescribed credit Hrs.
5.	Subject of Research Methodology is introduces instead of Recombinant DNA Technology in 5th Semester.	As the course content of Recombinant DNA Technology is being covered in different discipline specific foundation courses and within Major courses.
6.	Bioinformatics Computing II is shifted from 8th semester to 7th semester.	This said course is correlated with the Bioinformatics Computing I so It should be in continuation with the Bioinformatics Computing I as the concepts of both subjects are correlated.
7.	Microbiology and Immunology is Selected as Elective I in 7th Semester.	Because of the fact that students must learn and clear the concepts of immunology with special reference to Bioinformatics before staring the Research Project in 8th semester as this subject will help them to design their Research Project in Drug Designing And Drug Discovery.
8.	Operating system is selected as Elective II in 7th semester and added to the List of Electives.	This subject was not included in the list of elective subjects provided by HEC Because of the fact that students must learn before staring the Research Project in 7th & 8th semester as this subject will help them to design their Research Project in Bioinformatics on different plate forms.
9.	Modern Programming Languages System is selected as Elective III in 8th semester from the list of elective subjects provided.	This subject will helps to students understanding of biological data bases & helps to learn different tools used for designing of biological database. This subject will also help them to design their Research Project in Bioinformatics.
10.	Modern Phylogeny & Evolution is selected as Elective IV in 8th semester from the list of elective subjects provided.	Because of the fact that students must learn and clear the concepts of phylogeny and evolution.

DETAIL OF COURSES
Semester-I

Course Name: English Comprehension	**Course Code: ENG-321**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Course Objective: Enhance language skills and develop critical thinking.	
Course Outline Basics of Grammar ,Parts of speech and use of articles ,Sentence structure, active and passive voice Practice in unified sentence ,Analysis of phrase, clause and sentence structure ,Transitive and intransitive verbs ,Punctuation and spelling **Comprehension** :Answers to questions on a given text **Discussion** :General topics and every-day conversation (topics for discussion to be at the discretion of the teacher keeping in view the level of students) **Listening :**To be improved by showing documentaries/films carefully selected by subject teachers **Translation skills** ,**Urdu to English** .**Paragraph writing** :Topics to be chosen at the discretion of the teacher, **Presentation skills** :Introduction *Note: Extensive reading is required for vocabulary building*	
Recommended Books: 1. **Functional English** a) Grammar 1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 1. Third edition. Oxford University Press. 1997. ISBN 0194313492 2. Practical English Grammar by A .J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press. 1997. ISBN 0194313506 b) Writing 1. Writing. Intermediate by Marie-Christine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 0 19 435405 7 c) Reading/Comprehension 1. Reading. Upper Intermediate. Brain Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 453402 2.	

Course Name: Islamic Studies	**Course Code: Hum-104**
Course Structure: Lectures: 2, Labs: 0	**Credit Hours: 2**
Prerequisites:	

Course Objective: This course is aimed at:
1 To provide Basic information about Islamic Studies
2 To enhance understanding of the students regarding Islamic Civilization
3 To improve Students skill to perform prayers and other worships
4 To enhance the skill of the students for understanding of issues related to faith and religious life.

Course Outline Introduction to Quranic Studies:1) Basic Concepts of Quran 2) History of Quran 3) Uloom-ul -Quran **Study of Selected Text of Holly Quran** 1) Verses of Surah Al-Baqra Related to Faith (Verse No-284-286) 2) Verses of Surah Al-Hujrat Related to Adab Al-Nabi (Verse No-1-18) 3) Verses of Surah Al-Mumanoon Related to Characteristics of faithful (Verse No-1-11) 4) Verses of Surah al-Furqan Related to Social Ethics (Verse No.63-77) 5) Verses of Surah Al-Inam Related to Ihkam (Verse No-152-154) **Study of Selected Text of Holly Quran** 1) Verses of Surah Al-Ihzab Related to Adab al-Nabi (Verse No.6,21,40,56,57,58.) 2) Verses of Surah Al-Hashar (18,19,20) Related to thinking, Day of Judgment 3) Verses of Surah Al-Saf Related to Tafakar,Tadabar (Verse No-1,14) **Seerat of Holy Prophet (S.A.W) I** 1) Life of Muhammad Bin Abdullah (Before Prophet Hood) 2) Life of Holy Prophet (S.A.W) in Makkah 3) Important Lessons Derived from the life of Holy Prophet in Makkah **Seerat of Holy Prophet (S.A.W) II** 1) Life of Holy Prophet (S.A.W) in Madina 2) Important Events of Life of Holy Prophet in Madina 3) Important Lessons Derived from the life of Holy Prophet in Madina **Introduction To Sunnah** 1) Basic Concepts of Hadith 2) History of Hadith 3) Kinds of Hadith 4) Uloom-ul-Hadith 5) Sunnah & Hadith 6) Legal Position of Sunnah **Selected Study from Text of Hadith** ,**Introduction To Islamic Law & Jurisprudence** 1) Basic Concepts of Islamic Law & Jurisprudence 2) History & Importance of Islamic Law & Jurisprudence 3) Sources of Islamic Law & Jurisprudence 4) Nature of Differences in Islamic Law 5) Islam and Sectarianism. **Islamic Culture & Civilization** 1) Basic Concepts of Islamic Culture & Civilization 2) Historical Development of Islamic Culture & Civilization 3) Characteristics of Islamic Culture & Civilization 4) Islamic Culture & Civilization and Contemporary Issues. **Islam & Science** 1) Basic Concepts of Islam & Science 2) Contributions of Muslims in the Development of Science 3) Quranic & Science. **Islamic Economic System** 1) Basic Concepts of Islamic Economic System 2) Means of Distribution of wealth in Islamic Economics 3) Islamic Concept of Riba 4) Islamic Ways of Trade & Commerce. **Political System of Islam** 1) Basic Concepts of Islamic Political System 2) Islamic Concept of Sovereignty 3) Basic Institutions of Govt. in Islam. **Islamic History** 1) Period of Khlaft-E-Rashida 2) Period of Ummayyads 3) Period of Abbasids. **Social System of Islam** 1) Basic Concepts of Social System of Islam 2) Elements of Family 3) Ethical Values of Islam

Recommended Books:

1) Hameed ullah Muhammad, 'Introduction to Islam.
2) Hussain Hamid Hassan, "An Introduction to the Study of Islamic Law" leaf Publication Islamabad, Pakistan.
3) Ahmad Hasan, "Principles of Islamic Jurisprudence" Islamic Research Institute, International Islamic University, Islamabad (1993).
4) H. S. Bhatia, "Studies in Islamic Law, Religion and Society" Deep & Deep Publications New Delhi (1989).
5) Dr. Muhammad Zia-ul-Haq, "Introduction to Al Sharia Al Islamia" Allama Iqbal Open University, Islamabad (2001)

Course Name: Basic Mathematics	**Course Code:**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 03**

Prerequisites: None

Course Objective

1. Mathematical and statistical frameworks are being increasingly employed to understand and investigate biological processes.
2. These frameworks helps in analyzing vast amount of datasets generated from genome and related projects.
3. It is thus essential to introduce basic concepts of mathematics, probability and statistics early within the Bioinformatics curriculum.
4. This course will enable students to understand and appreciate computational problems in proper perspective.
5. This course will provide a foundation for pursuing higher level courses in Computational Biology.

Course Outline: Basic concepts of Linear Algebra, Introduction to functions: Mathematical and physical meaning of functions, graphs of various functions, introduction to trigonometry, Using graphs, Graph transforms, combination and permutations, introductory concepts in Integration and derivatives, rules of integration, exponentials, Logarithms, Basic concepts related to Complex Numbers, Basic probability, Introduction to Linear Equations and Algebraic Functions, Sequences and Series, Introductory concepts of vectors and various applications of vector calculus.

Recommended Books:

1. ‘‘Modular Math’’ by Heinemann. 22 Jun 2004 by Keith Pledger (Editor), Alistair Macpherson
2. ‘‘Core Mathematics’’ by Keith Pledger. Modular Mathematics Core Mathematics-Pearson Education (2008).
3. Elementary Linear Algebra, Howard Anton, Chris Rorres, John Wiley & Sons, 12-Apr-2010 - Mathematics - 773 pages.
4. Core Mathematics I http://www.math.kent.edu/ebooks/10021/CMI.pdf Department of Mathematical Sciences Kent State University July 23, 2010

Course Name: Chemistry	**Course Code: BI-301**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: None	
Course Objective: This course will familiarize students with basic principles, concepts and theories in chemistry.	
Course Outline: Atoms and Periodic Table,Ionic Compounds,Molecular Comounds,Chemical Reactions,Gases,Liguids and Solids,Solutions,Acids and Bases.Introduction to Organic Chemistry:Alkanes,Alkenes,alkynes and Aromatic Compounds,Amines,Aldehyde and Ketones,Carboxylic Acids and Their Derivatives.	
Lab Outline: Preparation of molar and normal solutions, use of pH meter to determine pH of various solutions, acid base titration, use of spectrophotometer to determine the absorbance, determination of melting point and boiling point.	

Course Name: Computer Fundamentals	**Course Code:** CSC-300
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: None	
Course Objective: This course focuses on introducing computing environments, general application software, basic computing hardware, operating systems, desktop publishing, Internet, software applications and tools and computer usage concepts.	
Course Outline: History, classification, computer and society, overview of numbering system with various Boolean functions, flow chart techniques, storage, programs & software, system software, application software, operating systems, office automation tools: word processing, graphics packages, databases and spreadsheets, various operating systems, current trends and research prospects. Legal and moral aspects of computing.	
Lab Outline Computation of Number system, Implementation of Boolean Functions, Basic machines organization including motherboard, memory, I/O cards, Networking devices, Use of flow charts, Introduction to office tools, overview of different browser including open source browsers, Introduction to various operating systems.	
Recommended Books: 1. "Introduction to Computer Science", P.K Sinha 2. **2.** "Computer Science- An Overview", Glenn Brooks. **3.** "Computer Applications", by Imran Saeed. **4.** "Fundamental Concepts of Computer System" by Asiya Sultan,Amena Nudrat.	

