R.V.COLLEGE OF ENGINEERING (R)

(Autonomous Institution Affiliated to VTU, Belagavi)

R.V. Vidyaniketan Post, Mysore Road

Bengaluru – 560 059

Scheme and Syllabus of III& IV Semesters

(Autonomous System of 2018 Scheme)

Master of Technology (M.Tech)

in

BIOTECHNOLOGY

DEPARTMENT OF

BIOTECHNOLOGY

R V COLLEGE OF ENGINEERNG,

BENGALURU-560 059

(Autonomous Institution Affiliated to VTU, Belagavi)

DEPARTMENT OF BIOTECHNOLOGY

THIRD SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MBT31	Downstream Process Technology	BT	4	0	1	5
2	18MBT3EX	Elective -E	BT	4	0	0	4
3	18MBT32	Internship	BT	0	0	5	5
4	18MBT33	Dissertation Phase I	BT	0	0	5	5
Total number of Credits				8	0	11	**19**
Total Number of Hours / Week							

FOURTH SEMESTER CREDIT SCHEME							
Sl. No.	**Course Code**	**Course Title**	**BoS**	**Credit Allocation**			
				L	**T**	**P**	**Total Credits**
1	18MBT41	Dissertation Phase II	BT	0	0	20	20
2	18MBT42	Technical Seminar	BT	0	0	02	02
Total number of Credits				**0**	**0**	**22**	**22**
Total Number of Hours / Week							

III Semester		
GROUP E: CORE ELECTIVES		
Sl. No.	**Course Code**	**Course Title**
1.	18MBT3E1	Nanobiotechnology
2.	18MBT3E2	Biobusiness, Project Management and Economics
3.	18MBT3E3	Next Generation Sequencing Technology

Semester: III		
Downstream Process Technology		
Course Code: 18MBT31		**CIE Marks:100+50**
Credits: L:T:P: 4:0:1		**SEE Marks:100+50**
Hours: : 50L+35P		**SEE Duration:3Hrs**

Course Learning Objectives:	
1	Learn about the different methods of cell separations and clarification of broth
2	Understand the basics of purification technology and its applications in Bioprocess industries
3	Know the new technologies adopted in industries
4	Understand different techniques of viral reduction in biological processes and explore case studies of current biological products.

Unit-I	**09 Hrs**
Introduction: Introduction to downstream processing, Recovery of intracellular and extracellular products, cell disruption techniques, separation by settling, terminal settling velocity, batch settling, Kynch Theory. Numericals	
Unit –II	**11 Hrs**
Filtration and Purification: Filtration: Pre-filtration, depth filtration, mechanism of depth filtration, modules of depth filtration. Flow rates and pressure variations in depth filtration. Membrane filtration, microfiltration, ultrafiltration, Diafiltration, cross-flow filtration, transmembrane pressure and Flux calculations with numerical. **Virus removal methods**: Viral removal and deactivation methods, Viral filtration, uv-radiation, membrane filtration for virus removal. Methods of operation and scale-up activities for viralclearance.	
Unit –III	**11 Hrs**
Chromatography: Introduction to chromatography, Types of chromatography: -Affinity chromatography, mechanism. -Membrane chromatography, types of membranes used in bioprocess, compatibility of membranes, biofouling of membranes, concentration polarization and methods of control. Membrane chromatography modules and mechanism and scale-up techniques for purification of bio molecules, Electrochromatography, Simulated moving bed chromatography.	
Unit –IV	**9 Hrs**
Drying: Drying curve, Batch and continuous dryers, Freeze drying, spray drying. Crystallization: Principles of crystallization. Extraction: process details, selection of solvent, percentage extraction, distribution coefficient. Adsorption: Types of adsorption, different adsorbents, isotherms.	
Unit –V	**10 Hrs**
Current Scenario in the bioprocess industries. Process design criteria for low volume high value products and high volume low value products. Process economics: cost cutting strategies, costing for purification of a by-product. **Case-Studies:** Purification Case studies on monoloclonal antibodies (mAbs), recombinant proteins, bacterial vaccines, traditional and cell culture based viral vaccines. Downstream processing of albumin and clotting factors.	
Unit-VI (Practical component)	**35 Hrs**
1) Cell disruption of intracellular biomolecules (ex: yeast cells) and to assay the total protein or enzyme content 2) Calculation of terminal settling velocity of disrupted yeast cells under the influence of	

flocculants & to design of thickener for batch sedimentation (under gravity) using Kynch's theory

