VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI

Scheme of Teaching and Examination
B.E. BIOTECHNOLOGY
III-VIII SEMESTER
(Effective from Academic year 2018-19)

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

III SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	BSC	18BT31	Biostatistics	Mathematics	3	1	--	03	40	60	100	3
2	PCC	18BT32	Microbiology	Biotech	4	0	--	03	40	60	100	4
3	PCC	18BT33	Unit Operations	Chemical/Biotech	3	1	--	03	40	60	100	3
4	PCC	18BT34	Introduction to Biomolecules	Biotech	3	1	--	03	40	60	100	3
5	PCC	18BT35	Cell Biology and Genetics	Biotech	3	0	--	03	40	60	100	3
6	PCC	18BT36	Python Programming	CSE	3	1	--	03	40	60	100	3
7	PCC	18BTL37	Microbiology Laboratory	Biotech	--	2	2	03	40	60	100	2
8	PCC	18BTL38	Unit Operations Laboratory	Chemical/Biotech	--	2	2	03	40	60	100	2
9	HSMC	18KVK39	Vyavaharika Kannada (Kannada for communication)/	HSMC	--	2	--	--	100	--	100	1
		18KAK39	Aadalitha Kannada (Kannada for Administration)									
		OR										
		18CPC39	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**19 OR 20**	**08 OR 10**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK39Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK39 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP31	Additional Mathematics - I	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech. programs shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.

(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B.Sc. degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE Activity Points to be earned by students admitted to BE/B. Tech./B. Plan. day college programme (For more details refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines):

Over and above the academic grades, everyday College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.

The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

III SEMESTER (continued)

Courses prescribed to lateral entry B.Sc. degree holders admitted to III semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics andElements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

AICTE Activity Points to be earned by students admitted to BE/B. Tech./B. Plan. day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines):

Over and above the academic grades, everyday College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.

The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
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Programme: BIOTECHNOLOGY

IV SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18BT41	Stoichiometry	Chemical/Biotech	3	1	--	03	40	60	100	3
2	PCC	18BT42	Molecular Biology	Biotech	4	0	--	03	40	60	100	4
3	PCC	18BT43	Immunotechnology	Biotech	3	0	--	03	40	60	100	3
4	PCC	18BT44	Cell Culture Techniques	Biotech	3	0	--	03	40	60	100	3
5	PCC	18BT45	Biochemical Thermodynamics	Chemical/Biotech	3	1	--	03	40	60	100	3
6	PCC	18BT46	Clinical Biochemistry	Biotech	3	0	--	03	40	60	100	3
7	PCC	18BTL47	Biochemistry Laboratory	Biotech	--	2	2	03	40	60	100	2
8	PCC	18BTL48	Immunotechnology Laboratory	Biotech	--	2	2	03	40	60	100	2
9	HSMC	18KVK49	Vyavaharika Kannada (Kannada for communication)/	HSMC **OR**	--	2	--	--	100	--	100	1
		18KAK49	Aadalitha Kannada (Kannada for Administration)									
		18CPC49	Constitution of India, Professional Ethics and Cyber Law		1	--	--	02	40	60		
					Examination is by objective type questions							
				TOTAL	**19 OR 20**	**06 OR 08**	**04**	**24 OR 26**	**420 OR 360**	**480 OR 540**	**900**	**24**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

18KVK49Vyavaharika Kannada (Kannada for communication) is for non-Kannada speaking, reading and writing students and 18KAK49 Aadalitha Kannada (Kannada for Administration) is for students who speak, read and write Kannada.

Course prescribed to lateral entry Diploma holders admitted to III semester of Engineering programs

10	NCMC	18MATDIP41	Additional Mathematics - II	Mathematics	02	01	--	03	40	60	100	0

(a)The mandatory non – credit courses Additional Mathematics I and II prescribed for III and IV semesters respectively, to the lateral entry Diploma holders admitted to III semester of BE/B. Tech. Programs shall attend the classes during the respective semesters to complete all the formalities of the course and appear for the University examination. In case, any student fails to register for the said course/fails to secure the minimum 40 % of the prescribed CIE marks, he/she shall be deemed to have secured F grade. In such a case, the students have to fulfill the requirements during subsequent semester/s to appear for SEE.
(b)These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.

Courses prescribed to lateral entry B.Sc. degree holders admitted to IV semester of Engineering programs

Lateral entrant students from B.Sc. Stream, shall clear the non-credit courses Engineering Graphics and Elements of Civil Engineering and Mechanics of the First Year Engineering Programme. These Courses shall not be considered for vertical progression, but completion of the courses shall be mandatory for the award of degree.
AICTE Activity Points to be earned by students admitted to BE/B. Tech./B. Plan. day college programme (For more details refer to Chapter 6, AICTE Activity Point Programme, Model Internship Guidelines): Over and above the academic grades, everyday College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card. The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression. In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

V SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	HSMC	18BT51	Bio-Business and Entrepreneurship	HSMC/Biotech	3	--	--	03	40	60	100	3
2	PCC	18BT52	Chemical Reaction Engineering	Chemical/Biotech	4	1	--	03	40	60	100	4
3	PCC	18BT53	Enzyme Technology & Biotransformation	Biotech	4	--	--	03	40	60	100	4
4	PCC	18BT54	Genomics & Proteomics	Biotech	3	1	--	03	40	60	100	3
5	PCC	18BT55	Bioanalytical Techniques	Biotech	3	--	--	03	40	60	100	3
6	PCC	18BT56	Genetic Engineering &Applications	Biotech	3	--	--	03	40	60	100	3
7	PCC	18BTL57	Biokinetics & Enzyme Technology Laboratory	Chemical/Biotech	--	2	2	03	40	60	100	2
8	PCC	18BTL58	Genetic Engineering and Cell Culture Laboratory	Biotech	--	2	2	03	40	60	100	2
9	HSMC	18CIV59	Environmental Studies	Civil/ Environmental [Paper setting: Civil Engineering Board]	1	--	--	02	40	60	100	1
					Examination is by objective type questions							
				TOTAL	**21**	**06**	**04**	**26**	**360**	**540**	**900**	**25**

Note: BSC: Basic Science, PCC: Professional Core, HSMC: Humanity and Social Science, NCMC: Non-credit mandatory course.

continued

AICTE Activity Points to be earned by students admitted to BE/B. Tech./B. Plan. day college programme (For more details refer to Chapter 6,AICTE Activity Point Programme, Model Internship Guidelines):

Over and above the academic grades, everyday College regular student admitted to the 4 years Degree programme and every student entering 4 years Degree programme through lateral entry, shall earn 100 and 75 Activity Points respectively for the award of degree through AICTE Activity Point Programme. Students transferred from other Universities to fifth semester are required to earn 50 Activity Points from the year of entry to VTU. The Activity Points earned shall be reflected on the student's eighth semester Grade Card.

The activities can be spread over the years, anytime during the semester weekends and holidays, as per the liking and convenience of the student from the year of entry to the programme. However, minimum hours' requirement should be fulfilled. Activity Points (non-credit) have no effect on SGPA/CGPA and shall not be considered for vertical progression.

In case students fail to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points. Students shall be admitted for the award of degree only after the release of the Eighth semester Grade Card.