Recommended Books:

Latest editions of following books

1. Brown *et al*., "Chemistry: The central Science", Pearson Printing Hall.
2. Raymond Chang, "Chemistry", McGraw Hill.
3. Christopher J. Crammer, "Computational Chemistry: Theories and Models", John Willey & Sons.
4. Philips / Mathews, "Advanced Chemistry: Physical and Industrial", Cambridge University Press.

Semester-II

Course Name: Communication Skills	**Course Code: ENG-322**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites: None	

Course Objective:
Enable the students to meet their real life communication needs.

Course Outline

Paragraph writing :Practice in writing a good, unified and coherent paragraph **Essay writing:** Introduction **CV and job application** :Translation skills ,Urdu to English **Study skills** :Skimming and scanning, intensive and extensive, and speed reading, summary and précis writing and comprehension **Academic skills:**Letter/memo writing, minutes of meetings, use of library and internet **Presentation skills:**Personality development (emphasis on content, style and pronunciation)
Note: documentaries to be shown for discussion and review

Recommended Books:

Communication Skills

a) Grammar

1. Practical English Grammar by A. J. Thomson and A. V. Martinet. Exercises 2. Third edition. Oxford University Press 1986. ISBN 0 19 431350 6.

b) Writing

1. Writing. Intermediate by Marie-Chrisitine Boutin, Suzanne Brinand and Francoise Grellet. Oxford Supplementary Skills. Fourth Impression 1993. ISBN 019 435405 7 Pages 45-53 (note taking).
2. Writing. Upper-Intermediate by Rob Nolasco. Oxford Supplementary Skills. Fourth Impression 1992. ISBN 0 19 435406 5 (particularly good for writing memos, introduction to presentations, descriptive and argumentative writing).

c) Reading

1. Reading. Advanced. Brian Tomlinson and Rod Ellis. Oxford Supplementary Skills. Third Impression 1991. ISBN 0 19 453403 0.
2. Reading and Study Skills by John Langan.
3. Study Skills by Riachard York.

Course Name: Pakistan Studies	**Course Code: Hum-302**
Course Structure: Lectures: 2, Labs: 0	**Credit Hours: 2**

Course Objective:

- Develop vision of historical perspective, government, politics, contemporary Pakistan, ideological background of Pakistan.
- Study the process of governance, national development, issues arising in the modern age and posing challenges to Pakistan.

Course Outline

1. **Historical Perspective** : a. Ideological rationale with special reference to Sir Syed Ahmed Khan, Allama Muhammad Iqbal and Quaid-e-Azam Muhammad Ali Jinnah. b. Factors leading to Muslim separatism c. People and Land i. Indus Civilization ii. Muslim advent iii. Location and geo-physical features. 2. **Government and Politics in Pakistan** Political and constitutional phases: a. 1947-58 b. 1958-71 c. 1971-77 d. 1977-88 e. 1988-99 f. 1999 onward 3. **Contemporary Pakistan** a. Economic institutions and issues b. Society and social structure c. Ethnicity d. Foreign policy of Pakistan and challenges e. Futuristic outlook of Pakistan

Recommended Books:

1. Burki, Shahid Javed. State & Society in Pakistan, The Macmillan Press Ltd 1980.
2. Akbar, S. Zaidi. Issue in Pakistan's Economy. Karachi: Oxford University Press, 2000.
3. S. M. Burke and Lawrence Ziring. Pakistan's Foreign policy: An Historical analysis. Karachi: Oxford University Press, 1993.
4. Mehmood, Safdar. Pakistan Political Roots & Development. Lahore, 1994.
5. Amin, Tahir. Ethno - National Movement in Pakistan, Islamabad: Institute of Policy Studies, Islamabad.
6. Afzal, M. Rafique. Political Parties in Pakistan, Vol. I, II & III. Islamabad: National Institute of Historical and cultural Research, 1998.
7. Haq, Noor ul. Making of Pakistan: The Military Perspective. Islamabad: National Commission on Historical and Cultural Research, 1993.

Course Name: Programming Fundamentals	**Course Code: CSC-302**
Course Structure: Lectures: 3, Lab: 1	**Credit Hours: 4**

Prerequisites: Computer Fundamentals/Basic Mathematics

Course Objective

The course is designed to familiarize students with the basic programming skills. It emphasizes upon problem analysis, algorithm designing, program development and testing.

Intended Learning Outcomes:

- This course is designed to familiarize students with the basic structured programming skills.
- It emphasis upon problem analysis, algorithm designing and program development and testing.

Course Outline : Overview of computers and programming. Types of programming languages(Low level, assembly language and High level Languages)**,** Overview of language for e.g. C++ language. Language processors(compiler, Interpreter, Assembler)**,**Basics of structured and Modular programming. **,**Basic Algorithms and problem solving, **,**Development of basic algorithms, analyzing problem, designing solution, testing designed solution,Fundamental programming constructs,Translation of algorithms to programmes,**,**Data types**,**Variables and constants**,**Operators (Arithmetic, assignment operator, increment and decrement, operator, precedence.Comments(Single line and multiple line)**,**Control structures(If structure, if-else structure, multiple if else structure, nested if structure, compound conditions witch structure)**,**Go to statement.**,**Looping structure(for loop, while loop, do-While), break, continue**,**Functions(Use defined and built in)**,**Arrays(Sequential search, binary search, Selection sort, bubble sort, two dimensional arrays and multi dimensional arrays)**,**Structures(Nested structures)**,**Union**,** Enumerations**,**Pointers**,**Testing programmes

Lab Outline

Introduction to various programming paradigms, Coding, executing and debugging simple programs, Implementation of simple control structures, Implementation of functions, arrays, records, file input / output techniques.

Recommended Books:

1. R. P. Halpern, "C for Yourself – Learning C Using Experiments", Oxford University Press.

2. "Using Information Technology", William.

3. "Computer Organization & Architecture", William.

4. Introduction to computer programming with C/C++ by "Tariq Siddiqui"

5. C.M Aslam & T.A Quershi. *Programming with C++ (Aikman Series)*, Lahore, Pakistan

6.Hanley & Kauffman.(Latest Edition). *Problem Solving and Program Design in C.* Addison-Wesley .

7.Deital,H.M., &Dietal,P.J. (Latest Edition). *C How to Program*. Prentice Hall

Course Name: Basic Calculus	**Course Code:**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 03**
Prerequisites: None	

Course Objective

1. This course will familiarize students with the basic principles of calculus and their application to problem solving.
2. To enable the students about practical applications of the course in different fields.
3. Make the students to polish their analytical skills.

Course Outline: Introduction to Limits: Theorems of limits and their application to functions: Introduction

to Continuity,. Derivatives: Introduction to derivatives, Partial derivatives and their geometrical significance Application problems (rate of change, marginal analysis) Higher derivatives: Mean value theorem, Applications of derivatives: Curvature and radius of curvature, maxima and minima of a function. Application partial derivatives: Integral calculus: Vector differentiation, vector integration and their application. Laplace transforms, Fourier series, Z-Transform.

Recommended Books:

1. Calculus by Thomas Finney, 11th Edition, Dec 26, 2010.
2. Brief Calculus and its applications by Doniel D.Benice, 5th Edition, 1997.
3. Applied Calculus by Raymond A. Barnett, 5th Edition, 08/28/1996
4. Calculus by Gerald L. Bradley, 2nd Edition, 2002.

Course Name: Basic Cell Biology	**Course Code: Bio-301**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 4**

Prerequisites: None

Course Objective

i. The course provides the basic concept of biological science.
ii. It emphasis on diversity of life, physical and chemical nature of living matter.
iii. The course provides form and function of the cell and organism.

Course Outline

Introduction to cell biology, Types of cells, Structure of biological membranes, pumps, channels, transporters, receptors, cellular transport, cell signaling, Cell division and regulation, Protoplasm and cell wall, Golgi bodies, Endoplasmic reticulum, cytoplasm, nucleus, structure and organization of chromosomes, ribosomes, mitochondria, apoptosis, Cytoskeleton, Lysosomes, extra cellular matrix, cancer types and mechanism, Stem cell and cloning, Cell visualization techniques

Lab Outline

1. Laboratory safety: Contamination and decontamination.
2. Study of cell structure using compound microscope.
3. Study of mitosis and meiosis by smear/squash method and from prepared slides.
4. To determine and measure cell size.
5. Eukaryotic and prokaryotic cell study from prepared slides.
6. Staining of cells- simple staining of bacterial cells.

Recommended Books:

1. Gerald Karp - Cell and molecular biology concepts and experiments - Hoboken, NJ - John Wiley - 2010 - 5th Ed
2. David M. P. Academic Press London, Methods in Cell Biology Lowery Sekivetz. Cell Structure and

Function. John Willey and Sons Publication. **3.** Enger, Eldon D. and Ross, Frederick C., Concepts in Biology, 10th Ed., McGraw-Hill, 2003 **4**. Lodish, et al. Molecular Cell Biology. 5th ed. New York, NY: W.H. Freeman and Company, 2003.

