Rashtreeya Sikshana Samithi Trust

R.V. College of Engineering

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Biotechnology

Master of Technology (M. Tech.)

Bioinformatics

Scheme and Syllabus of
Autonomous System w.e.f 2016

R.V. College of Engineering, Bengaluru – 59

(Autonomous Institution Affiliated to Visvesvaraya Technological University, Belagavi)

Department of Biotechnology

Vision:

A premier department in Biotechnology Education, Research and Innovation with a focus on sustainable technologies for the benefit of society and environment.

Mission:

- Create state-of-the-art infrastructure for research and training in Biotechnology.
- Develop graduates who are ethical and socially concerned.
- Promoting collaboration with academia, industries and research organizations at National and International level.
- Contribute to socioeconomic development through sustainable and inclusive technologies

Program Educational Objectives (PEO)

M. Tech. in Bioinformatics Program, graduates will be:

Program Specific Criteria (PSC)

Lead Society: The International Society for Computational Biology (ISCB)

Curriculum

The curriculum must include mathematics through differential equations, a thorough grounding in chemistry and biology and a working knowledge of advanced biological sciences consistent with the program educational objectives. Apply knowledge of high performance computing, object oriented programs, data mining and artificial intelligence to develop practical and efficient solutions for solving challenging biological problems.

Faculty

The program shall demonstrate that those faculty members teaching courses that are primarily design in content are qualified to teach the subject matter by virtue of education and experience or professional licensure.

Program Educational Objectives (PEO)

M. Tech. in Bioinformatics Program, graduates will be able to :

PEO 1. Demonstrate knowledge and understanding of engineering principles to analyze problems of life science and design solutions using computational techniques.

PEO 2. Apply modern software tools to simulate problems of healthcare, pharmaceutical and Agriculture industry and provide virtual Bioinformatics Solutions.

PEO 3. Exhibit professionalism, ethical attitude towards societal upliftment and appreciation of the necessity for lifelong learning.

Program Outcomes (PO)

M. Tech. in Bioinformatics Graduates will be able to:

PO 1. Scholarship of Knowledge: Derive scholarship of knowledge in the area of Bioinformatics through mathematics, science and engineering.

PO 2. Critical Thinking: Apply critical thinking to condense huge volumes of biological data for design, analysis and interpretation.

PO 3. Problem Solving: Problem solving through a system, component, or process to meet desired needs within constraints economic, environmental, social, political, ethical constituents.

PO 4. Research Skill: Identify, formulate and solve engineering problems through research skills.

PO 5. Usage of modern tools: Apply appropriate techniques, resources, and modern tools to solve complex Life Science problems.

PO 6. Collaborative and Multidisciplinary work: Perform tasks at the interface of biotechnology, information technology & other allied fields of technology through Interdisciplinary approach

PO 7. Project Management and Finance: Execute projects by optimizing, time, money and resources.

PO 8. Communication: Actions oral/written communication skills to execute jobs at research or industry of National / International reputes.

PO 9. Ethical Practices and Social Responsibility: Understand the need & importance of ethical practices & social responsibility.

PO 10. Independent and Reflective Learning: To contemplate on the problems on hand provide solutions using previous experience.

PO 11. Life-long Learning: Develop awareness of the need to learn lifelong and keep abreast of changing technology.

Program Specific Outcomes (PSO)

M. Tech. in Bioinformatics Graduates will be able to apply:

PSO 1. Genomic, proteomics and other omics skills to analyze complex biological problems in research or industry either independently or as a part of team.

PSO 2. Modeling, simulation and analytical skills to arrive at virtual solutions to life science problems.

PSO 3. High performance computing, Object oriented programs, data mining and artificial intelligence to solve the unknown of life science systems.

R. V. College of Engineering, Bengaluru – 59.

(An Autonomous Institution affiliated to VTU, Belagavi)

Department of Biotechnology

M. Tech. in Bioinformatics

FIRST SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture **L**	**Tutorial** **T**	**Practical** **P**	**Experiential Learning/ Self Study** **S**	
1	16MEM11P	Project Management	IM	3	1	0	0	4
2	16MBI12	Applied Statistics	BT	4	0	0	0	4
3	16MBI13	Principles of Bioinformatics (Theory and Practice)	BT	4	0	1	0	5
4	16MBI14	Biomolecular Modeling and Simulation	BT	4	0	0	1	5
5	16MBI15X	Elective -1	BT	4	0	0	0	4
6	16HSS16	Professional Skill Development	HSS	0	0	2	0	2
		Total		**19**	**1**	**3**	**1**	**24**

Elective -1			
16MBI151	Cell and Molecular Biology	16MBI152	Data Structures in C and C++

SECOND SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture **L**	**Tutorial** **T**	**Practical** **P**	**Experiential Learning / Self Study** **S**	
1	16MEM21R	Research Methodology	IM	3	1	0	0	4
2	16MBI22	Genomics, Proteomics and Genetic Circuits (Theory and Practice)	BT	4	0	1	0	5
3	16MBI23X	Elective - 2	BT	4	0	0	0	4
4	16MBI24X	Elective - 3	BT	4	0	0	0	4
5	16MBI25X	Elective - 4	BT	4	0	0	0	4
6	16MBI26	Minor Project	BT	0	0	5	0	5
		Total		**19**	**1**	**6**	**0**	**26**

Elective -2			
16MBI231	Data Warehousing and Mining	16MBI232	Artificial Intelligence
Elective – 3			
16MBI241	*Insilico* Drug Design	16MBI242	Pharmacogenomics
Elective – 4			
16MBI251	Essential Programming for Bioinformatics	16MBI252	High Performance Bio-Computing