3) Determination of clean water flux (CWF) and to calculate the flux and area of membrane required for the clarification of known cell broth (ex: yeast cells) in given time
4) Extraction of an antibiotic (ex: ceftriaxone and sulbatum) using different aqueous-organic solvent systems and determination of distribution coefficient and percentage extraction.
5) To carry out bulk precipitation of protein/enzyme from given suspension (ex; yeast cells) using ammonium sulfate and find the % cut of ammonium sulfate where the protein is highest precipitated
6) Determination of the partition coefficient and yield of total protein present in intracellular or extracellular compounds (such as yeast cells/pigments) using Polyethylene Glycol and salt system in single and/or multiple stages.
7) Extraction of amylase from fungal sources and its estimation
8) Determination of the constants of Freundlich equation by adsorbing BSA on silica.
9) Determination of the rate of drying for the given sample in a vacuum tray drier or by osmotic dehydration (ex: vegetables such as potatoes)
10) Purification of biomolecules (ex: pigments) using gel chromatography or ion exchange chromatography

Expected Course Outcomes: After going through this course the student will be able to	
CO1:	Summarize the current process involved in industrial purification of biological products
CO2:	Acquire the knowledge on different filtration and purification techniques.
CO3:	Understand the different types of chromatography and viral reduction, removal and its importance
CO4:	Overview on case studies pertaining to bioproducts currently in market

Reference Books:	
1	Uwe Gottschalk, Process Scale Purification Of Antibodies, John Wiley & Sons,2nd edition,2017,ISBN: 978-1-119-12691-1
2	Harrison R.G. Todd P. Rudge S.R. and D.P. Petrides, Bioseparations Science and Engineering, Oxford University Press,2nd edition, 2015, ISBN: 9780195391817
3	Mokesh Doble, Principles of Downstream Processing in Biological and Chemical Processes. CRC Press, Taylor & Francis group, 1st edition, 2015, ISBN 9781771881401
4	Nooralabettu Krishna Prasad,Downstream Process Technology: A New Horizon in Biotechnology, PHI Learning Publications, 1st edition, 2010, New Delhi. ISBN: 978-81-203-4040-4

Continuous Internal Evaluation (CIE): Total marks: 100+50=150

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)
CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Continuous Internal Evaluation (CIE) for Practicals: (50 Marks)
The Laboratory session is held every week as per the time table and the performance of the student is evaluated in every session. The average of marks over number of weeks is considered for 30 marks. At the end of the semester a test is conducted for 10 marks. The students are encouraged to implement additional innovative experiments in the lab and are rewarded for 10 marks. Total marks for the laboratory is 50.

Semester End Evaluation (SEE): Total marks: 100+50=150
Theory (100 Marks) + Practical (50 Marks) = Total Marks (150)

Scheme of Semester End Examination (SEE) for 100 marks:
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 full question from each unit.

Scheme of Semester End Examination (SEE); Practical (50 Marks)
SEE for the practical courses will be based on experiment conduction with proper results, is evaluated for 40 marks and Viva is for 10 marks. Total SEE for laboratory is 50 marks.

Semester: III		
Nanobiotechnology (Group E: Core Elective)		
Course Code:18MBT3E1		**CIE Marks:100**
Credits: L:T:P: 4:0:0		**SEE Marks:100**
Hours: : 50L		**SEE Duration:3Hrs**

Course Learning Objectives:	
1	Understand the fundamentals of nanomaterials.
2	Describe methods for their synthesis, characterization and their applications
3	To have awareness about the nanosensors used in diagnostic and therapeutic use.
4	To design a concept for a nanoscale product and their applications in medical field.