Semester-III

Course Name: Technical Report Writing	**Course Code:** ENG-421
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: None	
Course Objective: Enhance language skills and develop critical thinking	
Course Outline **Presentation skills,Essay writing** :Descriptive, narrative, discursive, argumentative **Academic writing :**How to write a proposal for research paper/term paper,How to write a research paper/term paper (emphasis on style, content, language, form, clarity, consistency) **Technical Report writing** ,**Progress report writing** *Note: Extensive reading is required for vocabulary building*	
Recommended Books: Technical Writing and Presentation Skills a) Essay Writing and Academic Writing 1. Writing. Advanced by Ron White. Oxford Supplementary Skills. Third Impression 1992. ISBN 0 19 435407 3 (particularly suitable for discursive, descriptive, argumentative and report writing). 2. College Writing Skills by John Langan. Mc-Graw-Hill Higher Education. 2004. 3. Patterns of College Writing (4th edition) by Laurie G. Kirszner and Stephen R. Mandell. St. Martin's Press. b) Presentation Skills c) Reading The Mercury Reader. A Custom Publication. Compiled by northern Illinois University. General Editors: Janice Neulib; Kathleen Shine Cain; Stephen Ruffus and Maurice Scharton. (A reader which will give students exposure to the best of twentieth century literature, without taxing the taste of engineering students).	

Course Name: **Linear Algebra And Differential Equations.**	**Course Code: MTH-401**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 03
Prerequisites: None	

Course Objectives

1. This course introduces matrices, determinants and differential equations for solving linear equations.
2. To enable the students about Practical applications of the in Bio-Informatics.
3. The aim is to provide a practical description of the topics, tools, issues and current trends in the fields including their impact on biology and human health and medicine.
4. Make students to polish their analytical skills.
5. Have well understanding to utilize this course in this program.

Course Outline: Introduction to matrices, elementary row operations and vector spaces: Brief introduction to matrices, system of linear equations, system of non-homogeneous and homogeneous linear equation, determinants, properties of determinants of order, axiomatic definition of a determinant, double and multiple integrals. Differential equations of first order, initial and boundary conditions, methods of solution of differential equation of first order and first degree, separable equation, homogeneous equation, first order linear differential equations, Bernoulli equations, Application of first order differential equations, Higher order linear differential equations, homogeneous linear equations, solution of higher order differential equation.

Recommended Books:

1. Linear Algebra, David C. Lay, Pearson Addison Wesley, 3rd Edition, July 18, 2002.
2. Advanced Engineering Mathematics, Michael Greenberg, and 2nd Edition.
3. Advanced Engineering Mathematics, 7/e, Erwin Kreyszig. John Wiley & Sons, 10th Edition, Seventh edition, August 11, 1992.
4. Text book of mathematics for B.Sc. part1.

Course Name: Biochemistry I	**Course Code:** Bio-411
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: None	

Course Objective: This course aims at

i. Preparing student nurse with basic biological molecules.
ii. To give the idea to the students to get the basic knowledge about the macromolecules along with their structure and bonding.
iii. They will familiarize with importance of these macromolecules needed various biological processes.

Course Outline

Water, pH and buffer systems, molecules of life, nucleic acid as genetic material, bilayers and membranes, Structure and functions of carbohydrates, saccharide chemistry, mono, di and polysaccharides, structure and function of protein amino acids the building block of proteins, levels of protein structures, protein structure and folding, physiological role of proteins, role in catalysis and signaling. lipids of physiologic importance with special reference to structure, assembly and functions of plasma membrane, structure and function of informational macromolecules, enzymes.

Lab Outline

Hydrolysis of a protein and qualitative tests for amino acids; paper chromatography of amino acids; estimation of proteins by Lowry‟s, dye-binding, titration curves of amino acids. Distinction between pentoses and hexoses, reducing and non-reducing sugars, acid value, saponification and iodine values of fat.

Recommended Books:

1. Nelson and Michel. 2005 LEHNINGER Principles of Biochemistry.4th Ed. Pub Freeman and Company.
2. Conn and Stumpf. 2002. Outlines of Biochemistry. John Willey and Son Pub.
3. Devlin and Thomas. 2002. Text book of Biochemistry with Clinical Correlations. 5th Ed.
4.Campbell M and Shawn F. 2003. Biochemistry. 4th Ed. Thomas Book Pub.
5.U.Satyanarayana and U.Chakrapani.2009. Biochemistry**.** 3rd Ed. Books and Allied (P) Ltd.

Course Name: Essential of Genetics	**Course Code:** Bio-412
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 3+1**
Prerequisites: Biochemistry I	

Course Objective

1. This course provides the basic principles of inheritance. Students will gain experience in variety of molecular techniques used in gene analysis.
2. Course will help develop tools aid in the comparison of genetic and genomic data and more generally in the understanding of evolutionary aspects of molecular biology

Course Outline:

Genetics introduction, Patterns and principles of inheritance, Mendelian inheritance, sex determination and sex-linked inheritance. Genetic linkage and gene mapping. Maternal inheritance and organelles. Physical structure of genes, chromosomal aberrations, tetrad analysis, Probability and pedigrees, transgenes. Mechanisms of Evolution, Population genetics and genetic variation, Hardy-Weinberg principle

Lab Outline

Determine ABO blood typing. Problems solving related to Mendelian inheritance. Problems solving in

ABO blood typing in Humans.

Recommended Books:

1. James M. and David V. 1997. The Book of Genetics. 2nd Ed.Ser.ELDs Pub.
2. Tortora et al. 2001. Microbiology an introduction. 7 Ed. Benjanium Lumming.
3. William S. Klug and Michael R. Cummings V.2001. Concepts of Genetics. 4 Ed.
4. Griffiths, Anthony J. F., Jeffrey H. Miller, David T. Suzuki, Richard C. Lewontin, and William M. Gelbart. *An Introduction to Genetic Analysis*. 7th ed. New York: W. H. Freeman, 2000.

Course Name: Data Structures and Algorithms	**Course Code: CSC-422**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4

Prerequisites: Programming fundamentals

Course Objective:

The course is designed to teach students structures and schemes, which allow them to write programmes to efficiently manipulate, store, and retrieve data. Students are exposed to the concepts of time and space complexity of computer programmes.

Intended Learning Outcomes:

After the completion of this course student would be able to write efficient programme using different data structures.

Course Outline:

Introduction to data structures (Basics of Data Structure: definition, types, operations performed, algorithms introduction),Arrays, Stacks, Queues, Priority Queues,,Linked Lists, Double linked lists, circular,Trees (types and traversals algorithms), Spanning Trees, Graphs and Traversals, isomorphoric graphs,Strategies for choosing the appropriate data structure, Recursion(tail, non-tail,indirect,nested), tail back tracking, Searching algorithms (Linear and Binary search), Sorting algorithms (Bubble, Insertion, Selection, Quick sort, Radix sort etc), Hashing , Storage and retrieval properties and techniques for the various data structures , Complexity analysis, memory management and garbage collection

Lab Outline:

Implementation of Basic Arrays, storing and Searching data in Arrays, implementation of Linear Search, implementation of Binary Search in Arrays, Using Bubble Sort, Selection Sort and Insertion on sample data, comparison study of simple sorting techniques, implementing Stacks and Queues, using priority queues for special cases, implementation of different types of Linked Lists for various applications.

Recommended Books:

1. Neil C. Jones, Pavel Persner , "An introduction to Bioinformatics Algorithms (Computational Molecular Biology)", 1st edition, 2004, MIT Press,.
2. John R. Hubbard , "Data structures with C++", Shaum's outline series., 1st edition, 2000, McGraw-Hill.
3. Goodrich, M.T. and Tamassia, R. and Mount, D.M. " Data Structures and Algorithms in C++", 2nd edition, 2011, John Wiley & Sons.
4. Robert Lafore, "Data Structures and Algorithms in Java", 2nd edition, 2002 Sams, Indianapolis, IN, USA.
5. Weiss, M.A. (Latest Edition). *Data Structures and Algorithm Analysis in Java.* Addison-Wesley
6. Sedgewick, R. (Latest Edition).*Algorithms in C++, Parts 1-4: Fundamentals, Data Structure, Sorting, Searching.* Addison-Wesley Professional.

Semester-IV

Course Name: Bioinformatics I	**Course Code:** BI-411
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4

Prerequisites: Computer fundamentals

Course Objective: The course is designed to introduce the most important and basic concepts, methods, and tools used in Bioinformatics. This course will introduce basic biological database sources, principles and methods for sequence and genome analysis. The overall aims are

a. To help the students to reach rapidly the frontier of bioinformatics and be able to use the bioinformatics biological Databases.

b. To convey the importance of bioinformatics for viewing the biomedical information.

c. To provide hands-on experience using Biological Databases searching, retrieving, critically evaluating results and interpreting their biological significance.

Course Outline

Introduction to Bioinformatics ,Historical Introduction,Goals,Scope,Applications,Limitations.Databases,Types of Databases, Biological Databases, Sequence Storage, Information retrieval and analysis, Sequence Alignment, Similarity and homology, Types of alignments, local and global alignment,. Methods of Alignment, pairwise and multiple sequence alignments, Significance of Sequence Alignment, Algorithm, Sequence Alignment Methods, dot matrix plots, dynamic programming algorithm, word (k-tuple) methods (BLAST and FASTA), substitution matrices PAM and BLOSUM, significance of scoring, gap penalties. Multiple Sequence Alignment. Uses of Multiple Sequence Alignment, Scoring Functions, Methods of Multiple Sequence Alignment, Position-Specific Scoring Matrices, Relationship of multiple sequence alignment to phylogenetic analysis,

Molecular phylogenetic, Phylogenetic Basis, Phylogenetic Tree construction methods and Programs.