M. Tech. in Bioinformatics

THIRD SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning/ Self Study S**	
1	16MBI31	Perl and Python (Theory and Practice)	BT	4	0	1	0	5
2	16MBI32X	Elective -5	BT	4	0	0	0	4
3	16MBI33X	Elective -6	BT	4	0	0	0	4
4	16MBI34X	Elective-7	BT	4	0	0	0	4
5	16MBI35	Internship/ Industrial Training	BT	0	0	3	0	3
6	16MBI36	Technical Seminar	BT	0	0	2	0	2
		Total		**16**	**0**	**6**	**0**	**22**

Elective -5			
16MBI321	Statistical Tools and Techniques	16MBI322	High Throughput Data Analytics
Elective – 6			
16MBI331	DNA chips and Microarray Data Analysis	16MBI332	Software Engineering for Computational Biology
Elective-7			
16MBI341	Next Generation Sequencing Informatics	16MBI342	Graph Theory and Algorithms

FOURTH SEMESTER								
Sl. No	**Course Code**	**Course Title**	**BoS**	**CREDIT ALLOCATION**				**Total Credits**
				Lecture L	**Tutorial T**	**Practical P**	**Experiential Learning/ Self Study S**	
1	16MBI41	Major Project	BT	0	0	26	0	26
2	16MBI42	Seminar	BT	0	0	2	0	2
		Total		**0**	**0**	**28**	**0**	**28**

THIRD SEMESTER

Perl and Python
(Theory and Practice)

Course Code	**:**	**16MBI31**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S 4:0:1:0**		**SEE Marks**	**:**	100+50
Credits	**:**	**5**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):
Graduates shall be able to

1. Explore conceptually programming applications in the domains of Life sciences and in general study the role of computer science in life sciences
2. Acquire knowledge of the Object Oriented Programming and Advanced programming skills in both Perl and Python
3. Study REGEX, BioPerl, BioPython and Database connectivity as well as Web programming in Perl and Python
4. Understand the importance of Threading, Event management, Database connectivity as well as Web programming to High throughput Data analysis
5. Explore practically the applications of BioPerl and BioPython for sequence, structure and micro-array data analysis

Unit – I	**09Hrs**

Perl: Introduction to Perl, writing and executing a Perl program. Operators, Variables and Special variables. Data Types – Scalar, Array and Associative array. Regular Expressions (REGEX), Components of REGEX - Operators, Metacharacters and Modifiers. Subroutines – types of functions, defining and calling functions in Perl, calling function - call by value and call by reference. Perl Package – writing and calling package. Perl Module – writing and calling module.

Unit – II	**10Hrs**

BioPerl: Introduction to BioPerl and BioPerl Objects - Brief descriptions, Location objects, Interface objects and Implementation objects. Sequence Representation: Representing large sequences, Representing changing sequences. Accessing Sequence data - Using Bioperl: Accessing sequence data from local and remote databases, Accessing remote databases, Indexing and accessing local databases. Sequence and Alignment format Interconversion - Transforming sequence files, Transforming alignment files. Performing Sequence analysis – Global alignment, Local alignment, Multiple sequence alignment, Parsing BLAST alignment report and Parsing multiple sequence alignment.

Unit – III	**10Hrs**

Python. Python basics – Variables, Operators, Data types and Assignments. Statements – Input/output statements, flow control - IF…THEN….ELSE, SWITCH, FOR, MAP, FILTER and WHILE, goto statements. Names, Functions and Modules.

Unit – IV	**10Hrs**

Object Oriented Programming in Python: Introduction to object oriented programming in python. Classes and objects. Inheritance, Polymorphism. Constructors and Destructors. Exception handling.

Unit – V	10Hrs

Biopython and Bioinformatics: Parsing DNA data files, Image manipulation, Sequence analysis - Sequence alignment (pair wise and multiple sequence alignment), Dynamic Programming, Detecting tandem repeats and generating Hidden Marko Models, Simulation of EST Clustering. Data mining - Text mining, Simulating Genetic algorithm. Analysis of Microarray data – Spot finding and Measurement.

Practicals

1. Using Perl's REGEX, perform the following
   i) Trim the sequences files
   ii) Read a bulk of HTML files and strip off the HTML tags, and write the data to new file
   iii) Extract all Fasta IDs from the given sequence file
   iv) Parse the Atomic and Hetero Atomics sections of the PDB
2. Write a Perl program that uses both recursive and non recursive functions to print the nth value in the Fibonacci sequence.
3. Write a Perl program to Implement Needleman and Wunch algorithm
4. Write a Perl program that prompts the user for an integer and then prints out all prime numbers up to that integer.
5. Write a Python program that prints all real solutions to the quadratic equation ax2 + bx + c = 0. Read in a, b, c and use the quadratic formula. If the descriminant b2-4ac is negative, display a message stating that there are no real solutions.
6. Write a Python Program to implement inheritance.
7. Design, Write and Execute Python Program that illustrate Exception Handling
8. Write a Python program that displays the number of characters, lines and words in a text file.
9. Write a Program to construct the Phylogenetic tree using sequential clustering by reading input distance matrix.
10. Write a Python program to implement Client Server(Client requests a file, Server responds to client with contents of that file which is then display on the screen by Client – Socket Programming)
11. Write a program to insert Protein information into Protein DB database and retrieve the list of Protein sequences based on particular queries
12. Design, Write and Execute Python Program to calculate the area of triangle and rectangle by using abstract class.
13. Create a sideshow which has three slides. Which includes only text, program should change to the new slide after 5 seconds. After the third slide program returns to the First Slide
14. Create a sideshow which has three slides, which includes pictures at PNG format. Program should change to the new slide other 5 seconds.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Define and explain concepts of Object Oriented Programming along with Threading, Event management, Database connectivity as well as Web programming

CO2: Apply Bioperl and Biopython, Database connectivity as well as Web programming to solve the problems in the area of Big Data Analytics

CO3: Analyze and evaluate programming applications of both Perl and Python with case studies

CO4: Design and implement basic algorithms to perform high throughput data analysis in the field Sequence and structure analysis

Reference Books:

1. James Tisdall. Beginning Perl for Bioinformatics An Introduction to Perl for Biologists. O'Reilly Media, 2001. ISBN: 978-0-596-00080-6
2. Sebastian BassiPython for Bioinformatics. Chapman & Hall/CRC , 2016. ISBN: 978-1-584-88930-4
3. D. Curtis Jamison. Perl Programming for Biologists. Wiley, 2003. ISBN: 978-0-471-43059-9.
4. James Tisdall. Beginning Perl for Bioinformatics. O'Reilly, 1st Edition, 2001. ISBN:978-0-596-10324-8.