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Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
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Programme: BIOTECHNOLOGY

VI SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18BT61	Process Control & Automation	Chemical	4	1	--	03	40	60	100	4
2	PCC	18BT62	Bioprocess Equipment Design & CAED	Chemical	4	2	--	04	40	60	100	4
3	PCC	18BT63	Bioinformatics	Biotech	4	--	--	03	40	60	100	4
4	PEC	18BT64X	Professional Elective -1	Biotech	3	--	--	03	40	60	100	3
5	OEC	18BT65X	Open Elective -A	Biotech	3	--	--	03	40	60	100	3
6	PCC	18BTL66	Process Control & Automation Laboratory	Chemical	--	2	2	03	40	60	100	2
7	PCC	18BTL67	Bioinformatics Laboratory	Biotech	--	2	2	03	40	60	100	2
8	MP	18BTMP68	Mini-project	-	--	1	2	03	40	60	100	2
9	Internship	--	Internship		To be carried out during the vacation/s of VI and VII semesters and /or VII and VIII semesters.							
				TOTAL	**18**	**08**	**06**	**25**	**320**	**480**	**800**	**24**

Note: PCC: Professional core, PEC: Professional Elective, OE: Open Elective, MP: Mini-project.

Mini-project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinary Mini-project can be assigned to an individual student or to a group having not more than 4 students.

CIE procedure for Mini-project:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the Min-project work, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college.

The CIE marks awarded for the Mini-project, shall be based on the evaluation of project report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

VI SEMESTER (continued)

SEE for Mini-project:
(i) Single discipline: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.
(ii) Interdisciplinary: Contribution to the Mini-project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belongs to.
Internship: All the students admitted to III year of BE/B.Tech. Shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and shall have to complete during subsequent University examination after satisfying the internship requirements.

Professional Elective -1

Course code under18BT64X	**Course Title**
18BT641	Food Process Engineering
18BT642	Phyto-Chemistry and Phyto-Harmones
18BT643	Human Physiology

Open Elective –A

18BT651: Biology for Engineers (Modified)

18BT652:Biomaterials (Modified)

18BT653: Nano-biotechnology (Modified)

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18BT65X).Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core courses or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.

Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

AICTE activity Points: In case a student fails to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

VII SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18BT71	Bioprocess Engineering	Chemical/ Biotech	4	1	--	03	40	60	100	4
2	PCC	18BT72	Clinical & Pharmaceutical Biotechnology	Biotech	4	--	--	03	40	60	100	4
3	PEC	18BT73X	Professional Elective – 2	Chemical/ Biotech	3	--	--	03	40	60	100	3
4	PEC	18BT74X	Professional Elective – 3	Biotech	3	--	--	03	40	60	100	3
5	OEC	18BT75X	Open Elective –B	Biotech	3	--	--	03	40	60	100	3
6	PCC	18BTL76	Bioprocess Engineering Laboratory	Chemical/ Biotech	--	2	2	03	40	60	100	2
7	Project	18BTP77	Project Work Phase – 1	-	--	--	2	--	100	--	100	1
8	Internship	18BT71	Internship	(If not completed during the vacation of VI and VII semesters, it shall be carried out during the vacation of VII and VIII semesters)								
TOTAL					**17**	**03**	**04**	**18**	**340**	**360**	**700**	**20**

Note: Note: PCC: Professional core, PEC: Professional Elective.

Project work:
Based on the ability/abilities of the student/s and recommendations of the mentor, a single discipline or a multidisciplinaryproject can be assigned to an individual student or to a group having not more than 4 students. In extraordinary cases, like the funded projects requiring students from different disciplines, the project student strength can be 5 or 6.

CIE procedure for Project Work Phase - 1:
(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -1, shall be based on the evaluation of the project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the Project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.
The CIE marks awarded for the project work phase -1, shall be based on the evaluation of project work phase -1 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

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VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

VI SEMESTER (continued)

Internship: All the students admitted to III year of BE/B. Tech. shall have to undergo mandatory internship of 4 weeks during the vacation of VI and VII semesters and /or VII and VIII semesters. A University examination shall be conducted during VIII semester and the prescribed credit shall be included in VIII semester. Internship shall be considered as a head of passing and shall be considered for the award of degree. Those, who do not take-up/complete the internship shall be declared as failed and shall have to complete during subsequent University examination after satisfying the internship requirements

Professional Elective – 2		**Professional Electives - 3**	
Course code under 18BT73X	**Course Title**	**Course code under 18BT74X**	**Course Title**
18BT731	Process Equipment & Plant Design	18BT741	Bioethics, Biosafety & IPR
18BT732	Bioreactor Design Concepts	18BT742	Agricultural Biotechnology
18BT733	Transport Phenomena	18BT743	Tissue Engineering

Open Elective –B	
Course code under 18BT75X	**Course Title**
18BT751	BT for sustainable Environment
18BT752	Forensic Science
18BT753	**Food, Nutrition and Human Health (Title Changed and Syllabus modified)**

Students can select any one of the open electives offered by other Departments expect those that are offered by the parent Department (Please refer to the list of open electives under 18BT75X). Selection of an open elective shall not be allowed if,

- The candidate has studied the same course during the previous semesters of the programme.
- The syllabus content of open elective is similar to that of Departmental core course/s or professional electives.
- A similar course, under any category, is prescribed in the higher semesters of the programme.
- Registration to electives shall be documented under the guidance of Programme Coordinator/ Advisor/Mentor.

AICTE activity Points: In case a student fails to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY, BELAGAVI
Scheme of Teaching and Examination 2018 – 19
Outcome Based Education(OBE) and Choice Based Credit System (CBCS)
(Effective from the academic year 2018 – 19)

Programme: BIOTECHNOLOGY

VIII SEMESTER

Sl. No	Course and Course Code		Course Title	Teaching Department	Teaching Hours /Week			Examination				Credits
					Theory Lecture	Tutorial	Practical/ Drawing	Duration in hours	CIE Marks	SEE Marks	Total Marks	
					L	T	P					
1	PCC	18BT81	Regulatory Affairs in Biotech Industry	Biotech	3	--	--	03	40	60	100	3
2	PEC	18BT82X	Professional Elective - 4	Biotech	3	--	--	03	40	60	100	3
3	Project	18BTP83	Project Work Phase - 2	-	--	--	2	03	40	60	100	8
4	Seminar	18BTS84	Technical Seminar	-	--	--	2	03	100	--	100	1
5	Internship	18BTI85	Internship	Completed during the vacation/s of VI and VII semesters and /or VII and VIII semesters.				03	40	60	100	3
				TOTAL	**06**	**--**	**04**	**15**	**260**	**240**	**500**	**18**

Note: PCC: Professional Core, PEC: Professional Elective.

Professional Electives - 4

Course code under 18BT82X	Course Title
18BT821	Environmental Biotechnology
18BT822	Industrial Microbiology
18BT823	Marine Biotechnology

Project Work

CIE procedure for Project Work Phase - 2:

(i) Single discipline: The CIE marks shall be awarded by a committee consisting of the Head of the concerned Department and two senior faculty members of the Department, one of whom shall be the Guide.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

(ii) Interdisciplinary: Continuous Internal Evaluation shall be group wise at the college level with the participation of all guides of the college. Participation of external guide/s, if any, is desirable.

The CIE marks awarded for the project work phase -2, shall be based on the evaluation of project work phase -2 Report, project presentation skill and question and answer session in the ratio 50:25:25.The marks awarded for the project report shall be the same for all the batch mates.

SEE for Project Work Phase - 2:

(i) Single discipline: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted at the department.

(ii) Interdisciplinary: Contribution to the project and the performance of each group member shall be assessed individually in semester end examination (SEE) conducted separately at the departments to which the student/s belong to.

Internship: Those, who have not pursued /completed the internship, will be declared as failed and have to complete during subsequent University examination after satisfying the internship requirements.

AICTE activity Points: In case a student fails to earn the prescribed activity Points, Eighth semester Grade Card shall be issued only after earning the required activity Points.
The principals shall include the prescribed activity points earned by the students along with the CIE marks.