Lab Outline

Accessing NBCI databases, sequence databases, Genbank, EMBL, SWISS-PROT Accessing structure database PDB, SCOP and CATH, Expasy server, using online alignment tools for pair wise and multiple sequence alignment, using BLAST and FASTA,phylogenetic analysis by ClustalW.

Recommended Books:

1. Arthur M. Lesk, Introduction to Bioinformatics.4th Edition (2008).Oxford University Press.
2. Ignacimuthu SJ. Basic Bioinformatics, 2nd Edition (2005) Narosa Publishing House.
3. S.C.Rastogi, N.Mendiratta,P.Rastogi,Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. 3rd Edition (2009). PHI Learning Pvt. Ltd.
4. David Mount, Bioinformatics: Sequence and Genome analysis.2nd Edition (2004). Cold Spring Harbour Laboratories.
5.Jin Xiong, Essential Bioinformatics,(2006), Cambridge University Press.

Course Name: Biochemistry II	**Course Code:** Bio-422
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 4**

Prerequisites: Biochemistry I

Course Objective:
This course focuses on macromolecules and their metabolisms with emphasis on various cellular pathways.

Course Outline Study of bioenergetics, introduction to metabolic pathways, metabolism of carbohydrates, Glycolysis, Citric acid cycle, Pentose pathway, electron transport chain, and oxidative phosphorylation, lipid metabolism, β-oxidation, ketone bodies formation and biosynthesis of triglyceride, protein metabolism, oxidative deamination and decarboxylation, transamination, urea cycle and amino acids metabolism, nucleic acid metabolism, break down and synthesis of pure and pyramidine bases.

Lab Outline

Estimation of normal and abnormal constituents in urine including glucose, albumin, uric acid, chloride and phosphate, Kidney Function test, Liver function test.

Recommended Books:

1. Nelson and Michel. 2005 LEHNINGER Principles of Biochemistry.4th Ed. Pub Freeman and Company.
2. Conn and Stumpf. 2002. Outlines of Biochemistry. John Willey and Son Pub.
3. Devlin and Thomas. 2002. Text book of Biochemistry with Clinical Correlations. 5th Ed.
4.Campbell M and Shawn F. 2003. Biochemistry. 4th Ed. Thomas Book Pub.
5.U.Satyanarayana and U.Chakrapani.2009. Biochemistry**.** 3rd Ed. Books and Allied (P) Ltd.

Course Name: Molecular Biology	**Course Code: Bio-423**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 4**
Prerequisites: Biochemistry I	

Course Objectives

1. To study classical and molecular aspects of cell.
2. The course emphasizes about the chromosome structure, transfers of genetic information, gene expression and regulation of gene activity.
3. The course is basis for structural biology, it aids in the simulation and modeling of DNA, RNA, and protein structures as well as molecular interactions.

Course Outline

Introduction to Molecular Biology. Basic concepts about DNA, RNA and proteins with special emphasis on nature of genetic material and its organization in viruses, prokaryotes and eukaryotes, Structure function and replication of DNA,DNA as Heritable material structure of DNA, physical structure of genes. Gene Expression Genetic Code, Codon, Anticodon, Ribosome, Translation, Gene Expression in Prokaryotes, the lac operon, Gene Expression in eukaryotes,Molecular Basis of Mutation Basis of mutation. RNA processing, splicing and editing, translation and post-translational modifications, control of gene expression in prokaryotes and eukaryotes. Introduction about plasmids and vectors. Recombinant Technology,CRISPR/CAS9-Targeted Genome Editing.

Lab Outline

Isolation of DNA from plant cells, Protocols for isolation of DNA from blood. Protocols for Amplification of DNA by PCR. Gel Electrophoresis

Recommended Books:

1. David M. P. Academic Press London, Methods in Cell Biology Lowery Sekivetz. Cell Structure and Function. John Willey and Sons Publication.
2. Gerald Karp - Cell and molecular biology concepts and experiments - Hoboken, NJ - John Wiley - 2010 - 5th Ed.
3. Brown T. A. Gene Cloning and DNA Analysis: An Introduction, 6th Edition, 2010
4. Robert Weaver. Molecular Biology. McGraw Hill, 5th Edition, 2007.
5. James D. Watson, Tania A. Stephen P. Bell, Alexander Gann, Michael Levine, Richard Losick, Molecular Biology of the Gene, *Pearson*,7th Edition.*2014*.

Course Name: Probability & Biostatistics	**Course Code:** BI-401

Course Structure: Lectures: 2, Labs: 1	**Credit Hours:** 3
Prerequisites: None	
Course Objective: This course introduces the concepts of statistical methods used in analyzing biological data.	
Course Outline Frequency distribution and probabilities, measure of central tendencies and dispersion, Elementary probability theory, Laws of Probability, Conditional Probability, Introduction to Bayes Theorem Introduction to Random Variable and Probability Distributions, Binomial Distribution, Properties of binomial distribution, Poisson distribution, Normal distribution area under the normal curves, Introduction to sampling and various sampling design, Applications of Normal distributions and tests of significance,. Test of independence or association, method related to one and two means, variance and covariance, heritability and its uses, analysis of variance (ANOVA), regression analysis, Pedcheck and merlin for LOD score calculation.	
Lab Outline Collection of data, acquisition of random samples, graphical/tabular representation of data, MS-Excel, SPSS/R, problems related to combining probabilities, central tendencies and dispersion, problems related to chi-square, problems of goodness of fit and independent events, verification of genetic ratios and test of association.	
Recommended Books: Latest editions of following books 1. Gravetter Frederick J. Statistics for Behavioral Sciences. 2. Mead R Curnow R. N. Statistical Methods in Agriculture and Experimental Biology. Chairman and Hall. 3. Mathews and Farewell: Using and understanding Medical Statistics, Krager New York.	

Course Name: Object Oriented Programming	**Course Code: CSC-412**
Course Structure: Lectures: 3, Lab: 1	**Credit Hours:** 4
Prerequisites: Programming Fundamentals	
Course Objectives: The course aims to focus on object-oriented concepts, analysis and software development. **Intended Learning Outcomes:** - After completion of the course students will be able to develop programs using Object Oriented Paradigm. - Identify the key principles in object-oriented programming (OOP);	

- Apply core OOP principles and techniques as well as advanced features provided by modern programming languages to computer programming
- Apply practical knowledge of OOP design and implementation to application development;

Course Outline

Evolution of Object Oriented (OO) programming, OO concepts and principles. Problem solving in OO paradigm. OO programme design process, classes, methods, objects. encapsulation; Constructors(Constructors with parameters, Default copy constructor) Destructors, Static data member, Friend functions, Friend classes, Static functions, Operator Overloading(Unary and Binary) ,Function overloading. Function overriding, derived classes, Inheritance (Multiple and multilevel, public, private and protected inheritance), Containership, Virtual functions and pure virtual functions, Polymorphism.Virtual base class, Templates,I/O and file processing, Exception handling, Association, Aggregation, Composition, Generalization.

Lab Outline

Programs implementation according to the Course outlines.

Recommended Books:

1. Complete Reference Java by "Herbert Schildt".
2. Bayross, I., (Latest Edition). Web enabled Commercial application development using JAVA.BPS Publications.
3. Lewis, J., and Loftus, W., (Latest Edition).JAVA software solutions.Sddison.Wesley Longman,Inc.
4. Object Oriented Programming by "Robert Lafore", JAVA How To Program Third edition by Deitel & Deitel.
5. Cay S. Horstmann,: 0, Java For Everyone, 978-1-1180-6331-6

Semester-V

Course Name: Discrete structures	**Course Code: CSC-304**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3
Prerequisites: Basic Calculus	

Course Objective

Introduces the foundations of discrete mathematics as they apply to Computer Science, focusing on providing a solid theoretical foundation. Further, this course aims to develop an understanding and appreciation of the finite nature inherent in most Computer Science problems and structures through study of combinatorial reasoning, iterative procedures, predicate calculus, tree and graph structures. In this

course emphasis shall be given to statistical and probabilistic formulation with respect to computing aspects.

Intended Learning Outcomes:

After completing the course, the students will:

- Have an understanding of standard propositional logic and logic connectives
- Have an understanding of algorithm and their complexity
- Have an understanding of graphs and be able to solve real world problems using Computer Science.

Course Outline: Introduction to logic, symbolic representation of statements, truth tables, logical equivalence, Laws of Logic,Predicate Calculus, quantifiersSets, set operations, Venn diagram, set identities, paradox**,**Sequences, arithmetic sequence, geometric sequence**,**Methods of Proof: Direct proofs; proofs by contradiction**,**Mathematical Induction**,**Relations (Recursion),Relations**,**Functions and relations, non-functions, types of functions, composition of functions, Recursion, recursively defined functions**,**Elementary number Theory, Applications of number theory Cardinality and countability**,**Pigeonhole principle**,**Graphs, types of graphs, paths, circuits, walk, matrices, directed graphs, isomorphism of graphs, graph coloring**,**Trees, types of trees, binary tree, representation of algebraic expressions by binary trees, spanning trees, minimal spanning tree, Kirchhoff's theorem**,**Optimization, shortest path problem, network flow**,**Discrete Probability, probability theory, Combinatorics, sum rule, product rule**,**Negation, Conjunction, Disjunction, rules of interference, partial orderings and peano postulates.

Recommended Books:

1. Kenneth H. Rosen, *Discrete Mathematics and Its Applications*, 6th edition, 2006, McGraw Hill Book Co.

2. Richard Johnsonbaugh, *Discrete Mathematics*, 7th edition, 2008, Prentice Hall Publishers.

3. Kolman, Busby & Ross, *Discrete Mathematical Structures*, 4th edition, 2000, Prentice-Hall Publishers.

4. Ralph P. Grimaldi and Rose-Hulman. *Discrete and Combinatorial Mathematics; an Applied Introduction*, 1985, Addison-Wesley Longman Publishing Co., Inc., Boston, MA, USA.