Scheme of Continuous Internal Evaluation (CIE):

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Scheme of Continuous Internal Evaluation (CIE) for Lab:

CIE for the practical courses will be based on the performance of the student in the laboratory, every week. The laboratory records will be evaluated for 40 marks. One test will be conducted for 10 marks. The total marks for CIE (Practical) will be for 50 marks.

Scheme of Semester End Evaluation (SEE) for Lab:

SEE for the practical courses will be based on conducting the experiments and proper results for 40 marks and 10 marks for viva-voce. The total marks for SEE (Practical) will be 50 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	M	M	M	H	H	L	-	L	-	-
CO2	H	M	H	H	H	H		M		-	-
CO3	H	H	H	M	M	H	L			L	
CO4	H	H	M	H	H	M					

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

Statistical Tools and Techniques						
Course Code	**:**	**16MBI321**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):

Graduates shall be able to:

1. Understand and analyze the sampling methods for sample estimation.
2. Comprehend the data transformations and the distribution functions.
3. Apply the temporal series for the goodness of fit.
4. Practice the data analytical methods to prove the hypothesis and find out the relationship between the data sets.
5. Accustomed to R programming to write the query and analyze the data.

Unit – I	**11 Hrs**

Statistical concepts: Sampling and sampling size, data preparation and cleaning, probability theory – odds, risks, Frequentist, Bayesian probability theory. Statistical modeling, computational statistics. Confidence intervals, power and robustness. Measures of complexity and matrices.

Unit – II	**8 Hrs**

Data transformation and standardization: Box-Cox and Power, Freeman-Tukey, log and exponential, logit transform. Exploratory data analysis. Normalization of the data – 1NF, 2NF, 3NF and BCNF.

Unit – III	**9 Hrs**

Probability distribution: Discrete distribution – Binomial, Poisson, Hypergeometric, Multinomial distribution. Continuous distribution – Normal, Beta, Pareto distribution. Multivariate distribution.

Unit – IV	**9 Hrs**

Time series analysis: Moving averages, trend analysis, ARMA and ARIMA models, spectral analysis. Tests and confidence intervals of mean values - spread sheets, randomness. R Code samples – Inequality, Latin square ANOVA, Log odd ratio plot, Normal distribution plot, Bootstrapping,

Unit – V	**11 Hrs**

R stats: Working with objects, descriptive statistics and tabulation, Graphical analysis, formula notation and complex statistics, manipulating data and extracting components, hypothesis testing using R,

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate the knowledge of specialized data analyzing tools.
CO2: Apply the statistical and computational methods for using R stats.
CO3: Able to write the R programs for any data to be analyzed.
CO4: Interpret the data sets using advanced statistical tools.

Reference Books:

1. James, G., Witten, D., Hastie, T., Tibshirani, R. An Introduction to Statistical Learning. Springer, 2013. ISBN 978-1-4614-7138-7.
2. Mark Gardener. Beginning R The Statistical Programming Language. Wiley Publication,

2015. ISBN: 978-1-118-16430-3.

Scheme of Continuous Internal Evaluation (CIE) for Theory

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	H	H	M	H	H	L	-	L	-	-
CO2	H	M	H	H	H	H	-	M	H	-	-
CO3	H	H	H	H	H	H	L	-	H	-	H
CO4	H	H	M	H	H	M	L	M	M	L	M

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

High Throughput Data Analytics						
Course Code	**:**	**16MBI322**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1. Understand the basics of Data analytics.
2. Explore and predict the patterns in big data.
3. Apply interdisciplinary research in the field of computational biology.
4. Practice computational analytics for massive and complex biological information.
5. Design methodologies and tools to manage big data analytics.

Unit – I	**9 Hrs**

Big Data Analysis Methods and Applications: Text Mining on Big and Complex Biomedical Literature, Interactive Data Visualization Techniques Applied to Healthcare Decision Making, Large-Scale Regulatory Network Analysis.

Unit – II	**10 Hrs**

Perspectives on Big Data Analysis : Big Data in Radiation Oncology: Challenges and Potentials, Genomic Data in a Cloud Computing Environment, Perspectives on Data Integration in Human Complex Disease Analysis, Current study Designs, Methods and Future Directions of Genetic Association Mapping.

Unit – III	**10Hrs**

Big Data Analytics in Genomics

Robust Methods for Expression Quantitative Trait Loci Mapping, Inference and Structure, Learning of Genotype–Phenotype Networks Using Genetic Variation, Genomic Applications of the Neyman–Pearson Classification Paradigm, Improving Re-annotation of Annotated Eukaryotic Genomes.

Unit – IV	**9 Hrs**

Next Generation Proteomics

Mass Spectrometry and Data Generation, Data Analysis – Algorithms and Computation, Software Tools and Algorithms, Parallelized data Acquisition Strategies, New Data Formats and Compression Methods.

Unit – V	**10 Hrs**

High throughput drug discovery:

Molecular similarity and virtual screening, Data fusion, Enrichment, Bioisosteric replacement methods, Scaffold diversity analysis, clustering and diversity , QSAR, protein-ligand docking, Denovo molecular design

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Understand the basic knowledge of data analytics.