Unit-I	**09 Hrs**
Fundamentals of Nanoscience and Engineering: History, Types of nanomaterials: Fullerenes, Nanoshells, Quntum dots, Dendrimers, Nanocarriers, Nanofibers, Approaches of Fabrication: Top-Down and Bottom-up methods of nanofabrication and Nanosynthesis, Biosynthesis of Nanoparticles, Microbial Nanoparticle production Biomineralization, Magnetosomes. Nanolithography: hard and soft lithography. Characterization of nanomaterials using spectroscopic (UV-VIS, FTIR and Raman) and microscopic methods (SEM, TEM, STM and AFM).	
Unit –II	**11 Hrs**
Nanobiomaterials: DNA and Protein based Nano structures. Biomaterial nanocircuitry; Protein based nanocircuitry; Neurons for network formation. DNA nanostructures for mechanics and computing and DNA based computation; DNA based nanomechanical devices. Function and application of DNA based nanostructures. **Bionanomaterials in Nature:** Lotus leaf as a model self cleansing system. Gecko foot as a case study for biological generation of adhesive forces. Diatoms as an example for silicon biomineralization. Mussel inspired nanofiber for tissue engineering. Biomechanical strength properties of Spider silk.	
Unit –III	**10 Hrs**
Micro & Nano Electromechanical systems **and Microfluidics**: BioMEMS/BioNEMS: Types of transducers: mechanical, electrical, electronic, magnetic and chemical transducers. Nano sensors: Types: Electronic nose and electronic tongue, magnetic nanosensors. mechanical nanosensors: Cantilever Nanosensors, Microfludics: Laminar flow, Hagen-Poiseuille equation, basic fluid ideas, Special considerations of flow in small channels, micro mixing, microvalves & micropumps, Body on a chip and lab on a chip.	
Unit –IV	**10 Hrs**
Nanosensors: Nanofabricated devices to separate and interrogate DNA, Interrogation of immune and neuronal cell activities through micro- and nanotechnology based tools and devices. Types of Nanosensors and their applications. Electromagnetic nanosensors: Electronic nose and electronic tongue, Magnetic nanosensors. Mechanical nanosensors: Cantilever Nanosensors, NanoBiosensors: NanoBiosensors in modern medicine.	
Unit –V	**10 Hrs**
Medical Nano biotechnology in Diagnostics, therapeutics, drug delivery, Nano Surgery and Tissue Engineering . Drug Delivery Applications, Bioavailability, Sustained and targeted release. Benefits of Nano drug delivery system. Use of Microneedles and nanoparticles for targeted and highly controlled drug delivery. Nano robots in drug delivery and cleaning system. Design of nanoparticles for oral delivery of peptide drugs. Nanotoxicity assessment: In-vitro laboratory tests on the interaction of nanoparticles with cells.	

Expected Course Outcomes: After going through this course the student will be able to	
CO1:	Understand and apply the knowledge of nanomaterials and nanobiomaterials to enable

	health sector advancements.
CO2:	Interpret and apply the techniques of manufacturing and characterization processes.
CO3:	Apply the knowledge for various applications in Biomedical field.
CO4:	Design devices and systems for various biological applications

Reference Books:	
1	Gabor L. H., Dutta J., Tibbals H. F., Rao A., Introduction to Nanosciences, 2008, CRC press, ISBN- 1420048058
2	Murthy B.S., Shankar P., Raj,B., Rath, B.B. and Murday, J. Textbook of Nanosciences and Nanotechnology, 2013, Springer, Co-publication with University Press (India) Pvt. Ltd. VCH, XII. ISBN- 978-3-642-28030-6.
3	Vinod kumar Khanna, Nanosensors: 2013, Physical, Chemical and Biological, CRC press, ISBN 9781439827123
4	Sandra J. Rosenthal, David W. Wright, NanoBiotechnology Protocols, Springer, 2nd edition, Humana Press, 2013. ISBN- 13 978-158829276

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

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 full question from each unit.

Semester: III		
Biobusiness, Project Management and Economics (Group E: Core Elective)		
Course Code: 18MBTE2		**CIE Marks:100**
Credits: L:T:P: 4:0:0		**SEE Marks:100**
Hours: : 50L		**SEE Duration:3Hrs**

Course Learning Objectives:	
1	Understand and appreciate the principles, components and integrated approach of project management.
2	Apply the knowledge for addressing the economical aspects for product development and commercialization
3	Apply the project management tools and techniques for managing project cost and project procurements for sustenance.
4	Design the reproducible, cost effective and justiciable business model for bio enterprise