Course Name: Research Methodology	**Course Code**: Bio-501
Course Structure: Lectures: 2, Labs: 0	**Credit Hours:** 2
Prerequisites: Biochemistry	

Course Objective:

The basic concept of this course is to provide knowledge about how to design a research project and present it a professional manner.

Course Outline

The main objectives of this course are: to understand the concepts of basic and applied research and their usefulness, formulation of research objectives, Communication in biosciences, Sources of Scientific Information, Searching for Scientific information,Library Technology, Electronic Searches, Primary Literature Searches, Primary Literature,Reading scientific papers, Research projects: applying the scientific method, types of projects and ideas for research,Critical analysis of research results, biostatistical methods used in data analysis Presenting Information: How to communicate outcomes and conclusions, Presenting figures and tables Presenting results, Writing reports.use of reference manager software (Endnote).

Recommended Books:

Latest texts related to research methodology.

Course Name: Database Management Systems	**Course Code: CSC-524**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4

Prerequisites: None

Course Objective:

The course aims to introduce basic database concepts, different data models, data storage and retrieval techniques and database design techniques. The course primarily focuses on relational data model and DBMS concepts.

Intended Learning Outcomes:

After completing the course, the students will be familiar with data modelling concepts used in DB development .undertake and successfully complete logical data base design tasks. be familiar with a broad range of data management issues, including data integrity, concurrency and security.

Course Outline:

Basic database concepts; Entity Relationship modeling, Relational data model and algebra,Structured Query language; RDBMS; Database design, functional dependencies and normal forms;query optimization concepts,Transaction processing and optimization concepts; concurrency control and recovery techniques; Database security and authorization. Small Group Project implementing a database. Physical database design: Storage and file structure; indexed files; b-trees; files with dense index; files with variable length records; Database efficiency and tuning.

Lab Outline:

Structured Query Language commands, creating and populating tables, design of simple databases, database normalization techniques, query optimization, indexing techniques, partial and full recovery techniques, developing GUI techniques, implementation of database security mechanisms.

Recommended Books:

1. Jeffrey A. Hoffer, V. Ramesh, Heikki Topi. MODERN DATABASE MANAGEMENT, 11th Edition, 2012, Prentice Hall.
2. Connolly,R., Begg,P. Database Systems: A Practical Approach to Design, Implementation and Management, 5th Edition, 2009, Addison-Wesley Pub. Co.
3. Ramez Elmasri and Shamkant B. Navathe. Fundamentals of Database Systems. 6th Edition, 2010, Pearson.
4. C.J.Date,. An Introduction to Database System, 8th Edition, 2004, Addison-Wesley.

Course Name: Bioinformatics II	**Course Code:** BI-521
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4

Prerequisites: Bioinformatics I

Course Objective: This course is design to
a) to learn and locate various analysis tools for amino acid & nucleotide sequences & set the attributes for each tool and process sequence data & How RNA sequence relates to structure.
b) How protein sequence information can be used for genome annotation, gene prediction process, protein folding, structure and function prediction.
c) learn and locate various 2D & 3D protein modeling tools & quantitative methods for predicting 3D structures and gene expression.
d) develop hands-on experiences using software, critically evaluating results and interpreting their biological significance with the bioinformatics methods through guided exercises

Course Outline

Introduction to gene prediction, Basis of gene Prediction, Gene Prediction in prokaryotes and eukaryotes, gene Prediction Methods, ORF, TFBS, codon usage table, EST and SNP databases, primer designing, restriction enzyme databases, RNA structure prediction, computational secondary and tertiary protein structure prediction methods, hydrogen bonding, PTMs of proteins, Chou Fasman, PHD and PSIPred, neural network, X-ray crystallography, NMR, *ab initio*, threading and homology modeling, structure prediction evaluation, protein fold identification using Pfam and other tools.

Lab Outline

Online tools: Gene finder, ORF finder, EST database, SNP data, Primer 3, protein structure prediction using online server, protein structure visualizing using visualization programs, Secondary structure prediction, using pfam database.

Recommended Books:

1. Ignacimuthu SJ. Basic Bioinformatics, 2nd Edition (2005) Narosa Publishing House.
2. S.C.Rastogi, N.Mendiratta,P.Rastogi,Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery. 3rd Edition (2009). PHI Learning Pvt. Ltd.

3. Jin Xiong, Essential Bioinformatics,(2006), Cambridge University Press
4. David Mount, Bioinformatics: Sequence and Genome analysis.2nd Edition (2004). Cold Spring Harbour Laboratories.
5.Des.Higgins,Willie Taylor, Bioinformatics Sequence,Structure & Databanks. (2002) Oxfoard University Press.

Course Name: Ethical & Legal Issues in Bioinformatics	**Course Code:** BI-502
Course Structure: Lectures: 2, Labs: 0	**Credit Hours:** 2
Prerequisites: None	
Course Objective: This course introduces the ethical and legal aspects related to bioinformatics practices and products.	
Course Outline Social context of computing and biology, Intellectual property, Privacy and civil liberties, Economic issues in bioinformatics, monopolies and their economic implications, effect of skilled labor supply and demand on the quality of bioinformatics products, pricing strategies in the bioinformatics domain, differences in access to bioinformatics resources and the possible effects thereof. Health, psychological and legal issues in GMOs. Biosafety and Bio-security issues.	
Recommended Books: Latest editions of following books 1. Legal and Ethical Issues in Acquisitions. Edited by Katina Strauch. A Bruce Strauch. 2. Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing By Tom Forester, Perry Morrison. 3. Public Management Information Systems**.** By Bruce A Rocheleau. 4. Security in Computing**.** By Willis H. Ware, Charles P. Pfleeger, Shari Lawrence Pfleeger. 5. Computer Ethics: Cautionary Tales and Ethical Dilemmas in Computing By Tom Forester, Perry Morrison.	

Course Name: Genomics	**Course Code:** Bio-531
Course Structure: Lectures: 3, Labs: 1	**Credit Hours: 4**
Prerequisites: Biochemistry I/Molecular Biology	
Course Objective: Students will be trained to grasp knowledge about structural and functional genomics and their applications.	
Course Outline Introduction to genomics, genome anatomy, gene expression, genome evolution, genome mapping, DNA markers, linkage analysis. QTL, mutations, Human Genome Project, Microarray, Genevestigator, Non- coding RNAs and their regulation, siRNA.	
Recommended Books:	

1. Biochemistry. 3rd Ed. U.Satyanarayana and U.Chakrapani.2009.. Books and Allied (P) Ltd.
2. Analysis of Genes & Genomes. Richard J.Reece.2004 John Wiley & Sons, Ltd.
3. BIOINFORMATICS Methods & Applications By S.c Rastogi, N.Mendiratta.Prentic-Hall of India Private Limited.
4. Basic Bioinformatics By S.Ignacimuthu, S.j. Narosa Publishing House.

Semester-VI

Course Name: Bioinformatics Computing-I	**Course Code:** BI-522
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: Programming Fundamentals	
Course Objective: This course aims to introduce the concepts of data representation, searching, security and ownership. Develop techniques for pattern matching, recognition and their applications in bioinformatics.	
Course Outline: Databases: Data management, networks, geographical scope, communications models, transmissions technology, protocols, bandwidth, topology, hardware, contents, security, ownership, implementation, Search engines. Search process, search engine technology, searching and information theory, computational methods, knowledge management, data, sequence and structure visualization, data mining methods and technology, pattern recognition and discovery, pattern matching, dot matrix analysis, substitution matrices, dynamic programming, Scripting.	
Lab Outline: Simulation of various bioinformatics entities, application of various bioinformatics methods, scripting languages python, perl and PHP, and their applications in Bioinformatics.	
Recommended Books: 1. "Bioinformatics Computing" Bryan Borgeron, Pearson Education (US), 19 November 2002 . 2. "Methods in Biotechnology and Bioengineering", Vyas S.P. and Kohli D.V.2002. 3. *Bioinformatics Methods and Techniques*. Banatao, R. Stanford University, Stanford Center for Professional Development, 2002. 4. "What's Next in High-Performance Computing?" Bell, G. and J. Gray. *Communications of the ACM.*2002. 5. *Essentials of Knowledge Management*. Bergeron, B. New York: John Wiley & Sons, 2003.	

Course Name: Modeling & Simulation	**Course Code: CSC-637**
Course Structure: Lectures: 2, Lab: 1	**Credit Hours:** 3
Prerequisites: None	

Course Objective

This course emphasizes the development of modeling and simulation concepts and analysis skills necessary to design, program, implement, and use computers.

Course Outline

Baics, Performance modeling and evaluation, bench marking, performance evaluation of high parallel systems architecture, application of performance evaluation, measurement techniques, hardware monitoring, software monitoring, hybrid monitoring, fundamentals of queuing models, structure and performance parameters, operational analysis of queuing models, general features of queuing models, birth and death processes, m/m/i and m/g/1 systems, dependability modeling, analysis of reliable, available and 30 high assurance systems, fault-tolerant techniques, software reliability modeling, adaptive modeling, agent based modeling.

Lab Outline

Introduction to modeling techniques using simulation tools like MATLAB. Bioinformatics toolbox for various performance modeling,evaluation, analysis and study various queuing techniques.

Recommended Books:

1. Simulation Techniques for Discrete Event Systems By "I. Mitran", Cambridge Computer Science text 14, Published by University Press, Cambridge,1982.