CO2: Analyze and apply the appropriate tools and techniques to generate patterns.

CO3: Design pipeline for various genomics and proteomics applications.

CO4: Develop high throughput data analysis tools for insilico drug discovery.

Reference Books:

1. Baoying Wang, Ruowang Li, William Perrizo. Big Data Analytics in Bioinformatics and Healthcare. Idea Group, 2014. ISBN-13: 978-1-466-66611-5
2. Wong. Big Data Analytics in Genomics. Springer, 2016. ISBN: 978-3-319-41279-5.

Scheme of Continuous Internal Evaluation (CIE):

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	L	L	M	L	L	-	L	-	L
CO2	H	H	M	M	H	M	L	L	M	L	M
CO3	M	M	H	H	M	M	M	L	M	L	M
CO4	M	M	H	M	H	H	H	M	H	M	L

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	-
CO2	H	H	H
CO3	L	-	H
CO4	M	H	H

DNA Chips and Microarray Data Analysis						
Course Code	**:**	**16MBI331**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):

Graduates shall be able to:

1. Understand and analyze the DNA chip and Microarray data.
2. Comprehend the DNA data transformations and the validations.
3. Practice the DNA and Microarray data analytical methods to develop the effective models.
4. Apply the Microarray data for the decision making.
5. Accustomed to programming techniques to analyze the data.

Unit – I	**9 Hrs**

Introduction to Biochip and Microarray Construction: Basics of Biochips and Microarray Technology, Biochip technologies. Types of Biochips - DNA Microarrays, Oligonucleotide, cDNA and genomic microarrays, Integrated biochip system. Biochip versus gel-based methods. Limitations of biochip technology. Biochip construction -Megac10ne technology for fluid microarrays, Microarray labels, Microarray scanners, Microarray robotics. Microfluidics systems, Chips and Mass Spectrometry. Electrical detection methods for microarrays. Applications of Biochips - Tissue Chip, RNA Chip, Protein Chip Technology, Glycochips, Biochip assays, Combination of microarray and biosensor technology. Bioinformatics and microarrays,

Unit – II	8 Hrs

Applications of Biochip Technology: Molecular diagnostics, Pharmacogenomics, application of microarray technology in drug discovery and development, Use of DNA chip technology for drug safety, drug delivery, population genetics and epidemiology. Applications of Microarray technology in Forensics. DNA chip technology for water quality management, Application of micro arrays in the agro-industry; use of microarrays in Genetic disease monitoring.

Unit – III	12 Hrs

Microarray Data analysis: Introduction, Image Acquisition and Analysis, Detection of differential gene expression. Pathway analysis tools. Data validation.

Genomic Signal Processing: Introduction, Mathematical models, and Modeling DNA Microarray data - Singular Value Decomposition algorithm. Online Analysis of Microarray Data Using Artificial Neural Networks – Introduction, Methods. Signal Processing and the Design of Microarray. Time-Series Experiments.

Predictive Models of Gene Regulation: Introduction, Regression Approach to Cis-Regulatory Element Analysis, Cooperativity. Spline Models of Cooperative Gene Regulation. Statistical Framework for Gene Expression Data Analysis – Materials and Methods. Analysis of Comparative Genomic Hybridization Data on cDNA Microarrays – Introduction, materials and methods. Interpreting Microarray Results With Gene Ontology and MeSH – Introduction, Materials and methods. Incorporation of Gene Ontology Annotations to Enhance Microarray Data Analysis – Materials and Methods.

Unit – IV	10 Hrs

DNA Computing: Introduction, Junctions, other shapes, Biochips and large-scale structures.

Strand algebras for DNA computing – Introduction, Strand Algebras. Discussion of Robinson and Kallenbach's methods for designing DNA shapes, DNA cube, computing with DNA, Electrical analogies for biological circuits, Challenges, Future Trends.
DNA programming - Deoxyribozyme-Based Logic Gate design processes. Renewable, Time responsive DNA Logic Gates for scalable digital circuits. Design of Bimolecular device.

Unit – V	8 Hrs

Commercial Aspects of Biochip Technology: Markets for biochip technologies, Commercial and Government support for biochip development, Business strategies, and Patent issues.

Expected Course Outcomes:

After going through this course the student will be able to:
CO1: Demonstrate the knowledge of graph theory for data analyzing and representation.
CO2: Apply the statistical and computational methods using the graph theory algorithms.
CO3: Able to write the algorithms to modify and consistent analytical algorithms.
CO4: Interpret the data sets using advanced algorithms.

Reference Books:

1. Russell Deaton, Akira Suyama. DNA Computing: 15th International Meeting on DNA Computing, DNA 15, Fayetteville, AR, USA, June 8-11, 2009. Springer, 2009. ISBN: 978-3-642-10604-0.
2. Paul F. Predki. Functional Protein Microarrays in Drug Discovery. CRC Press, 2007. ISBN: 978-0-849-39809-4.

Scheme of Continuous Internal Evaluation (CIE) for Theory
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE) for Theory
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	H	H	M	H	H	L	-	L	-	-
CO2	H	M	H	H	H	H	-	M	H	-	-
CO3	H	H	H	H	H	H	L	-	H	-	H
CO4	H	H	M	H	H	M	L	M	M	L	M

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

Software Engineering for Computational Biology						
Course Code	**:**	**16MBI332**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S 4:0:0:0**		**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):
Graduates shall be able to,

1. Understand and Appreciate principles behind the development of complex and evolving software-intensive systems in Computational Biology
2. Acquire knowledge of widely used development lifecycle models to plan and deliver an effective software-intensive systems
3. Study and make effective use of Software engineering tools such as UML, design strategies like defining a software architecture and design patterns to deliver smart applications.
4. Apply testing strategy for a software system by employing unit testing, test driven development and functional testing in the process of software engineering.
5. Implement and maintain software systems by employing strategies of software requirement evaluation, analysis and design of software systems

Unit – I	**09Hrs**

Software engineering basics: Software, software engineering and software crisis. Types of software. Generic stages in software development. Software errors, software behavior, structure, architecture and software engineering. Software project, process and people. Desirable software capabilities.