VISVESVARAYA TECHNOLOGICAL UNIVERSITY BELAGAVI

Scheme of Teaching and Examination and Syllabus
B.E. BIOTECHNOLOGY
III-VIIISEMESTER
(Effective from Academic year 2018-19)

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

BIOSTATISTICS

Course Code	**18BT31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn how to formulate and test the hypotheses about means, proportions and standard deviation to draw conclusions based on the results of statistical tests in large sample.
- To learn how to formulate and test the hypotheses about means, variances for small samples using t and F test for small sample and have knowledge on ANOVA.
- To understand the fundamentals of quality control and the methods used to control systems and processes.

Module-1

INTRODUCTION TO STATISTICS AND STUDY DESIGN:
Introduction, graphical representation of data. Measures of central tendency, dispersion. Significance of statistics to biological problems, experimental studies; randomized controlled studies, historically controlled studies, factorial design, cluster design,; completely randomized block design, analysis and interpretation.

Module-2

DESCRIPTIVE STATISTICS AND OBSERVATIONAL STUDY DESIGN:
Types of variables, measure of spread, logarithmic transformations, multivariate data. Basics of study design, cohort studies, case control studies, outcomes, odd ratio and relative risks. Principles of statistical inference: Parameter estimation, hypothesis testing. variables; categorical data, binomial distribution, Normal distribution

Module-3

COMPARISON OF MEANS:
Test statistics; t-test, F distribution, independent and dependent sample comparison, Wilcoxon Signed Rank Test, Wilcoxon Mann-Whitney Test, ANOVA. Correlation and simple linear regression: Introduction, Karl Pearson correlation coefficient, Spearman Rank correlation coefficient, simple linear regression, regression model fit, Multiple linear regression and linear models**:** Introduction, Multiple linear regression model, ANOVA table for multiple linear regression model, assessing model fit, polynomials and interactions. One-way and Two-way ANOVA tables, F-tests.

Module-4

DESIGN AND ANALYSIS OF EXPERIMENTS:
Random block design, multiple sources of variation, correlated data and random effects regression, model fitting. Completely randomized design, stratified design. Biological study designs. Optimization strategies with case studies.

Module-5

SAS PROGRAMMING:
Basic syntax: variables, strings, arrays, decision making, input methods. SAS data set operations: Read raw data; write, merging, subsetting, sort, format data sets, output delivery system. SAS representations (Histogram, bar chart, pie chart, scatter plot). SAS basic statistical procedure (Arithmetic mean, Standard deviation, T-tests, correlation analysis, frequency distribution, linear regression, Chi square test, one way ANOVA, Hypothesis testing).

Course Outcomes: At the end of the course the student will be able to:

- Study and design various statistical problems
- Foundation to tackle live problems in various spheres of bioscience and bioengineering.
- Demonstrate strong basics in statistics and numerical analysis

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Biostatistics	Alvin E. Lewis	McGraw-Hill Professional Publishing	2013
2	Statistics and Numerical Methods in BASIC for Biologists	J.D. Lee and T.D. Lee	Van Nostr and Reinhold Company	1982
3	Statistical Analysis of Gene Expression Microarray Data	T.P. Chapman	CRC	2003
4	SAS Essentials: Mastering SAS for Data Analytics	Alan C. Elliott , Wayne A. Woodward	John Wiley & Sons	2nd Edition, 2015
Reference Books				
1	Numerical Methods of Statistics (Cambridge Series in Statistical and Probabilistic Mathematics)	John F. Monahan	Cambridge University Press	2011
2	Numerical Methods for Engineers and Scientists	Joe D. Hoffman	CRC Press	2nd Edition, 2001
3	Statistical Methods in Bioinformatics: An Introduction (Statistics for Biology and Health)	Warren J. Ewens Gregory Grant	Springer	2005

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

MICROBIOLOGY

Course Code	**18BT32**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:0:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To learn the details of classification, structural features and functional aspects of prokaryotic and eukaryotic microorganisms.
- To gain insights into microbial metabolism and metabolic pathways.
- To understand the details of microbial techniques for growth, cultivation and characterization of microorganisms.
- To appreciate the recent developments in the area of medical microbiology, environmental microbiology, industrial microbiology, etc.

Module-1

INTRODUCTION TO MICROORGANISMS: Scope and History of microbiology(Milestone contributions from scientists); Origin of life-: Archaea, Prokaryotes and Eukaryotes. Microbial Diversity and Taxonomy. Structure, Classification and Reproduction of bacteria, Fungi, Viruses, Protozoa and Algae. General features of Prions, Spirochetes, Actinomycetes, Rickettsiae and Mycoplasma.

Module-2

METHODS AND TECHNIQUES IN MICROBIOLOGY: Microscopy: Concepts, Light, Electron, Phase Contrast, Acoustic Microscopy, camera Lucida and Micrometry. Media preparation, types of media, Culture methods, pure culture techniques, Differential Staining Techniques. Sterilization &disinfection techniques

Module-3

MICROBIAL GROWTH AND METABOLISM: Growth curve patterns, Physical conditions required for growth. Metabolism; Primary and Secondary metabolites with examples, metabolic pathways important in Microorganisms-Respiration and Fermentation.

Module-4

MEDICAL MICROBIOLOGY: Introduction to Medical Microbiology, Common diseases caused by microbes: Bacterial diseases: Typhoid, Diphtheria, Cholera, Tuberculosis, Leprosy, Plague, Syphilis, Gonorrhea; Viral diseases: Herpes, Polio, Hepatitis, AIDS, Rabies, SARS and H1N1; Protozoan diseases: Malaria: common types of fungal infections

Module-5

AIR, WATER AND SOIL MICROBIOLOGY: Soil Microbiology: Role of microbes and soil fertility. Biogeochemical cycles. Bio fertilizers: VAM, Rhizobium and Azotobacter. Air sampling techniques and commonly found atmospheric microbe profile. Water sampling techniques and commonly found atmospheric microbe profile.

Course Outcomes:

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

- Describe the structure and function of typical prokaryotic and eukaryotic cell structure like bacteria, algae, yeast & molds, protozoa, viruses, etc.
- Understand the techniques used for the isolation, growth, identification, disinfection and sterilization

of microorganisms.

- Define the role of microorganisms towards environmental protection, industrial applications and infectious diseases.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	General Microbiology	Roger Y Stanier, John L Ingraham, and Mark L Wheels	Macmillan Press Ltd	Fifth Edition 1992
2	Microbiology	Prescott, Harley, Klein	McGrawHill	Seventh Edition 1996
3	Microbiology	Michael J PelczarJr Chan ECS, Noel R Krieg	Tata McGraw-Hill Education Pvt	Fifth Edition 2013
Reference Books				
1	The Air Spora: A manual for catching and identifying airborne biological particles	Maureen E. Lacey and Jonathan S. West	Springer	2006
2	Soil Microbiology	N S SubbaRao	Oxford and IBH	1999
3	Text Book of Microbiology	Ananthanarayan and JayaramPanicker	Universities Press	Seventh Edition 2006

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

UNIT OPERATIONS

Course Code	**18BT33**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To know the fundamental concepts of fluid mechanics, heat and mass transfer.
- To solve the engineering problems related to fluid flow, heat and mass transfer.
- To understand the design concepts of fluid and particulate technology.
- To design and operate the heat exchange equipment

Module-1

FLUID MECHANICS CONCEPTS:
Fluid definition and classification of fluids, types of fluids, Rheological behaviour of fluids & Newton's Law of viscosity. Fluid statics-Pascal's law, Hydrostatic equilibrium, Barometric equation and pressure measurement(problems),Basic equations of fluid flow - Continuity equation, Euler's equation and Bernoulli equation; Types of flow - laminar and turbulent; Reynolds experiment; Flow through circular and non-circular conduits - Hagen Poiseuille equation (no derivation). Flow through stagnant fluids – theory of Settling and Sedimentation – Equipment (cyclones, thickeners) Conceptual numericals.