Unit-I	**09 Hrs**
Introduction: Project, Project management, portfolio management, program management, organizational project management, operations management and organizational strategy, role of the project manager. **Generation and Screening of Project Ideas and project life cycle:** Generation and preliminary screening of ideas, project state holders & governance, project team, project life cycle	
Unit –II	**11 Hrs**
Limbs of project management: Project Integration Management: Develop project charter, develop project management plan, Project Scope Management: create and validate WBS, validateProject Quality management: quality assurance, control quality. Project Risk Management: identify risks, risk analysis, plan risk resources, control risk. **Network Techniques for Project Management**: Development of project network, time estimation, determination of the critical path, scheduling when resources are limited, PERT model. CPM model.	
Unit –III	**10 Hrs**
Introduction to Economics: Concept of Economy and its working, basic problems of an Economy, Market mechanism to solve economic problems, Essentials of Micro Economics: Concept and scope, tools of Microeconomics, Uses of Microeconomics. Essentials of Macroeconomics**:** Prices and inflation, Exchange rate, Gross domestic product(GDP) , components of GDP, the Labor Market, Money and banks, Interest rate.	
Unit –IV	**10 Hrs**
Biomanufacturing: Overview of biomanufacturing requirements, Design in biomanufacture, technical considerations for biomanufacturing, life cycle, GMP, GLP & NABL, Quality System Regulations (QSR), Good Manufacturing Practice (GMP), Good Laboratory Practices (GLP), Good Clinical Practice (GCP), and FDA. Elements of quality system, Unique approaches to quality management: Risk based approach, ISO, TQM and six sigma, quality systems for research	
Unit –V	**10 Hrs**
Bioenterprises: Business plans, Business models, funding of biotech business: Financing alternatives, Angel funding, Venture Capital funding, funding for biotech in India, Exit strategy, licensing strategies and valuation. Business laws applied to Biotech industries in India. funding agencies in India and biotech policy initiatives. Bio entrepreneurship in India. History of pioneer biotech companies: Alembic, Shanta Biotech & Biocon,	

Expected Course Outcomes: After going through this course the student will be able to	
CO1:	Explain and comprehend the concept of project management, economics and bio business.
CO2:	Appraise and illustrate various project management processes in the project management framework.
CO3:	Analyze, plan and develop quality control & assurance along with economics for development of biobusiness for sustenance.
CO4:	Develop project plans and apply project management techniques to monitor, review and evaluate progress on different types of project.

Reference Books:	
1	Project Management Institute, "A Guide to the Project Management Body of Knowledge (PMBOK Guide)", 5th Edition, 2013, ISBN: 978-1-935589-67-9
2	Harold Kerzner, "Project Management A System approach to Planning Scheduling & Controlling", John Wiley & Sons Inc., 11th Edition, 2013, ISBN 978-1-118-02227-6.
3	Stephen Robbins, Mary Coulter & NeharikaVohra, Management, Pearson Education Publications, 10th Edition, ISBN: 978-81-317-2720-1.
4	Dwivedi D.N, Macroeconomics: Theory and Policy,McGraw Hill Education; 3rd Edition, 2010, ISBN-13: 978-0070091450.

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

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 full question from each unit.

Semester: III		
Next Generation Sequencing Technology (Group E: Core Elective)		
Course Code: 18MBTE3		**CIE Marks:100**
Credits: L:T:P: 4:0:0		**SEE Marks:100**
Hours: : 50L		**SEE Duration:3Hrs**

Course Learning Objectives:	
1	Understand the standard data structure (what information is included in each file)
2	Implement different analysis tools (such as alignment, variant call, ...)
3	Interpret the analysis results
4	Design an experiment for solving the problem of your own research interest

Unit-I	**09 Hrs**
Introduction to Sequencing technology: Sequencing platforms, Chemistry of difference sequencing platforms, Advantages and disadvantages of the platforms, Need of Hybrid platforms. Base calling algorithms, Base quality, phred values, Reads quality checks, Interpretations from quality checks. Adapter and primer contamination. Processing reads using clipping of reads-Advantages and disadvantages of processing of reads	
Unit –II	**11 Hrs**
Overview of NGS Application : Burrows-Wheeler Aligner (BWA) and Bowtie Alignment programs, burrows wheeler algorithm. Reference indexing and Alignment. Building from source, The bowtie aligner, The -n alignment mode, The -v alignment mode, Reporting Modes, Paired-end Alignment, Colorspace Alignment, Colorspace reads, Building a colorspace index, Decoding colorspace alignments, Paired-end colorspace alignment, Performance Tuning, SAM and BAM format. Artifacts in alignment programs Whole Genome Sequencing, Human Exome sequencing, Transcriptome sequencing, chip Sequencing, smallRNA sequencing, Methylome sequencing, RAD Sequencing and RRL sequencing.	
Unit –III	**11 Hrs**
Big Data Analytics : Introduction of Cloud computing, Hadoop architecture. MIKE2.0 , Multiple layer architecture, Distributed Parallel architecture , NGS data analysis using Hadoop, **HPC overview and programming :** Introduction to Linux operating system, Basic commands used in HPC cluster, Major components and its functions in HPC Cluster- head node, login node, interactive node, compute node, I/O node, HPC Data Storage, Serial and parallel batch jobs and scripting to run processes in parallel.	
Unit –IV	**09 Hrs**
Tools and Techniques for high throughput data analysis : NGS data –Retrieval, Format Conversion, Quality Check, Trimming low quality reads, Alignment and Assembly, Visualization, Variant Calling, Annotation. Gene–Level Statistical Analyses, Identifying Functional Modules	
Unit –V	**10 Hrs**
Clinical Applications : States of the genetic research for complex disease, NGS and genetics of complex disease, personal genome sequencing, Disease gene identification, Differential expression analysis, Next generation sequencing in cancer research, Clinical sequencing, Diagnostic NGS.	