Unit – II	**10Hrs**

Software development life cycle models: Life cycle models, predevelopment activities and deliverables. Waterfall model, prototype waterfall model, object oriented model, incremental and iterative model, spiral model, software processes maturity model. Software engineering standards and tools. Unified modeling languages. Software specification: Software modeling, behavior modeling, process modeling, data modeling. Formal specification techniques, validation of specifications and traceability.

Unit – III	**10Hrs**

Software design: Introduction to design, architectural design; styles, pattern, tactics and reference architectures. Detailed design – functional decomposition, relational database design, object-oriented design and user-interface design; consistency, reusability, flexibility, efficiency, forgiveness and tolerance, readability, simplicity, simplicity clarity and user-friendliness. Object oriented design: Object oriented high level architectural design. Architectural patterns; layered, client server, transaction processing, peer-to-peer, three tier, multi tier, pipe and filter, distributed object, mobile object, service oriented. Design patters; fundamental, creational, structural and behavioral.

Unit – IV	10Hrs
Software implementation: Mapping design into code, software libraries and APIs, fault tolerance, exception handling. Writing secure software – input/output validation and representation errors, security violations, API abuse, coding errors and code quality, error handling and code review. Software Testing: Testing and test coverage, dynamic and state testing. Anatomy of test case. Black box, white box, grey box testing; boundary value testing, equivalence class testing, decision table and decision tree based testing.	
Unit – V	**10Hrs**
Software maintenance: Importance of software maintenance, taxonomy of software maintenance activities. Software maintenance process, software maintenance management, software configuration management and activities. Software maintenance techniques; reverse engineering and design recovery, restructuring and reengineering and regression testing.	

Expected Course Outcomes:

After going through this course the student will be able to,

CO1: Define and explain conceptually principles and software models behind the development of complex and effective software systems.
CO2: Apply software engineering tools such as testing strategies, UML, defining a software architecture and design patterns to develop software systems in Computational Biology.
CO3: Analyze and evaluate the software requirements and design a software in the field of Computational Biology
CO4: Implement and maintain effective and evolving software systems by employing professional skills and strategies

Reference Books:

1. Kassem A. Saleh. Software Engineering. J.Ross, 2009. ISBN: 978-1-932159-94-3.
2. Frank Tsui, Orlando Karam. Essentials of Software Engineering. Jones & Bartlett Learning; 3 edition, 2009. ISBN-13: 978-1449691998.

Scheme of Continuous Internal Evaluation (CIE):
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	L	M	M	L	L	-	L	-	
CO2	H	H	M	L	H	M	L	L		L	
CO3	M	L	H	H	M	M	M		M		
CO4	L	M	H	M	H	H	H				

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

Next Generation Sequencing Informatics						
Course Code	**:**	**16MBI341**		**CIE Marks**	**:**	100
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	100
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):

Graduates shall be able to

1 Understand the basics of Next generation sequencing (NGS).

2 Understand the standard highthrouput data structures.

3 Implement different tools and techniques in NGS analysis.

4 Design a protocol for different biological problems using informatics approach.

Unit – I	**10 Hrs**

Introduction to Next-Generation Sequencing (NGS) and NGS Data Analysis NGS Technologies: Ins and Outs Early-Stage NGS Data Analysis: NGS Data Storage, Transfer, and Sharing, Base Calling, FASTQ File Format, and Base Quality Score, NGS Data Quality Control and Preprocessing, Reads Mapping, Tertiary Analysis, Common Steps Computing Needs for NGS Data Management and Analysis.

Unit – II	**10 Hrs**

Transcriptomics RNA-Seq and Small RNA Sequencing: Principle of RNA-Seq**;** Experimental Design, RNA-Seq Data Analysis, RNA-Seq as a Discovery Tool. Small RNA NGS Data Generation and Upstream Processing, Identification of Differentially, Expressed Small RNAs, Functional Analysis of Identified Small RNAs.

Unit – III	**10Hrs**

Whole Genome Resequencing and *De novo* Genome Assembly from NGS Reads : Data Preprocessing, Mapping, Realignment, and Recalibration, Single Nucleotide Variant (SNV) and Indel Calling, Annotation of Called Variants, Sequencing Strategies for *de novo* Assembly: Assembly of Contigs, Scaffolding, Assembly Quality Evaluation.

Unit – IV	**09 Hrs**

Mapping Protein–DNA Interactions with ChIP-Seq: Principle of ChIP-Seq, Experimental Design, Read Mapping, Peak Calling, and Peak Visualization, Differential Binding Analysis, Functional Analysis, Motif Analysis, Integrated ChIP-Seq Data Analysis.

Unit – V	**10 Hrs**

Metagenome Analysis by NGS : Metagenome Sequencing Data Analysis, Sequencing Data Quality Control and Preprocessing Taxonomic Characterization of a Microbial Community, Functional Characterization of a Microbial Community, Comparative Metagenomic Analysis, Integrated Metagenomics Data Analysis Pipelines, Metagenomics Data Repositories

Expected Course Outcomes:

After going through this course the student will be able to:
CO1: Understand the basic knowledge of Next Generation Sequencing
CO2: Analyze and apply the appropriate tools and techniques to perform high throughput data analysis
CO3: Design pipeline for various applications of NGS analysis
CO4: Develop high throughput data analysis tools for various biological applications.