2. Discrete Event system simulation/5th edition by "Banks,Jerry", Pearson Prentice Hall, 2009

3.Simulation modeling and analysis/3rd edition by "Law,A.M,Kelton and W.David, Mcgraw Hill,2000.

Course Name: Proteomics	**Course Code:** Bio-532
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 3

Prerequisites: Biochemistry I /Molecular Biology

Course Objective

This course intends to provide basic concepts regarding proteome and protein chemistry with special focus on protein identification techniques.

After taking this module, students should:

i) Be familiar with different types of sample preparation workflows.

ii) Be able to identify advantages and limitations of the major types of mass spectrometers and ion

sources, and appropriately select instrumentation that will provide useful information for a given proteomics application.

Course Outline

Introduction to proteomics and protein chemistry, Proteomics in relation to genomics and bioinformatics, Techniques for identification and separation of proteins. bioinformatics tools for analysis of proteomics data, proteomics databases, NMR and X-ray crystallography, 1D-SDS-PAGE ,2D-SDS PAGE. Gel electrophoresis, Detection and quantitation of proteins in gels. Basics of mass spectrometry. Malditof and ESI, and their application in proteomics. Tandem MS/MS spectrometry. Peptide sequencing by tandem mass spectrometry,Chromatography and its types, Microarrays,Proteomics of protein modification, Interactomes, Applications and future development of proteomics

Recommended Books:

1. Introduction to Proteomics: Principles and Applications by Nawin C. Mishra, Günter Blobel ISBN: 978-0-471-75402-2 **, 2011 edition**

2. HEYER, L. -- CAMPBELL, A. *Discovering Genomics, Proteomics and Bioinformatics.* USA: Cold Spring Harbor Lab. Press, 2006. 352 p. ISBN 0-8053-4722-4

3. Rastogi *et al.* Bioinformatics methods and applications. Genomics, Proteomics and Drug discovery.

4. *Mass Spectrometry - A Textbook*, 1st Ed., Springer-Verlag: Berlin, Heidelberg, 2004. ISBN-10 3-540-40739-1; ISBN-13 978-3-540-40739-3. E. de Hoffmann and V. Stroobant

5. Principles of Proteomics Advanced Texts by Richard Twyman,Publisher Garland Science, 2004, ISBN 0203507398, 9780203507391

Course Name: Graphics and Visualization	**Course Code: CSC-525**
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4

Prerequisites: Programming Fundamentals

Course Objective

This course is designed to provide a comprehensive introduction to computer graphics, learn concepts of computer graphics and its algorithms. The aim is to learn concepts of illumination, animation, shading and geometrical transformations. This will lead to the ability to understand contemporary terminology, progress, issues, and trends in computer graphics.

Intended Learning Outcomes:

After completion of the course students will be able to:

- Have an understanding of the concepts of computer graphics
- Be able to implement the concepts of computer graphics on a suitable platform

Course Outline:

Introduction, Applications of Computer Graphics, Overview of Image Representation,Graphics Hardware, Applications of Graphics, Image resolution, Image quality issues, Cathode Ray Tubes, Vector Display Devices, Colour Lookup Table, LCD Technology, Plasama, classes of logical input devices, Physical input devices, Interactive Devices,Scan-converting point, lines, ellipse, arcs and sectors, polygon, characters and circles,Line Drawing Algorithm: Digital Differential Analyzer, Bresenham's, Circle Drawing: mid-point, Line Algorithms,Scaling, Rotation, Translation, composite transformations: 2D and 3D,Region Filling, aliasing effects, anti-aliasing, image compression,Window to Viewport mapping, 2-D Clipping, point clipping, line clipping, polygon clipping,Panning and Zooming,Projections: Taxonomy of projection, perspective projection orthogonal projection,Advanced geometric and Raster Algorithms, Clipping scan converting primitives, special problems with text, making copyPixel fast, Page description languages,Hidden Surfaces, depth comparisons, Z-buffer algorithm, Back-Face Removal, Scan-line algorithm, Hidden Line Elimination, Rendering of mathematical surfaces,Curve and Surface Design, simple geometric forms, wireframe models, curved surfaces, curve design, polynomial basis function, curved-surface design,Rendering, Shading, Phong Model, Colour and Animation, basic rules of animation,Ray tracing, the Pinhole Camera, Ray-surface intersection, A recursive ray tracer,Hardware for interactive graphics: fundamental graphics unit, rasterizer, pixel driver,Segmentation, two and three dimensional image geometry and transformation

Lab Outline:

Line drawing techniques, clipping effects, 2D and 3D representations and transformations using open GL, development of graphical user interface with various blocks and modules, elliptical and curve creation exercises.

Recommended Books:

1. Foley, J.D., Dam,A.V., Feiner,S.K., Hughes,J.F. (Latest edition) *Computer Graphics, Principles and Practice.* Addison-Wesley .
2. Hill,. F.S.(Latest edition) *Computer Graphics*.MacMillan.
3. Burger,P., Gillies,D.F. (Latest edition). *Interactive Computer Graphics: Functional, Procedural and Device-level methods.* Addison-Wesley.
4.Computer Graphics (C Version), by Donald Hearn and M. Pauline Baker (Prentice Hall, 1997)
5.Graphics & Visualization Principles and Algorithms by Theoharis, Georgios Papaioannou.
6.Matthew Ward,Georges Grinstein, Daniel Keim. Interactive Data Visualization: Foundations, Techniques, and Applications. (May, 2010).

Course Name: Special Topics in Bioinformatics	**Course Code: BI-523**

Course Structure: Lectures: 3, Labs: 0	**Credit Hours: 3**
Prerequisites: Bioinformatics I	
Course Objective: This course intends to introduce recent advances in bioinformatics	
Course Outline: The course will review the major advances in Bioinformatics. Students are required to make presentation of the selected topics as determined by the faculty members / Coordinator conducting Bioinformatics Programme.	
Recommended Books: 1. Namita M. Bioinformatics concepts, skills and applications, CSB publishers and distributors. 2. Lacroix Zor. Bioinformatics managing scientific data, Morgan Kaufmann publishers. 3. Higgs Paul. G. Bioinformatics and Molecular evolution, Black well Publishing. 4. Schulze. S. Kremer. Advances in molecular Bioinformatics, Netherland Printing.	

Semester-VII

Course Name: Bioinformatics Computing II	**Course Code:** BI-621
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:** 4
Prerequisites: Bioinformatics Computing I	
Course Objective This course introduces advanced concepts of artificial intelligence, neural networks and pattern recognition for solving bioinformatics problems.	
Course Outline: This course emphasized on cellular, tissue, organ and system modeling, simulation, analysis using an object oriented programming languages, Bio-inspired computation, evolutionary algorithms, Swarm Intelligence, neural networks, application of neural networks to Bioinformatics, neural computation, approximate matching algorithm and their applications for DNA Matching.	
Lab Outline: Simulation and application of neural network related techniques for bioinformatics, implementation of approximate matching algorithms, DNA matching algorithms and applications.	

Recommended Books:
Latest editions of following books 1. "Bioinformatics Concepts, Skills and Applications" Namita M, CSB Publishers. 2. "Bioinformatics Managing Scientific Data", Lacroix Zor, Morgan Kauffmann Publishers.

Course Name: Bioinformatics Software Engineering	**Course Code: BI-622**
Course Structure: Lectures: 2, Labs: 1	**Credit Hours: 3**
Prerequisites: None	
Course Objective: This course introduces the software engineering principles and methodologies with the goal of developing bioinformatics applications	
Course Outline: Software development methodology, waterfall model, iterative model, rapid application development, prototyping, software life cycle. Development of software projects for bioinformatics problems, overview of software architecture, web based applications architecture, developing front end applications.	
Lab Outline: Introduction to software development techniques, implementation of various software models using simple case studies, introduction to HTML, XML, use of front end application tool.	
Recommended Books: 1.Ian Sommerville, Software Engineering, Eighth Edition, Addison-Wesley, 2001 2.Roger S. Pressman,Software Engineering: A Practitioner's Approach, Seventh Edition.McGraw-Hill, 2001 3.Bioinformatics software engineering by Paul Weston. 4.Namita M . 2003. Bioinformatics concepts, skills and applications.CSB publishers and distributors.	

Course Name: ELECTIVE I (Microbiology and immunology)	**Course Code:** BIE-611
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:**3
Prerequisites: None	
Course Outlines: The course is chosen from the list of elective and course content will be design by the subject teacher at the time of teaching according to the need and requirements of discipline.	

Course Name: ELECTIVE II (Operating System)	**Course Code:** BIE-612

Course Structure: Lectures: 3, Labs: 1	**Credit Hours:**4
Prerequisites: None	
Course Outlines: The course is chosen from the list of elective and course content will be design by the subject teacher at the time of teaching according to the need and requirements of discipline.	

Course Name: System Biology	**Course Code:Bio-641**
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:** 03
Prerequisites: Probability & Statistics, Linear Algebra & Differential Equations,Genomics	
Course Objective **1.**The purpose of the course is to introduce the students to the field of systems biology and to provide an understanding of the cell at systems level.	
Course Outline: Introduction to systems biology; modeling of biochemical systems; kinetic modeling of enzymatic reactions; law of mass action; Michaelis-Menten Kinetics; rate equation; model systems: lac operon, phages, plasmids and chemotaxis; analysis of high throughput data; gene expression models; stochastic modeling of biological systems; chemical master equation. stochastic simulation, fluctuations in gene expression; biological networks; network structure, network dynamics and function; network motifs, network modularity.	
Recommended Books: Latest editions of following books 1. Klipp, E., Wolfram L., Christoph W., Axel K., Hans L., and Ralf H., "Systems biology", Wiley. 2. Ullah, M., and Olaf W., "Stochastic approaches in systems biology", Springer. 3. Newman M., "Networks: An Introduction", Oxford University Press, USA. 4. Alon U., "An introduction to systems biology: design principles of biological circuits. Boca Raton", Chapman & Hall/CRC.	