Module-2

FLOW MEASUREMENTS & MECHANICAL OPERATIONS:
Different types of flow measuring devices (Orifice meter, Venturimeter, Rotameter) with derivations, flow measurements –. Pumps – types of pumps (Centrifugal & Reciprocating pumps), Energy calculations and characteristics of pumps. Size reduction–characteristics of comminute products, sieve analysis, Properties and handling of particulate solids – characterization of solid particles, average particle size, screen analysis-Conceptual numericals of differential and cumulative analysis. Size reduction, crushing laws, working principle of ball mill. Filtration & types, filtration equipments (plate and frame, rotary drum). Conceptual numericals.

Module-3

CONDUCTIVE & CONVECTIVE HEAT TRANSFER:
Modes of heat transfer; Conduction – steady state heat conduction through unilayer and multilayer walls, cylinders; Insulation, critical thickness of insulation. Convection- Forced and Natural convection, principles of heat transfer co-efficents, log mean temperature difference, individual and overall heat transfer co-efficients, fouling factor; Condensation – film wise and drop wise (no derivation). Heat transfer equipments – double pipe heat exchanger, shell and tube heat exchanger (with working principle and construction with applications). Conceptual numericals.

Module-4

BASICS OF MASS TRANSFER: Diffusion-Fick's law of diffusion. Types of diffusion. Steady state molecular diffusion in fluids at rest and laminar flow (stagnant / unidirection and bi direction). Measurement of diffusivity, Mass transfer coefficients and their correlations. Conceptual numerical.

Module-5

MASS TRANSFER OPERATIONS: Basic concepts of Liquid-liquid extraction – equilibrium, stage type extractors (belt extraction and basket extraction).Distillation – Methods of distillation, distillation of binary mixtures using McCabe Thiele method.Drying- drying operations, batch and continuous drying. Conceptual numerical.

Course Outcomes: At the end of the course the student will be able to:

- State and describe the nature and properties of the fluids.
- Study the different flow measuring instruments, the principles of various size reductions, conveying equipment's, sedimentation and mixing tanks.
- Comprehend the laws governing the heat and mass transfer operations to solve the problems.
- Design the heat transfer equipment suitable for specific requirement.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Unit operations in Chemical Engineering	Warren L. McCabe, Julian C. Smith & Peter Harriot	McGraw-Hill Education	(India) Edition 2014
2	Fluid Mechanics	K L Kumar	S Chand & Company Ltd	2008
3	Introduction to Chemical Engineering	Badger W.I. and Banchero, J.T.,	Tata McGraw Hill New York	1997
Reference Books				
1	Principles of Unit Operations	Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson	John Wiley & Sons	2nd edition 2008
2	Unit Operations of Chemical Engineering, Vol I &II	Chattopadhyaya	Khanna Publishers, Delhi-6	1996
3	Heat Transfer	J P Holman	McGraw Hill	International Ed

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

INTRODUCTION TO BIOMOLECULES

Course Code	**18BT34**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn the basic structure ,organization ,scope and function of Biomolecules
- To learn the transformation of energy within the living organisms
- To learn the composition, structure and function of biological membranes
- To learn the types and functions of transport system

Module-1

Carbohydrates & Lipids: Introduction, sources, classification into mono, oligo and polysaccharides. Classification of monosaccharaides, based on no. of C-atoms. Functional groups- aldoses and ketoses(stressing the difference between reducing and non-reducing sugars). Isomerism of Carbohydrates, Fischer projections, Haworth structures, pyranose and furanose structures, Anomers, Chair and boat conformations. Structure and properties of oligosaccharides and polysaccharides. Lipids**:** Introduction, sources, Nomenclature, Important saturated & unsaturated fatty acids. Properties & functions. Derived lipids: Phospholipids, glycolipids, Waxes, Steroids-Structure of steroid nucleus, Biological role of cholesterol

Module-2

Amino acid and Proteins: Introduction, classification, optical isomerism, chemical properties, Acid –Base properties, polyionic nature, zwitter ions, pKa, pI .Peptide bond formation and properties.Composition and primary structures of proteins, Conformational analysis and forces that determine protein structures, geometries, phi, psi, omega angles, Ramachandran or steric contour diagram, allowed chi angles of side chains in proteins, hydrogen bonding, disulphide bonds, hydrophobic interactions, vanderwaals forces, , alpha helices, beta sheets, helix to coil transition, general features and thermodynamic aspects of protein folding, Relationship between the primary, secondary, and tertiary structure of proteins. Structure of fibrous proteins (structure of collagen, keratin). Quaternary structures - dimers, homo &hetero dimers, trimers, tetramers; Protein folds, structural families and classes, multifunctional domains.

Module-3

Nucleic acids: Structures of purine and pyrimidine bases, nucleosides, nucleotides, RNA and DNA (differences) forces and stabilizing geometries, glycosidic bond, rotational isomers. Stabilizing ordered forms of DNA (A, Band Z), base pairing types, base stacking, tertiary structure of DNA (Supercoiled DNA), Melting of the DNA double helix (Hyperchromicity), Interaction with small ions and small molecules. Ribose puckering and Types of RNA- mRNA, rRNA&tRNA (secondary & tertiary structure of tRNA.)

Module-4

Bioenergetics: Energy, Energy flow cycle, energy conversion, Structure and properties of ATP, High energy compounds, Thermodynamic considerations, coupling reactions of ATP & NDP(Nucleotide di-phosphate),Photosynthesis, light reactions, dark reaction, ancillary pigments, PS I & II.

Module-5

Biological membranes and Transport Mechanism:
Biological membranes: structure, permeability, properties, passive transport and active transport, facilitated transport, energy requirement, mechanism of Na+ /K+, glucose and amino acid transport. Organization of transport activity in cell. Action Potentials. Role of transport in signal transduction processes.

Course Outcomes: At the end of the course the student will be able to:

- Present the foundational principles of macromolecular structure and function
- Understand the principle of high energy molecules and Photosynthesis
- Understand about biological membrane and transport mechanism across the cell membrane and analyse its regulation

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Principles of Biochemistry	Albert Lehninger	CBS publishers	2nd edition 1993
2	Biophysical Chemistry	Cantor R. and Schimmel P.R,	W. H. Freeman and Company	1980
3	Principles of Structure & Function	Fred M. Snell & Sidney Shulman	AddsionWeslsey Longman Publishing Group	1967
Reference Books				
1	Principles of protein structure	G Schulz and R H Schrimer,	Springer Verlag	1979
2	Principles of nucleic acid structure	Sanger,	Springer Verlag	1984
3	Biophysics – An Introduction	Rodney Cotterill	Wiley Student Edition	2003

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

CELL BIOLOGY AND GENETICS

Course Code	**18BT35**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To gain basic concepts of cell biology and genetics.
- To understand cellular processes, pathways occurring at cellular level in living organisms.
- To learn and apply the Fundamental aspects of genetics in biotechnology.

Module-1

CYTOSKELETON:

Eukaryotic and prokaryotic cells, Plant and animal cells, brief mention of membrane organization. Cytosketal elements, Microtubules: structure & functions, shaping of the cells and mechanical support. Microfilaments: structure & functions. Structure of intermediate filaments. Cytoplasmic micro trabecular system (lattice). Covalent modifications of cytosketal proteins. Cytoskeletal architecture.