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	Next-generation DNA sequencing informatics by Stuart M. Brown 2015. Cold Spring Harbor Laboratory Press, Cold Spring Harbor: New York. ISBN-13: 978-1936113873.
2	Bioinformatics for High Throughput Sequencing by Naiara Rodríguez-Ezpeleta, Michael Hackenberg, Ana M. Aransay. Springer New York, 2011. ISBN-13: 9781461407812
3	High-Throughput Next Generation Sequencing Methods and Applications Series: Young Min Kwon, Steven C. Ricke. Humana Press,2011.ISBN: 978-1-61779-088-1 (Print) 978-1-61779-089-8
4	Clinical Applications for Next-Generation Sequencing by Urszula Demkow and Rafal Ploski: Academic Press, 2015, ISBN: 978-0-12-801739-5

Scheme of Continuous Internal Evaluation (CIE); Theory (100 Marks)

CIE is executed by way of quizzes (Q), tests (T) and assignments. A minimum of two quizzes are conducted and each quiz is evaluated for 10 marks adding up to 20 marks. Faculty may adopt innovative methods for conducting quizzes effectively. The three tests are conducted for 50 marks each and the sum of the marks scored from three tests is reduced to 50 marks. A minimum of two assignments are given with a combination of two components among 1) solving innovative problems 2) seminar/new developments in the related course 3) Laboratory/field work 4) mini project. **Total CIE is 20+50+30=100 Marks.**

Scheme of Semester End Examination (SEE) for 100 marks:

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 full question from each unit.

INTERNSHIP						
Course Code	**:**	**18MBT33**		**CIE Marks**	**:**	**100**
Credits	**:**	**L:T:P**	**0:0:5**	**SEE Marks**	**:**	**100**
Hours/week	**:**	**10Hrs**		**SEE Duration**	**:**	**3 Hrs**

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 lifelong 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 report their progress and submit periodic progress reports to their respective guides.
5) 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.
6) 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.
7) 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.

1. 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%

Dissertation Phase 1						
Course Code	**:**	**18MBT34**		**CIE Marks**	**:**	**100**
Credits	**:**	**L:T:P**	**0:0:5**	**SEE Marks**	**:**	**100**
Hours	**:**	**10**		**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 carried out 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 project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
5. 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.
6. 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
4th week	Topic approval along with Synopsis	20%
8th week	Literature survey with Problem Statement	20%
12th week	Motivation and Objectives	20%
15th week	Preliminary report for the approval of selected topic along with	40%
	methodology.	

CIE Evaluation shall be done with marks distribution as follows:

- Selection of the topic 10%
- Literature review and framing of objectives 25%
- Defining the brief methodology along with the algorithm development/experimental setup 25%
- 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. Presentation 25%
4. Report 20%
5. Viva Voce 30%

Dissertation Phase II						
Course Code	**:**	**18MBT41**		**CIE Marks**	**:**	**100**
Credits	**:**	**L:T:P**	**0:0:20**	**SEE Marks**	**:**	**100**
Hours/Week	**:**	**40**		**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 project can be carried out on-campus or in an industry or an organization with prior approval from the Head of the Department.
5. 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.
6. 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 II	Activity	Weightage
5th week	Review and refinement of Objectives and methodology.	20%
10th week	Mid-term progress review shall check the compliance with the objectives and methodology presented in Phase I, review the work performed.	40%
15th week	Oral presentation, demonstration and submission of project report. Outcome and publication	40%

CIE Evaluation shall be done with marks distribution as follows:

- Review of formulation of objectives and methodology 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%

TECHNICAL SEMINAR						
Course Code	**:**	**18MBT42**		**CIE Marks**	**:**	**50**
Credits	**:**	**L:T:P**	**0:0:2**	**SEE Marks**		**50**
Hours/Week	**:**	**4**		**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%