Semester-VIII

Course Name: Artificial Intelligence	**Course Code:** CSC-543
Course Structure: Lectures: 2, Labs: 1	**Credit Hours:** 3

Prerequisites: Data Structures and Algorithms, Discrete Structures

Course Objective

This course studies four main objectives of AI. Modeling the environment by constructing computer representations of the real world. Perception and reasoning - obtaining and creating information/**knowledge** to populate a computational representation. Taking actions by using the knowledge of the environment and desired goals to plan and execute actions. Learning from past experience.

Intended Learning Outcomes

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

- Develop an understanding of the role of AI in various fields of life
- Understand the thinking, reasoning capabilities and expertise of human beings
- Learn various tools for representing human intelligence and expertise in machines.
- Knowledge about structure and working of expert systems, and robotics.

Course Outline:

Artificial Intelligence: Cybernetic intelligence, Introduction, Intelligent Agents. Problem-solving: Solving Problems by Searching, Informed Search and Exploration, Constraint Satisfaction Problems, Adversarial Search. Knowledge and reasoning: Logical Agents, First-Order Logic, Inference in First-Order Logic,Knowledge Representation. Planning and Acting in the Real World. Uncertain knowledge and reasoning: Uncertainty, Probabilistic Reasoning, Probabilistic Reasoning over Time, Making Simple Decisions, Making Complex Decisions. Learning: Learning from Observations, Knowledge in Learning, Statistical Learning Methods, Reinforcement Learning. Communicating, perceiving, and acting: Communication, Probabilistic Language Processing, Perception and Robotics. Introduction to LISP/PROLOG and Expert Systems (ES) and Applications.Artificial general intelligence, Issues in safe AI, Introduction to cognitive and conscious systems.

Recommended Books:

1. Kumar, E., Artificial Intelligence, 2008, I.K. International Publishing House Pvt. Limited.
2. Stuart Russell and Peter Norvig, Artificial Intelligence: A Modern Approach, 3rd edition, 2009, Pearson.
3. Spivey, M., An Introduction to Logic Programming Through Prolog, 2002, Prentice Hall International Series in Computer Science.
4. Luger, G.F. (Latest Edition).Artificial Intelligence: Structures and Strategies for Complex Problem Solving. Pearson Education.

Course Name: ELECTIVE III (Modern Programming Languages)	**Course Code:** BIE-613
Course Structure: Lectures: 3, Labs: 1	**Credit Hours:**4
Prerequisites: None	
Course Outlines: The course is chosen from the list of elective and course content will be design by the subject teacher at the time of teaching according to the need and requirements of discipline.	

Course Name: ELECTIVE IV (Modern Phylogeny and Evolution)	**Course Code:** BI-614
Course Structure: Lectures: 3, Labs: 0	**Credit Hours:**3
Prerequisites: None	
Course Outlines: The course is chosen from the list of elective and course content will be design by the subject teacher at the time of teaching according to the need and requirements of discipline.	

Course Name: Research Project	**Course Code:** BI-689
Course Structure: Lectures: 0, Labs: 6	**Credit Hours:**3
Prerequisites: None	
Course Outlines: The student can opt for research project/Internship/Optional subjects from the list of elective. The research project will be supervised and directed by a full time faculty member of the department.	

RECOMMENDED BOOKS:

The latest editions of:

Cell and Molecular Biology: Concepts and Experiments Gerald Karp John Wiley and Sons
Introduction to Computational Molecular Biology Setubal, Meidanis Brooks/Cole
Principles and Techniques of Biochemistry and Molecular Biology Keith Wilson, John Walker Cambridge University Press
Instant Notes: Biochemistry B D Hames Viva Books Pvt. Ltd.
Basics of Theoretical and Computational Chemistry BM Rode John Willey and Sons
Instant Notes: Genetics P C Winter Viva Books Pvt. Ltd.
Instant Notes: Molecular Biology P C Turner Viva Books Pvt. Ltd.
Molecular Cloning: A laboratory manual Sambrook Cold Dpring Harbor, Laboratory Press.
Instant Notes: Bioinformatics David R. Westhead, J. Howard Parish and Richard M. Twyman Viva Books Pvt. Ltd.
Bioinformatics for Dummies Jean-Michel Claverie,Cedric Notredame Wiley Publishing, Inc.
Essential Bioinformatics Jin Xiong Cambridge University Press.
Bioinformatics Bal Tata McGraw-Hill.
Bioinformatics Andrzej Polański, Marek Kimmel Springer.
Bioinformatics: An Introduction Jeremy Ramsden Springer.
Bioinformatics: A Concept-based Introduction Venkatarajan Subramanian Mathura, Pandjassarame Kangueane Springer.
Bioinformatics: Tools and Applications David Edwards, Jason Eric Stajich, David Hansen Springer.
Bioinformatics: Principles and Basic Internet Applications Hassan A. Sadek Trafford Publishing, Canada.
Bioinformatics: Applications in Life and Environmental Sciences M. H. Fulekar Springer.
Bioinformatics: A Practical Approach Shui Qing Ye Chapman & Hall / CRC.
Applied Bioinformatics: An Introduction Paul M. Selzer, Richard J. Marhöfer, Andreas Rohwer Springer.
Bioinformatics: A Practical Guide to the Analysis of Genes and Proteins Andreas D. Baxevanis, B. F. Francis Ouellette John Wiley and Sons, USA.
Bioinformatics: a Swiss perspective Ron D. Appel, Ernest Feytmans World Scientific, Singapore.
Bioinformatics: Genomics and Post-genomics Frédéric Dardel, François Képès, Translated by Noah Hardy John Wiley and Sons, France.
Bioinformatics: Methods and Applications: Genomics, Proteomics and Drug Discovery S. C. Rastogi, Namita Mendiratta, Parag Rastogi PHI Learning Pvt. Ltd.
Bioinformatics and drug discovery Richard S. Larson Humana Press.
Computational molecular biology: an algorithmic approach Pavel Pevzner MIT Press.
Bioinformatics algorithms: techniques and applications Ion Măndoiu, Alexander Zelikovsky Wiley-Interscience.
Bioinformatics: problem solving paradigms Volker Sperschneider, Jana Sperschneider, Lena Scheubert Springer.
Parallel computing for bioinformatics and computational biology Zomaya A. Y. John Wiley & Sons, Inc.
Research and trends in data mining technologies and applications David Taniar Idea Group Inc (IGI).
Machine learning in bioinformatics Yan-Qing Zhang, Jagath Chandana Rajapakse John Wiley and Sons.
Computational Intelligence in Bioinformatics Árpád Kelemen, Ajith Abraham, Yuehui Chen Springer.
Bioinformatics and the Cell: Modern Computational Approaches in Genomics, Proteomics and Transcriptomics Xuhua Xia Springer.

Bioinformatics for Dummies 2nd Edition Jean-Michel Claverie and Cerdric Notredame
Bioinformatics-Sequence and Genome Analysis David W. Mount.
Introduction to Bioinformatics T K Attwood and D J Parry-Smith.
Bioinformatics-Gene, Proteins and Computers C. A. Orengo, D. T. Jones and J. M. Thornton.

CURRICULUM

OF

BIOINFORMATICS
MS

(Session 2018 Onwards)

MASTER OF SCIENCE (MS) IN BIOINFORMATICS

Introduction:

The purpose of MS degree programme in bioinformatics is to provide the students with an advanced knowledge and practices that will train them to decipher the biological processes with the help of computational tools. Exponential growth and complexity of biological data can be translated effectively into knowledge by the use of computer based approaches.

General objectives

The enormous influx of biological data can only be handled with better and faster computational approaches together with advanced knowledge in functional genomics and proteomics. Advanced concepts, structures, algorithms and tools are required for effective processing and analysis. Specialized courses in molecular biology, bioinformatics and computation are needed to achieve these objectives.

Program objectives

At the end of MS program, the graduates should be able to:

1. Develop innovative computer applications to solve biological problems
2. Facilitate other researchers using bioinformatics tools and databases
3. Undertake problem-based research
4. Tackle research based problems in various industries such as pharmaceutical, biotechnology, software industry etc

Learning Outcomes

After completion of MS program in bioinformatics, the graduates will be able to:

- Answer questions about molecular evolution, biological functions and control of biological systems
- Use bioinformatics skills to predict functions from structures, networks, complexes, transcriptome and proteome data
- Develop advanced computational applications related to bioinformatics

Admission Requirements:

Eligibility:

1. BS in Bioinformatics/Biological Sciences/Computer sciences/ Biotechnology or equivalent in relevant disciplines (deficiency courses to be completed if needed).
2. 2nd Division or GPA 2.50 or above.
3. Subject GRE/NTS or in-house written test.
4. Interview.

Duration:

2 years (course work may be completed in two semesters and one year for research work).

Total Credit Hrs: 30 (24 credit hours course work + 6 credit hours thesis).

Scheme of Studies for MS Program in Bioinformatics Semester I and II

Note:
Students coming from computer and physical sciences background must take 1-2 courses from group A and may take at most one course from group B. Similarly, students coming from biological sciences background must take 1-2 courses from group B and may take at most one course from group A.

Students coming from bioinformatics background may take at most 1 course each from groups A and B.

Remaining credit hours for all students must be completed from group C.