Module-2

CELL STRUCTURE AND FUNCTION:

Mitosis and Meiosis. Structure of cytoplasm, Nucleus, Mitochondria, Ribosome, Golgi bodies, Lysosomes. Endoplasmic Reticulum, Peroxisomes, Chloroplast and Vacuoles. Cell to cell integration, Cell locomotion (Amoeboid, Flagella, Cillar).Types of cell functions, cell division. Apoptosis and Ageing

Module-3

GENETICS:

Nature of genetic material, Mendelian Laws of inheritance, monohybrid and dihybrid inheritance, law of segregation & independent assortment, Gene interactions, supplementary genes - Comb patterns in fowls, Complementary genes - Flower color in sweet peas, Epistasis- Inhibitory and colored genes in fowls, simple problems. Identification of genetic material, classical experiments- Hershey & Chase, Avery, McLeod etc., Multiple alleles and groups antigens. Numericals based on concepts.

Module-4

CHROMOSOMES STRUCTURE AND ORGANIZATION & POPULATION GENETICS:

Chromosome, Centrosome, telomere, Chemical composition of chromatin, structural organization of nucleosomes, heterochromatin. Polytene and lamp-brush chromosomes, human chromosomes. Introduction, Gene frequency, and equilibrium estimation, changes in gene frequency, inbreeding and heterosis, genetic structure of population, speciation and evolution, prospects for the control of human evolution. Spontaneous and induced mutations, Eugenics. Pedigree analysis.

Module-5

SEX CHROMOSOMES AND INHERITED DISEASES:

The organ of heredity, chromosomes, morphology, classification. Sex determination in plants, animals XX-XY, XX-XO, ZW-ZZ, ZO-ZZ types in animals. Chromosomal disorders. Sex linked inheritance molecular diseases, hemoglobinpathies. Disorders of coagulation, Color blindness, hemophilia, Non-disjunction as a proof of chromosomal theory of inheritance, Linkage maps, crossing over. Chromosomal maps, interference coincidence.

Course Outcomes: At the end of the course the student will be able to:

- Comprehend the basics of cell biology & genetics
- Understand the basis of inherited disorders.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Cell Biology	S C Rastogi	New Age International Pub	2011. 3rd Edition
2	Cell Biology	Kimbal	Willey Pub	3rd Edition
3	Genetics	W Strick, Monroe	Macmillan Publication	1968
Reference Books				
1	Molecular Cell Biology	Darnell, and Baltimore	Freeman Pub	2nd Edition 1993
2	Cellular & Biochemical Science	G. Tripathi	I K Intl	2010
3	Principles of Genetics	Gardener, Simmons and Slustad	Wiley Pub	8 Edition

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

PYTHON PROGRAMMING

Course Code	**18BT36**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To read and write simple Python programs.
- To develop Python programs with conditionals and loops.
- To define Python functions and call them.
- To use Python data structures – lists, tuples, dictionaries.

Module-1

ALGORITHMIC PROBLEM SOLVING

Algorithms, building blocks of algorithms (statements, state, control flow, functions), notation (pseudo code, flow chart, programming language), algorithmic problem solving, simple strategies for developing algorithms (iteration, recursion). Illustrative problems: find minimum in a list, insert a card in a list of sorted cards, and guess an integer number in a range, Towers of Hanoi.

Module-2

DATA, EXPRESSIONS,

Python interpreter and interactive mode; values and types: int, float, boolean, string, and list; variables, expressions, statements, tuple assignment, precedence of operators, comments; modules and functions, function definition and use, flow of execution, parameters and arguments.

Module-3

STATEMENTS, CONTROL FLOW

Illustrative programs: exchange the values of two variables, circulate the values of n variables, distance between two points. Conditionals: Boolean values and operators, conditional (if), alternative (if-else), chained conditional (if-elif-else); Iteration: state, while, for, break, continue, pass; Strings: string slices, immutability, string functions and methods, string module.

Module-4

FUNCTIONS, LISTS

Fruitful functions: return values, parameters, local and global scope, function composition, recursion; Lists as arrays. Illustrative programs: square root, gcd, exponentiation, sum an array of numbers, linear search, binary search. Lists: list operations, list slices, list methods, list loop, mutability, aliasing, cloning lists, list parameters.

Module-5

TUPLES, DICTIONARIES

Tuples: tuple assignment, tuple as return value; Dictionaries: operations and methods; advanced list processing - list comprehension; Illustrative programs: selection sort, insertion sort, mergesort, histogram.

Course Outcomes: At the end of the course the student will be able to:

- Develop algorithmic solutions to simple computational problems
- Read, write, execute by hand simple Python programs.
- Structure simple Python programs for solving problems.
- Decompose a Python program into functions.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Think Python: How to Think Like a Computer Scientist	Allen B. Downey	Shroff O'Reilly Publishers	2nd edition 2016
2	An Introduction to Python – Revised and updated for Python 3.2	Guido van Rossum and Fred L. Drake Jr	Network Theory Ltd.,	2011
Reference Books				
3	Introduction to Computer Science using Python: A Computational Problem-Solving Focus	Charles Dierbach	Wiley India Edition	2013
4	Introduction to Programming in Python: An Inter-disciplinary Approach	Robert Sedgewick, Kevin Wayne, Robert Dondero	Pearson India Education Services Pvt. Ltd	2016
5	Fundamentals of Python: First Programs	Kenneth A. Lambert	CENGAGE Learning	2012

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

MICROBIOLOGY LABORATORY

Course Code	**18BTL37**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Working principle and use of Microbiological Lab equipment's like autoclave, incubators, LAF, microscope, etc
- The basic laboratory techniques for isolation, characterization, enumeration and control of microorganisms

Sl. No.	Experiments
1	Study of Laboratory Instruments.
2	Media preparation, Preparation of plates and tubes.
3	Pure culture techniques (Streak, pour and spread - plates).
4	Enumeration of microbes by Plate count and haemo-cytometer.
5	Acid Fast Staining
6	Gram staining, Capsule staining, and endospore and flagella staining.
7	Staining of fungi.
8	Characterization of bacteria by Biochemical Tests: IMViC, Starch hydrolysis, carbohydrate fermentation, Catalase, Urease, hydrogen sulphide, Nitrate reduction.
9	Isolation of actinomycetes and rhizobium and their identification.
10	Determination of bacterial motility:
11	Growth curve studies.
12	Antibiotic sensitivity tests.
13	Milk reduction and alkaline phosphatase test
14	Experiment related to MPN test

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Use different laboratory equipment and instruments such as Microscope, Laminar Air Flow Station, Autoclave, oven, incubators.
- Prepare the media and use for the cultivation of the microorganisms.
- Perform laboratory experiments for the isolation, identification and characterization of microorganisms
- Carry-out experiments for the enumeration, staining and control

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Microbiology: A Lab Manual by Cappuccino Pearson education, 2007
2. Lab Math by Dany Spencer Adams, IK Intl. Pub house.
3. Lab Ref by JaineRoskams& Linda Rodgers IK Intl.Pub house.
4. Case-Microbiology: An Introduction by Gerard J. Tortora, Berdell R. Funke, Christine L.