Reference Books:

1. Xinkun Wang. Next-Generation Sequencing Data Analysis. CRC Press, Taylor and Francis Group, 2016. ISBN: 9781482217889.
2. Stuart M. Brown. Next-generation DNA sequencing informatics. Cold Spring Harbor Laboratory Press, Cold Spring Harbor: New York, 2015. ISBN-13: 978-1936113873.

Scheme of Continuous Internal Evaluation (CIE):
CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):
The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	M	L	L	M	L	L	-	L	-	L
CO2	H	H	M	M	H	M	L	L	M	L	M
CO3	M	M	H	H	M	M	M	L	M	L	M
CO4	M	M	H	M	H	H	H	M	H	M	L

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

Graph Theory and Algorithms						
Course Code	**:**	**16MBI342**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**4:0:0:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**4**		**SEE Duration**	**:**	**3 hrs**

Course Learning Objectives (CLO):

Graduates shall be able to:

1. Understand and analyze the sampling methods for sample estimation.
2. Comprehend the data transformations and the distribution functions.
3. Apply the temporal series for the goodness of fit.
4. Practice the data analytical methods to prove the hypothesis and find out the relationship between the data sets.
5. Analyze using R programming and interpret the results.

Unit – I	**8 Hrs**

Introduction to graph theory: Definitions and examples, types of graphs, complements and graph isomorphism, walks and connectedness, vertex degree, Euler and Hamiltonian graph - trails and circuits, planar graphs, Hamilton paths and cycles, intersection graphs. Operations on graphs. Blocks- cutpoints bridges and blocks, Factorization.

Unit – II	**9 Hrs**

Trees: Definitions, properties and examples. Construction of routed trees, trees and sorting, weighted trees and prefix codes, attributes of trees, centers and centroids, Dijkstra's shortest path algorithm, minimal spanning trees – Kruskal and Prim algorithms. Transport networks, max-flow min-cut theorem, matching theory.

Unit – III	**10 Hrs**

Matrices and groups: Adjacency, incidence and cycle matrix, Groups – automorphism group of the graph, operations on permutation groups, group of composite graph, graphs with a given group, symmetric and highly symmetric graphs. Enumeration – labeled graphs, Polya's enumeration theorem, graph enumeration and trees, algorithms.

Unit – IV	**9 Hrs**

Counting theorems: Rules of sum and product, Permutation, combinations, binomial theorem, Principle of inclusion and exclusion, generalizations of the principle, Rook polynomials, derangements, and arrangements with forbidden positions. Generating functions – definitions and examples, partition of integers, exponential generating functions.

Unit – V	**11 Hrs**

Recurrence relations: The First order linear recurrence relation, II order liner homogeneous recurrence, relation with constant coefficient, non homogenous recurrence relation, method of generating functions, nonlinear recurrence relation, divide and conquer algorithms.

Expected Course Outcomes:

After going through this course the student will be able to:

CO1: Demonstrate the knowledge of graph theory for data analyzing and representation.
CO2: Apply the statistical and computational methods using the graph theory algorithms.
CO3: Able to write the algorithms to modify and consistent analytical algorithms.
CO4: Interpret the data sets using advanced algorithms.

Reference Books:

1.Ralph P Grimaldi, B.V. Ramana. Graph Theory and Combinatorics. Pearson, 5h edition, 2013. ISBN-10: 8131797384.
2.Mark Gardener. Beginning R The Statistical Programming Language. Wiley Publication, 2015. ISBN: 978-1-118-16430-3.

Scheme of Continuous Internal Evaluation (CIE):

CIE will consist of TWO Tests, TWO Quizzes and ONE assignment. The test will be for 30 marks each and the quiz for 10 marks each. The assignment will be for 20 marks. The total marks for CIE (Theory) will be 100 marks.

Scheme of Semester End Examination (SEE):

The question paper will have FIVE questions with internal choice from each unit. Each question will carry 20 marks. Student will have to answer one question from each unit. The total marks for SEE (Theory) will be 100 marks.

Mapping of COs with POs

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	L	H	H	M	H	H	L	-	L	-	-
CO2	H	M	H	H	H	H	-	M	H	-	-
CO3	H	H	H	H	H	H	L	-	H	-	H
CO4	H	H	M	H	H	M	L	M	M	L	M

Mapping of COs with PSOs

	PSO1	PSO2	PSO3
CO1	L	L	L
CO2	H	H	H
CO3	L	M	H
CO4	L	H	H

INTERNSHIP / INDUSTRIAL TRAINING						
Course Code	**:**	**16MBI35**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:6:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**3**		**SEE Duration**	**:**	**30 min**

GUIDELINES FOR INTERNSHIP

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to produce product and provide services.

(2) Explain the importance of management and resource utilization

(3) Comprehend the importance of team work, protection of environment and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) The duration of the internship shall be for a period of 8 weeks on full time basis between II semester final exams and beginning of III semester.

2) The student must submit letters from the industry clearly specifying his / her name and the duration of the internship on the company letter head with authorized signature.

3) Internship must be related to the field of specialization or the M.Tech program in which the student has enrolled.

4) Students undergoing internship training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.

5) Every student has to write and submit his/her own internship report to the designated faculty.

6) Students have to make a presentation on their internship activities in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the internship final report. However interim or periodic reports and reports as required by the industry / organization can be submitted as per the format acceptable to the respective industry /organizations.

7) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

8) The broad format of the internship final report shall be as follows

- Cover Page
- Certificate from College
- Certificate from Industry / Organization
- Acknowledgement
- Synopsis
- Table of Contents

- Chapter 1 - Profile of the Organization – Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices,
- Chapter 2 - Activities of the Department -
- Chapter 3 – Tasks Performed – summaries the tasks performed during 8 week period
- Chapter 4 – Reflections – Highlight specific technical and soft skills that you acquired during internship
- References & Annexure

Course Outcomes:

After going through the internship the student will be able to:

CO1: Apply engineering and management principles
CO2: Analyze real-time problems and suggest alternate solutions
CO3: Communicate effectively and work in teams
CO4: Imbibe the practice of professional ethics and need for lifelong learning.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of the Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries 35%

(2) Ability to comprehend the functioning of the organization/ departments 20%

(3) Importance of resource management, environment and sustainability 25%

(4) Presentation Skills and Report 20%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL TRAINING

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the process of applying engineering knowledge to industrial products & processes

(2) Explain the importance of skilling, training and resource management.

(3) Comprehend the importance of team work, communication and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) The duration of industrial training must be for a minimum of 1 week and maximum of 8 weeks on full time basis.

2) Industrial Training in which students pays a fee to the organization / industry will not be considered.

3) He/she can undergo training in one or more industry /organization.

4) The student must submit letters from the industry clearly specifying his / her name and the duration of the training provided by the company with authorized signatures.

5) Industrial training must be related to the field of specialization or the M.Tech program in which the student has enrolled.

6) Students undergoing industrial training are advised to use ICT tools such as skype to report their progress and submission of periodic progress reports to the faculty members.

7) Every student has to write and submit his/her own industrial training report to the designated faculty.

8) Students have to make a presentation on their industrial training in front of the departmental cmmittee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.

9) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

10) The broad format of the industrial training report shall be as follows

- Cover Page
- Certificate from College
- Training Certificate from Industry / Organization
- Acknowledgement
- Executive Summary
- Table of Contents
- Chapter 1 - Profile of the Organization –Organizational structure, Products, Services, Business Partners, Financials, Manpower, Societal Concerns, Professional Practices
- Chapter 2 – Details of the Training Modules
- Chapter 3 – Reflections – Highlight specific technical and soft skills that you acquired

References & Annexure

Course Outcomes:

After going through the industrial training the student will be able to:

CO1: Understand the process of applying engineering knowledge to solve industrial problems

CO2: Develop skills through training relevant to industrial requirement

CO3: Communicate effectively and work in teams

CO4: Imbibe ethical practices and develop it as life skill.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation on the application of engineering knowledge 25%

(2) Ability to comprehend the importance of skilling and training 25%

(3) Importance of communication, professional ethics, sustainability 20%

(4) Oral Presentation and Report 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

GUIDELINES FOR INDUSTRIAL VISITS

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the role of industries and service organization in meeting the demands of the society.

(2) Explain the working of different industries and organizations with an engineering perspective

(3) Comprehend the importance of team work, communication and sustainable solutions.

(4) Imbibe values, professional ethics for life long learning.

1) Student must visit a minimum of THREE organizations/industry. The duration of the visit per organization must be for ONE full day, during which he/she must comprehend the importance of organization structure, function of various departments, application of engineering knowledge, resource management, importance to environment and safety, professional ethics.

2) It is mandatory to visit ONE private multi-national company or public sector industry / organization, ONE medium-small enterprise and ONE rural based or NG organization.

3) The student must submit letter from the industry clearly specifying his / her name and the date of visit to the industry with authorized signatures.

4) Industrial visit must be related to the field of specialization or the M.Tech program in which the student has enrolled.

5) Every student has to write and submit his/her own report on each industrial visit and submit the report to the designated faculty advisor for evaluation.

6) A photograph outside the industry with the name and logo of the industry in the background along with the students and faculty members could be included in the report.

7) Students have to make a presentation on their industrial visit in front of the departmental committee and only upon approval of the presentation should the student proceed to prepare and submit the hard copy of the final report.

8) The reports shall be printed on bond paper – 80GSM, back to back print, with soft binding – A4 size with 1.5 spacing and times new roman font size 12.

9) The broad format of the industrial visit report shall be as follows
   - Cover Page
   - Certificate from College
   - Acknowledgement
   - Synopsis / Executive Summary
   - Table of Contents
   - Chapter 1 - Profile of the PSU or MNC – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
   - Chapter 2 – Profile of the SME – must include Organizational structure, Products, Services, Financials, Manpower, Societal Concerns, Professional Practices
   - Chapter 3 - Profile of the NGO – must include Organizational structure, services, Manpower, Societal Concerns, Professional Practices
   - Chapter 4 – Comparative Analysis of PSU/MNC – SME – NGO
   - References & Annexure (Permission letters from the organizations for the visit & photographs)

Course Outcomes:

After going through this course the student will be able to:

CO1: Classify the role of different industries and organization in addressing the needs of the society.

CO2: Explain the process of applying engineering knowledge in industries and organizations.

CO3: Describe the importance of communication and team work

CO4: Recognize the importance of practicing professional ethics and need for life skills.

Scheme of Continuous Internal Evaluation (CIE):

A committee comprising of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide would review the presentation and the progress reports in two phases. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

(1) Explanation of the application of engineering knowledge in industries 25%

(2) Ability to comprehend the functioning of the organization/ departments 30%

(3) Importance of resource management, environment and sustainability 20%

(4) Presentation Skills and Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		M	H	M		M				L	
CO2				H	M	M		L			
CO3					L		M	H	H		
CO4					L		H			M	H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	
CO2	L	L
CO3		M
CO4	M	H

TECHNICAL SEMINAR						
Course Code	**:**	16MBI36		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

(1) Understand the technological developments in their chosen field of interest

(2) Explain the scope of work and challenges in the domain area

(3) Analyze these engineering developments in the context of sustainability and societal concerns.

(4) Improve his/her presentation skills and technical report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project
4) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
5) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1:Identify topics that are relevant to the present context of the world

CO2: Perform survey and review relevant information to the field of study.

CO3: Enhance presentation skills and report writing skills.