Group A- Biological Sciences

1. Advance Molecular Biology
2. Cell Biology
3. Genomics
4. Proteomics
5. Metabolomics
6. Microbial Genetics
7. Biochemistry
8. Gene Manipulation
9. Enzymology
10. Epigenetics.
11. Immunology
12. Biostatistics
13. Advance System biology
14. DNA microarrays and integrative genetics
15. Functional genomics
16. Clinical Epidemiology
17. Research Method in Biological Sciences
18. Gene regulation and expression
19. Principles and application of proteomics
20. Medical genetics
21. Introduction and Applications of Biotechnology.
22. Molecular Biophysics
23. Advance Molecular Techniques.

Group B- Computer Sciences

1. Fundamentals of Programming
2. Object Oriented Programming
3. Data structure
4. Database Design
5. Software engineering
6. Graphics and visualization
7. Probability and Statistics
8. Data warehousing and Data mining
9. Molecular dynamics simulation
10. Intelligent systems
11. Advance topics in information systems
12. Neural Computing
13. Data Mining
14. Advanced Computer Programming
15. Advanced Database Systems
16. Agile Software Development
17. Design and Analysis of Algorithms
18. Natural Language Processing
19. Numerical Computing
20. Advanced Digital Image Processing
21. Information Processing.
22. Modern Programming Languages.

Group C- Bioinformatics

1. Genome Informatics/Computational Genomics
2. Advanced Bioinformatics/Computational Biology
3. Computational Systems Biology
4. Protein Informatics/Computational Proteomics
5. Computational Drug Design
6. Computational Molecular Evolution
7. Biophysics
8. Molecular Modelling and Simulation
9. Mathematical Models in Biology
10. Machine Learning
11. Metagenomics
12. Data Mining
13. Stochastic Modeling
14. Computational Neuroscience
15. Synthetic Biology
16. Cheminformatics
18. Health informatics
19. Big data analysis and management
20. Current trends in bioinformatics
23. Mathematical modeling and Simulation
24. Neural Computing and Genetics Algorithms
25. Pathways and Networks in Biology
26. Bioinformatics Scripting and Programming
27. R for Bioinformatics
28. Statistical Methods for Computational Biology
29. Advances In Molecular Dynamics.
30. Pattern Recognition and Matching.
31. Bioinformatics Algorithms.
32. Medical Image Processing.

Scheme of Studies for MS Program in Bioinformatics

Semester I and II

Note:
Students coming from computer and physical sciences background must take 1-2 courses from group A and may take at most one course from group B. Similarly, students coming from biological sciences background must take 1-2 courses from group B and may take at most one course from group A.

Students coming from bioinformatics background may take at most 1 course each from groups A and B.

Remaining credit hours for all students must be completed from group C.

A: <u>Students Coming From Biological Sciences Background</u>

Course Code	Semester 1 (Credit Hours)		Course Code	Semester 2 (Credit Hours)	
	Courses	Credit Hours		Courses	Credit Hours
***	Elective I From the List of Group B	3	***	Elective II From the List of Group B	3
BI-621	Advance Bioinformatics	3	BI-624	Computational Drug Design	3
BI-622	Genome Informatics	3	BI-625	Molecular Modeling & Simulation	3
BI-623	Protein Informatics	3	BI-626	Bioinformatics Scripting and Programming	3
Total Credit Hours		**12**	**Total Credit Hours**		**12**
Semester 3 & 4 (Credit Hours)					
BI-650	Research/Thesis		**6**		
	Total Credit Hours		**30**		

B: <u>Students Coming From Computer Sciences Background</u>

Course Code	Semester 1 (Credit Hours)		Course Code	Semester 2 (Credit Hours)	
	Courses	Credit Hours		Courses	Credit Hours
	Elective I From the List of Group A	3		Elective II From the List of Group A	3
BI-621	Advance Bioinformatics	3	BI-624	Computational Drug Design	3

BI-622	Genome Informatics	3	BI-625	Molecular Modeling & Simulation	3
BI-623	Protein Informatics	3	BI-626	Bioinformatics Scripting and Programming	3
Total Credit Hours		**12**	**Total Credit Hours**		**12**
Semester 3 & 4 (Credit Hours)					
BI-650	Research/Thesis **Total Credit Hours**		**6** **30**		

C: <u>Students Coming From Bioinformatics Background</u>

Course Code	**Semester 1 (Credit Hours)**		**Course Code**	**Semester 2 (Credit Hours)**	
	Courses	**Credit Hours**		**Courses**	**Credit Hours**
	Elective I From the List of Group A	3		Elective II From the List of Group B	3
BI-621	Advance Bioinformatics	3	BI-624	Computational Drug Design	3
BI-622	Genome Informatics	3	BI-625	Molecular Modeling & Simulation	3
BI-623	Protein Informatics	3	BI-626	Bioinformatics Scripting and Programming	3
Total Credit Hours		**12**	**Total Credit Hours**		**12**
Semester 3 & 4 (Credit Hours)					
BI-650	Research/Thesis **Total Credit Hours**		**6** **30**		

Note
In addition to the above, the universities can offer any other course in the respective groups according to their specialization.

Semester III and IV
Research Thesis (6 Credit Hours)

Research Project
1. Duration of the research project will be at least two regular semesters. An independent research topic chosen by the student and supervised by a full-time faculty member of the department is required for all students in M.S Bioinformatics.
2. The research work of each student will be reviewed periodically by the supervisor/head of department to ensure the objectives laid down for study are being met.
3. All students must present and defend their research work before the panel of examiners as per the rules of the university.

Recommended Text Books For MS Bioinformatics Programme

1. Bioinformatics: sequence and Genome Analysis, David W. Mount.
2. Bioinformatics: A practice Guide to Analysis of Gene and Proteins Andreas Baxevnis, B. F. Francis Ouellet.
3. Developing Bioinformatics Computer Skills, Cynthia Gibbs, Per Jambeck.
4. Discovering Genomics, Proteins and Bioinformatics, A. Makom Cambell, Laurie J. Heyer.
5. Microarray Bioinformatics, Dov Stekel, Ed Southern.
6. Introduction to Bioinformatics, Arthur M. Lesk.
7. Bioinformatics Computing, Bryan P. Bergeron.
8. A Primer of Genome Sequencing, Greg Gibson.
9. Instant Notes on Bioinformatics, Howard J. Parish.
10. Bioinformatics and functional Genomics, Donis Marshall, Jonathan Persner.
11. Bioinformatics: The Machine learning approach, Pierre Baldi, Sren Brunak, Soren Brunak.
12. An introduction to Bioinformatics, Algorithims Neil C. Jones, Pavel A. Persner.
13. Essentials of Genomics and Bioinformatics, C.W Sensen.
14. Bioinformatics, Biocomputing and Perl. An introduction to Bioinformatics Computing Skills and Practice Michael Moorhouse, Paul Berry.
15. Statistical Methods in Bioinformatics Warren Ewens, Gregory Grant.
16. Microarray for An Integrative Genomics S. Isaac, J-Atul, Alvin Khd
17. Bioinformatics; Sequence and Databanks: A Practical Approach Des Higgins, Willie Taylor.
18. Genomic Perl: From Basic To Workinf Code Rex A.Dwyer
19. Bioinformatics: From Genome To Drugs, Vol 1: Basic Technologies
Vol 2: Application Thomas Lengauer.
20. Biotechnology, Genomics and Bioinformatics Teresa Atwood, David Perry-Smith
21. Introduction To Bioinformatics Teresa Atwood, David Perry-Smith
22. Structured Bioinformatics Philip Bourne, Helge Weissig
23. Bioinformatics Methods and Protocols Stephen Misener, Stephen Krawetz.
24. New Biology for Engineers and scientists, Aydin Tozeren, Stephen W.Byers.
25. Computational Molecular Biology: An Introduction, Peter Clote, RlfBackofen.
26. Bioinformatics in Post-Genomic Era: Genomic Transcription, Proteome and Information Based Medicine Jeffery Augen.
27. Bioinformatics: Using Computational Intelligence Paradims U. Seiffert, L.C.Jain, Pschwetzer
28. Introduction To Bioinformatics: a theoretical and Practical Approach Stephen Krawetz, David D.Womble.
29. Bioinformatics for Geneticsts, Michaeal R.Barens, Ian C.Gray.
30. Immunological Bioinformatics, Lund Ole Nielsen.
31. Bioinformatics Basics Hooman Rashidi, Lukas Buehler.
32. Bioinformatics: Genes, Proteins and Computers C.Orengo, D.Jones, J.Thornton.
33. Bioinformatics and Molecular Evolution Paul G. Higgs.
34. The Application of Bioinformatics in Cancer Detection Asad Umar
35. Bioinformatics, Ralf Hofestadt.
36. Bioinformatics, Genomics and Proteomics: Getting the Bio PictureAnn Batiza, Bernice Schacter
37. Knowledge Discovery in Proteomics Igor Jerisca, Dennis Wigle
38. Proteomics and Protein-Protein Introductions:
Biology, Chemistry, Bioinformatics and Drug Design, Gabreil Waksman
39. An introduction to Bioinformatics Jermy Ramsden.

40. Bioinformatics Basics: Application in Biological Science and Medicine Hookman Rashidi, Lukas Buehler.
41. Medical Genetics Lynn B.Jorde, Jhon C.Carey, Micheal .Bamshad, Raymound L. White
42. Essential of Genetics, William S.Klug, Michel R.Cummings.
43. Thompson & Thompson Genetics in Mediccine Robert I.Nussbaum, Rodreick R.Mclnnes. Huntington F. Willard.
44. Medical Molecular Genetics, Patrick A.Hoffe.
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