11th Edition- Pearson publications.
5. Laboratory Manual Of Microbiology And Biotechnology by Aneja K.R. Medtec, 2014

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

UNIT OPERATIONS LABORATORY

Course Code	**18BTL38**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Basic unit processes in industrial set up pertaining to fluid mechanics, mechanical operations.
- Trouble shooting of problems related to fluid mechanics & Mechanical operations

Sl. No	Experiments
1	Friction losses in circular pipes
2	Flow measurements using Venturi /Orificemeter.
3	Centrifugal /Reciprocating pumps
4	Packed bed flow
5	Batch Sedimentation
6	Ball Mill
7	Leaf / Pressure filter
8	Screen analysis/effectiveness.
9	Natural convection in bare tubes
10	Heat transfer in packed bed
11	Heat transfer through DPHE
12	Diffusion of organic solvent in air
13	Simple Distillation
14	Steam Distillation
15	Single Stage Extraction
16	Drying-Tray dryer

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Record observations systematically and arrive at required results based on experiments conducted.
- Study and design different flow measuring instruments.
- Understand and Estimate the shape and size of irregular particles

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Principles of Unit Operations by Alan S Foust, L.A. Wenzel, C.W. Clump, L. Maus, and L.B. Anderson , John Wiley & Sons.
2. Engineering Fluid Mechanics by Kumar K.L. Eurasia Publishing House (P) Ltd., New Delhi, 1984.
3. Mechanics of fluids by B.S. Massey, Chapman & Hall Publishers.
4. Chemical Engineers Hand Book by Perry, McGraw Hill Publications

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II / III / IV

Aadalitha Kannada

Course Code	**18KAK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

DqÀ½vÀ PÀ£ÀßqÀ PÀ°PÉAiÀÄ GzÉÝÃ±ÀUÀ¼ÀÄ:

- ¥ÀzÀ« «zÁåyð¼ÁVgÀÄªÀÅzÀjAzÀ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀjZÀAiÀÄ ªÀiÁrPÉÆqÀÄªÀÅzÀÄ.
- «zÁåyðUÀ¼À°è PÀ£ÀßqÀ ¨sÁµÉAiÀÄ ªÁåPÀgÀtzÀ §UÉÎ CjªÀÅ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ gÀZÀ£ÉAiÀÄ°è£À ¤AiÀÄªÀÄUÀ¼À£ÀÄß ¥ÀjZÀ¬Ä¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ §gÀºÀzÀ°è PÀAqÀÄ§gÀÄªÀ zÉÆÃµÀUÀ¼ÀÄ ºÁUÀÆ CªÀÅUÀ¼À ¤ªÁgÀuÉ. ªÀÄvÀÄÛ ¯ÉÃR£À aºÉßUÀ¼À£ÀÄß ¥ÀjZÀ¬Ä¸ÀÄªÀÅzÀÄ.
- ¸ÁªÀiÁ£Åå CfðUÀ¼ÀÄ, ¸ÀPÁðj ªÀÄvÀÄÛ CgÉ ¸ÀPÁðj ¥ÀvÀæªÀåªÀºÁgÀzÀ §UÉÎ CjªÀÅ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- ¨sÁµÁAvÀgÀ ªÀÄvÀÄÛ ¥Àæ§AzsÀ gÀZÀ£É §UÉÎ C¸ÀQÛ ªÀÄÆr¸ÀÄªÀÅzÀÄ.
- PÀ£ÀßqÀ ¨sÁµÁ¨sÁå¸À ªÀÄvÀÄÛ ¸ÁªÀiÁ£Åå PÀ£ÀßqÀ ºÁUÀÆ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀzÀUÀ¼À ¥ÀjZÀAiÀÄ ªÀiÁrPÉÆqÀÄªÀÅzÀÄ.

¥Àj«r (¥ÀoÀå¥ÀÄ¸ÀÛPÀzÀ°ègÀÄªÀ «µÀAiÀÄUÀ¼À ¥ÀnÖ)
CzsÁåAiÀÄ – 1 PÀ£ÀßqÀ¨sÁµÉ – ¸ÀAQë¥ÀÛ «ªÀgÀuÉ.
CzsÁåAiÀÄ – 2 ¨sÁµÁ ¥ÀæAiÉÆÃUÀzÀ¯ÁèUÀÄªÀ ¯ÉÆÃ¥ÀzÉÆÃµÀUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À ¤ªÁgÀuÉ.
CzsÁåAiÀÄ – 3 ¯ÉÃR£À aºÉßUÀ¼ÀÄ ªÀÄvÀÄÛ CªÀÅUÀ¼À G¥ÀAiÉÆÃUÀ.
CzsÁåAiÀÄ – 4 ¥ÀvÀæ ªÀåªÀºÁgÀ.
CzsÁåAiÀÄ – 5 DqÀ½vÀ ¥ÀvÀæUÀ¼ÀÄ.
CzsÁåAiÀÄ – 6 ¸ÀPÁðgÀzÀ DzÉÃ±À ¥ÀvÀæUÀ¼ÀÄ.
CzsÁåAiÀÄ – 7 ¸ÀAQë¥ÀÛ ¥Àæ§AzsÀ gÀZÀ£É (¦æ¸ÉÊ¸ï gÉÊnAUï), ¥Àæ§AzsÀ ªÀÄvÀÄÛ ¨sÁµÁAvÀgÀ.
CzsÁåAiÀÄ – 8 PÀ£ÀßqÀ ±À§Ý¸ÀAUÀæºÀ.
CzsÁåAiÀÄ – 9 PÀA¥ÀÆålgï ºÁUÀÆ ªÀiÁ»w vÀAvÀæeÁÕ£À.
CzsÁåAiÀÄ – 10 ¥Áj¨sÁ¶PÀ DqÀ½vÀ PÀ£ÀßqÀ ¥ÀzÀUÀ¼ÀÄ ªÀÄvÀÄÛ vÁAwæPÀ/ PÀA¥ÀÆålgï ¥Áj¨sÁ¶PÀ ¥ÀzÀUÀ¼ÀÄ.

DqÀ½vÀ PÀ£ÀßqÀ PÀ°PÉAiÀÄ ¥sÀ°vÁA±ÀÀUÀ¼ÀÄ:

- DqÀ½vÀ ¨sÁµÉ PÀ£ÀßqÀzÀ ¥ÀjZÀAiÀÄªÁUÀÄvÀÛzÉ.
- «zÁåyðUÀ¼À°è PÀ£ÀßqÀ ¨sÁµÉAiÀÄ ªÁåPÀgÀtzÀ §UÉÎ CjªÀÅ ªÀÄÆqÀÄvÀÛzÉ.
- PÀ£ÀßqÀ ¨sÁµÁ gÀZÀ£ÉAiÀÄ°è£À ¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¯ÉÃR£À aºÉßUÀ¼ÀÄ ¥ÀjZÀ¬Ä¸À®àqÀÄvÀÛªÉ.
- ¸ÁªÀiÁ£Åå CfðUÀ¼ÀÄ, ¸ÀPÁðj ªÀÄvÀÄÛ CgÉ ¸ÀPÁðj ¥ÀvÀæªÀåªÀºÁgÀzÀ §UÉÎ CjªÀÅ ªÀÄÆqÀÄvÀÛzÉ.
- ¨sÁµÁAvÀgÀ ªÀÄvÀÄÛ ¥Àæ§AzsÀ gÀZÀ£É §UÉÎ C¸ÀQÛ ªÀÄÆqÀÄvÀÛzÉ.
- PÀ£ÀßqÀ ¨sÁµÁ¨sÁå¸À ªÀÄvÀÄÛ ¸ÁªÀiÁ£Åå PÀ£ÀßqÀ ºÁUÀÆ DqÀ½vÀ PÀ£ÀßqÀzÀ ¥ÀzÀUÀ¼ÀÄ ¥ÀjZÀ¬Ä¸À®àqÀÄvÀÛªÉ.