CO4: Develop alternative solutions which are sustainable

Scheme of Continuous Internal Evaluation (CIE):

Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of Head of the Department / Associate Dean, Associate Professor, Assistant Professor and Guide. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

1) Topic – Technical Relevance, Sustainability and Societal Concerns 15%
2) Review of literature 25%
3) Presentation Skills 35%
4) Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L

IV SEMESTER

MAJOR PROJECT						
Course Code	**:**	**16MBI41**		**CIE Marks**	**:**	**100**
Hrs/Week	**:**	**L:T:P:S**	**0:0:52:0**	**SEE Marks**	**:**	**100**
Credits	**:**	**26**		**SEE Duration**	**:**	**3 Hours**

Course Learning Objectives:

The students shall be able to

1. Understand the method of applying engineering knowledge to solve specific problems.
2. Apply engineering and management principles while executing the project
3. Demonstrate good verbal presentation and technical report writing skills.
4. Identify and solve complex engineering problems using professionally prescribed standards.

GUIDELINES

1. Major project will have to be done by only one student in his/her area of interest.
2. Each student has to select a contemporary topic that will use the technical knowledge of their program of specialization.
3. Allocation of the guides preferably in accordance with the expertise of the faculty.
4. The number of projects that a faculty can guide would be limited to three.
5. The project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
6. The standard duration of the project is for 16 weeks, however if the guide and the evaluation committee of the department, after the assessment feel that the work is insufficient and it has to be extended, then the student will have to continue as per the directions of the guide and the committee.
7. It is mandatory for the student to present his/her work in one of the international conferences or publish the research finding in a reputed unpaid journal with impact factor.

Course Outcomes:

After going through this course the students will be able to

CO1: Conceptualize, design and implement solutions for specific problems.

CO2: Communicate the solutions through presentations and technical reports.

CO3: Apply project and resource managements skills, professional ethics, societal concerns

CO4: Synthesize self-learning, sustainable solutions and demonstrate life long learning

Scheme of Continuous Internal Examination (CIE)

Evaluation will be carried out in THREE Phases. The evaluation committee will comprise of: guide, two senior faculty members, one industry member and Head of the Department.

Phase	Activity	Weightage
I 5^{th} week	Synopsis, Preliminary report for the approval of selected topic along with literature survey, objectives and methodology.	20%

II 10th week	Mid-term progress review shall check the compliance with the objectives and methodology presented in Phase I, review the work performed.	40%
III 15th week	Oral presentation, demonstration and submission of project report. After this presentation, the student will have one week time to correct / modify his report to address the issues raised by the committee members.	40%

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic & formulation of objectives 10%
- Design and simulation/ algorithm development/experimental setup 25%
- Conducting experiments / implementation / testing / analysis 25%
- Demonstration & Presentation 20%
- Report writing 20%

Scheme for Semester End Evaluation (SEE):

The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

1. Brief write-up about the project 5%
2. Formulation of Project Objectives & Methodology 20%
3. Experiments / Analysis Performed; Results & Discussion 25%
4. Report 20%
5. Viva Voce 30%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1	H	H	H	M	L	M	L				
CO2				L				M	H		
CO3					L	M	M			H	
CO4					L	M	H	M			H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	L	H
CO3	M	H
CO4	H	H

SEMINAR						
Course Code	**:**	**16MBI42**		**CIE Marks**	**:**	**50**
Hrs/Week	**:**	**L:T:P:S**	**0:0:4:0**	**SEE Marks**		**50**
Credits	**:**	**2**		**SEE Duration**		**30 min**

Course Learning Objectives (CLO):

The students shall be able to:

1) Understand the technological developments in their chosen field of interest
2) Explain the scope of work and challenges in the domain area
3) Analyze these engineering developments in the context of sustainability, societal concerns and project management.
4) Improve his/her verbal presentation and report writing skills

GUIDELINES

1) The presentation will have to be done by individual students.
2) The topic of the seminar must be in one of the thrust areas with in-depth review and analysis on a current topic that is relevant to industry or on-going research.
3) The topic could be an extension or complementary to the project topic.
4) Topics could be in multidisciplinary areas and strongly address the technical design issues.
5) The student must be able to highlight or relate these technological developments with sustainability and societal relevance.
6) The students must mandatorily address legal, ethical issues as related to the topic of study.
7) The student shall make an attempt to perform financial / cost analysis or apply project management tools as related to his/her topic of study.
8) Each student must submit both hard and soft copies of the presentation.

Course Outcomes:

After going through this course the student will be able to:

CO1: Identify topics that are relevant in the present context of the world and relate it to sustainability and societal relevance.

CO2: Perform literature/market/product survey and analyse information to the field of study.

CO3: Enhance presentation and report writing skills.

CO4: Develop creative thinking abilities.

Scheme of Continuous Internal Evaluation (CIE): Evaluation would be carried out in TWO phases. The evaluation committee shall comprise of TWO senior faculty members. The evaluation criteria shall be as per the rubrics given below:

Scheme for Semester End Evaluation (SEE):
The evaluation will be done by ONE senior faculty from the department and ONE external faculty member from Academia / Industry / Research Organization. The following weightages would be given for the examination. Evaluation will be done in batches, not exceeding 6 students.

Rubrics for Evaluation:

- Topic – Technical Relevance, Sustainability and Societal Concerns 15%
- Literature Review 25%
- Presentation Skills 35%
- Report 25%

Mapping of Course Outcomes (CO) to Program Outcomes (PO)

	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10	PO11
CO1		H	M	M	L	H	H	--	---	---	M
CO2	L	M								H	
CO3							L	M	H		
CO4		L	M		H	H					H

Mapping of Course Outcomes (CO) to Program Specific Outcomes (PSO)

	PSO1	PSO2
CO1	H	L
CO2	M	H
CO3	M	L
CO4	H	L