¥ÀjÃPÉëAiÀÄ «zsÁ£À : ¤gÀAvÀgÀ DAvÀjPÀ ªÀiË®åªÀiÁ¥À£À - CIE **(Continuous Internal Evaluation):**

PÁ¯ÉÃdÄ ªÀÄlÖzÀ°èAiÉÄ DAvÀjPÀ ¥ÀjÃPÉëAiÀÄ£ÀÄß 100 CAPÀUÀ½UÉ «±Àé«zÁå®AiÀÄzÀ

¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¤zÉðÃ±À£ÀzÀAvÉ £ÀqÉ¸ÀvÀPÀÌzÀÄÝ.

¥ÀoÀå¥ÀÄ¸ÀÛPÀ : DqÀ½vÀ PÀ£ÀßqÀ ¥ÀoÀå ¥ÀÄ¸ÀÛPÀ (Kannada for Administration)
¸ÀÀA¥ÁzÀPÀgÀÄ

qÁ. J¯ï. wªÉÄäÃ±À
¥ÉÆæ. «. PÉÃ±ÀªÀªÀÄÆwð
¥ÀæPÀluÉ : ¥Àæ¸ÁgÁAUÀ, «±ÉéÃ±ÀégÀAiÀÄå vÁAwæPÀ «±Àé«zÁå®AiÀÄ, ¨É¼ÀUÁ«.

B. E. (Common to all Programmes)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER –II & III/IV

Vyavaharika Kannada

Course Code	**18KVK28/39/49**	CIE Marks	100
Teaching Hours/Week (L:T:P)	(0:2:0)		
Credits	01		

Course Learning Objectives:

The course will enable the students to understand Kannada and communicate in Kannada language.

Table of Contents:

Chapter - 1: Vyavaharika kannada – Parichaya (Introduction to Vyavaharika Kannada).
Chapter - 2: Kannada Aksharamale haagu uchcharane (Kannada Alpabets and Pronunciation).
Chapter - 3: Sambhashanegaagi Kannada Padagalu (Kannada Vocabulary for Communication).
Chapter - 4: Kannada Grammar in Conversations (Sambhashaneyalli Kannada Vyakarana).
Chapter - 5: Activities in Kannada.

Course Outcomes:

At the end of the course, the student will be able to understand Kannada and communicate in Kannada language.

¥ÀjÃPÉëAiÀÄ «zsÁ£À : ¤gÀAvÀgÀ DAvÀjPÀ ªÀiË®åªÀiÁ¥À£À - CIE **(Continuous Internal Evaluation):**

PÁ¯ÉÃdÄ ªÀÄlÖzÀ°èAiÉÄ DAvÀjPÀ ¥ÀjÃPÉëAiÀÄ£ÀÄß 100 CAPÀUÀ½UÉ «±Àé«zÁå®AiÀÄzÀ

¤AiÀÄªÀÄUÀ¼ÀÄ ªÀÄvÀÄÛ ¤zÉðÃ±À£ÀzÀAvÉ £ÀqÉ¸ÀvÀPÀÌzÀÄÝ.

Textbook (¥ÀoÀå¥ÀÄ¸ÀÛPÀ): ªÁåªÀºÁjPÀ PÀ£ÀßqÀ ¥ÀoÀå ¥ÀÄ¸ÀÛPÀ (Vyavaharika Kannada Text Book)

¸ÀÀA¥ÁzÀPÀgÀÄ
qÁ. J¯ï. wªÉÄäÃ±À
¥ÉÆæ. «. PÉÃ±ÀªÀªÀÄÆwð
¥ÀæPÀluÉ : ¥Àæ¸ÁgÁAUÀ, «±ÉéÃ±ÀégÀAiÀÄå vÁAwæPÀ «±Àé«zÁå®AiÀÄ, ¨É¼ÀUÁ«.

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - III

CONSTITUTION OF INDIA, PROFESSIONAL ETHICS AND CYBER LAW (CPC)
(Mandatory Learning Course: Common to All Programmes)

Course Code	**18CPC39/49**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Course Learning Objectives: To

- know the fundamental political codes, structure, procedures, powers, and duties of Indian government institutions, fundamental rights, directive principles, and the duties of citizens
- Understand engineering ethics and their responsibilities; identify their individual roles and ethical responsibilities towards society.
- Know about the cybercrimes and cyber laws for cyber safety measures.

Module-1

Introduction to Indian Constitution:
The Necessity of the Constitution, The Societies before and after the Constitution adoption. Introduction to the Indian constitution, The Making of the Constitution, The Role of the Constituent Assembly - Preamble and Salient features of the Constitution of India. Fundamental Rights and its Restriction and limitations in different Complex Situations. Directive Principles of State Policy (DPSP) and its present relevance in our society with examples. Fundamental Duties and its Scope and significance in Nation building.

Module-2

Union Executive and State Executive:
Parliamentary System, Federal System, Centre-State Relations. Union Executive – President, Prime Minister, Union Cabinet, Parliament - LS and RS, Parliamentary Committees, Important Parliamentary Terminologies. Supreme Court of India, Judicial Reviews and Judicial Activism. State Executives – Governor, Chief Minister, State Cabinet, State Legislature, High Court and Subordinate Courts, Special Provisions (Articles

Module-3

Elections, Amendments and Emergency Provisions:
Elections, Electoral Process, and Election Commission of India, Election Laws. Amendments - Methods in Constitutional Amendments (How and Why) and Important Constitutional Amendments. Amendments – 7,9,10,12,42,44, 61, 73,74, ,75, 86, and 91,94,95,100,101,118 and some important Case Studies. Emergency Provisions, types of Emergencies and its consequences.

Constitutional special provisions:
Special Provisions for SC and ST, OBC, Women, Children and Backward Classes.

Module-4

Professional / Engineering Ethics:
Scope & Aims of Engineering & Professional Ethics - Business Ethics, Corporate Ethics, Personal Ethics. Engineering and Professionalism, Positive and Negative Faces of Engineering Ethics, Code of Ethics as defined in the website of Institution of Engineers (India): Profession, Professionalism, and Professional Responsibility. Clash of Ethics, Conflicts of Interest. Responsibilities in Engineering Responsibilities in Engineering and Engineering Standards, the impediments to Responsibility. Trust and Reliability in Engineering, IPRs (Intellectual Property Rights), Risks, Safety and liability in Engineering

Module-5

Internet Laws, Cyber Crimes and Cyber Laws:
Internet and Need for Cyber Laws, Modes of Regulation of Internet, Types of cyber terror capability, Net neutrality, Types of Cyber Crimes, India and cyber law, Cyber Crimes and the information Technology Act 2000, Internet Censorship. Cybercrimes and enforcement agencies.

Course Outcomes: On completion of this course, students will be able to,

CO 1: Have constitutional knowledge and legal literacy.

CO 2: Understand Engineering and Professional ethics and responsibilities of Engineers.

CO 3: Understand the the cybercrimes and cyber laws for cyber safety measures.

Question paper pattern for SEE and CIE:

- The SEE question paper will be set for 100 marks and the marks scored by the students will proportionately be reduced to 60. The pattern of the question paper will be objective type (MCQ).
- For the award of 40 CIE marks, refer the University regulations 2018.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Constitution of India, Professional Ethics and Human Rights	Shubham Singles, Charles E. Haries, and et al	Cengage Learning India	2018
2	Cyber Security and Cyber Laws	Alfred Basta and et al	Cengage Learning India	2018
Reference Books				
3	Introduction to the Constitution of India	Durga Das Basu	Prentice –Hall,	2008.
4	Engineering Ethics	M. Govindarajan, S. Natarajan, V. S. Senthilkumar	Prentice –Hall,	2004

B. E. BIOTECHNOLOGY
Choice Based Credit System (CBCS) and Outcome Based Education (OBE)
SEMESTER - III

ADDITIONAL MATHEMATICS – I

(Mandatory Learning Course: Common to All Programmes)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech programmes)

Course Code	**18MATDIP31**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:2:0)	SEE Marks	60
Credits	0	Exam Hours	03

Course objectives:

- To provide basic concepts of complex trigonometry, vector algebra, differential and integral calculus.
- To provide an insight into vector differentiation and first order ODE's.

Module-1

Complex Trigonometry: Complex Numbers: Definitions and properties. Modulus and amplitude of a complex number, Argand's diagram, De-Moivre's theorem (without proof).
Vector Algebra: Scalar and vectors. Addition and subtraction and multiplication of vectors- Dot and Cross products, problems.

Module-2

Differential Calculus: Review of successive differentiation-illustrative examples. Maclaurin's series expansions-Illustrative examples. Partial Differentiation: Euler's theorem-problems on first order derivatives only. Total derivatives-differentiation of composite functions. Jacobians of order two-Problems.

Module-3

Vector Differentiation: Differentiation of vector functions. Velocity and acceleration of a particle moving on a space curve. Scalar and vector point functions. Gradient, Divergence, Curl-simple problems. Solenoidal and irrotational vector fields-Problems.

Module-4

Integral Calculus: Review of elementary integral calculus. Reduction formulae for $\sin^n x$, $\cos^n x$ (with proof) and $\sin^m x \cos^n x$ (without proof) and evaluation of these with standard limits-Examples. Double and triple integrals-Simple examples.

Module-5

Ordinary differential equations (ODE's. Introduction-solutions of first order and first degree differential equations: exact, linear differential equations. Equations reducible to exact and Bernoulli's equation.

Course outcomes: At the end of the course the student will be able to:

- CO1: Apply concepts of complex numbers and vector algebra to analyze the problems arising in related area.
- CO2: Use derivatives and partial derivatives to calculate rate of change of multivariate functions.
- CO3: Analyze position, velocity and acceleration in two and three dimensions of vector valued functions.
- CO4: Learn techniques of integration including the evaluation of double and triple integrals.

CO5: Identify and solve first order ordinary differential equations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.

- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook				
1	Higher Engineering Mathematics	B.S. Grewal	Khanna Publishers	43rd Edition, 2015
Reference Books				
1	Advanced Engineering Mathematics	E. Kreyszig	John Wiley & Sons	10th Edition, 2015
2	Engineering Mathematics	N.P.Bali and Manish Goyal	Laxmi Publishers	7th Edition, 2007
3	Engineering Mathematics Vol.I	Rohit Khurana	Cengage Learning	1st Edition, 2015

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

STOICHIOMETRY

Course Code	**18BT41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn fundamentals of chemical calculations and material and energy balance.
- To discuss the material balance aspects involving chemical reactions and without chemical reactions.
- To highlight the energy balance and material balance for the development of bioprocess technology

Module-1

BASIC CHEMICAL CALCULATIONS AND MATERIAL BALANCE

Concept of atom and mole, expressing composition of mixtures in Solids, liquids and gases. Expressing composition of mixtures and solutions - Percentage by weight percentage, mole percentage and Volume percentage; Normality, Morality, Molality. Generalized material balance equations for distillation, absorption, extraction, crystallization, mixing, drying & evaporation

Module-2

MATERIAL BALANCE WITHOUT CHEMICAL REACTIONS AND FUELS

Material balances calculation in Distillation, Absorption, Extraction, Crystallization, Drying, Mixing and Evaporation Operations, Fuels – types of fuels, (solid, liquid and gaseous fuel), relevance to biofuels, characteristics of fuels, Ultimate and proximate analyses of fuels

Module-3

MATERIAL BALANCE INVOLVING CHEMICAL REACTIONS

Material balances calculation involving bypass, recycle and operations. Generalized material balance equations, Principles of stoichiometry, Definitions of limiting and excess reactants, and percentage conversion, yield and percentage yield, Selectivity, and problems relating to these unit processes

Module-4

ENERGY BALANCE

General energy balance equation for steady state. Heat capacity, estimation of heat capacity for solids, liquids, gases and their mixtures. Enthalpy, Standard Heat of formation, standard heat of reaction, Standard heat of combustion, Calculation of heat of reaction at elevated temperature.

Module-5

BIOPROCESS PRINCIPLES & STOICHIOMETRY OF BIOPROCESS

Historical development of bioprocess technology; Bioprocess principles and operations, generalized process flow sheets. General material balance equation for steady state (for manufacture of penicillin and ethanol) - outline of a bioprocess and the various (upstream and downstream) unit operations involved in bioprocesses.

Course Outcomes: At the end of the course the student will be able to:

- Discuss the significance of material and energy balance for bioprocess technology.
- Solve problems related to material and energy balance to give solutions for bioprocess development.
- Develop the flow-sheet for general processes operating in bioprocess industry.
- Apply the stoichiometry of microbial growth and product formation involved in bioprocess technology

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Principles of Biochemistry	Albert L. Lehninger, David L. Nelson, and Michael M. Cox	W.H. freeman and company	1970
2	Bioprocess Engineering Principles	Pauline Doran	Academic Press	2nd Edition 2012
3	Biochemical Engg. Fundamentals	J E Bailey & D. F. Ollis	McGraw Hill	1986
4	Biochemical Calculations	I.H.Segel	John Wiley & Sons	1976
Reference Books				
1	Basic Principles and Calculations in Chemical Engineering	David Himmelblau	PHI	Eighth Edition 2012
2	Bioprocess Engineering	Shule and Kargi,	Prentice Hall	3rd Edition 2017
3	Chemical Process Calculations	R. Asokan	University Press	2011

Web links and Video Lectures:

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

MOLECULAR BIOLOGY

Course Code	**18BT42**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:0:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To familiarize with the cell and molecular biology of both Prokaryotes and Eukaryotes.
- To acquire basic fundamental knowledge and explore skills in molecular biology
- To become aware of the complexity and harmony of the cells.
- To learn the molecular mechanism of DNA replication, repair, transcription, protein synthesis and gene regulation in various organisms.

Module-1

INTRODUCTION & REPLICATION OF DNA:
Chromosomal theory of heredity, genes and their location. Genetic code, Information flow in biological systems: central dogma, updated central dogma. Structures and forms of nucleic acids – DNA and RNA. Reversible denaturation and hyperchromic effect. Tertiary structure of DNA: DNA supercoiling. Replication of DNA, structure and function of DNA polymerases, models of replications in prokaryotes, mechanism of DNA replication and enzymes involved. Proteomics of DNA replication, Fidelity of DNA replication, Inhibitors of DNA replication

Module-2

TRANSCRIPTION:
Structure and function of RNA polymerases (prokaryotes & eukaryotes), mechanism of transcription in prokaryotes and eukaryotes, transcription factors, Fidelity of RNA synthesis, post-transcriptional processing (RNA editing, siRNA, splicing, poly A tail and 5' capping), Ribozymes, transcription inhibitors.

Module-3

TRANSLATION:
Mechanism of translation, activation of amino acid initiation, elongation and termination of protein synthesis. Post-translational modification and protein targeting, protein splicing. Differences between prokaryotic and eukaryotic protein synthesis, inhibitors of translation.

Module-4

GENE EXPRESSION IN PROKARYOTES & EUKARYOTES:
Regulation of gene expression in prokaryotes: Operon model, gal, lac, trp Operons; positive versus negative regulation. Regulation of eukaryotic gene expression, transcriptional control, homeobox in the control of developments in insects and vertebrates.

Module-5

GENETIC RECOMBINATION, MUTATION & GENE MAPPING:
Genetic recombination in bacteria and viruses, site specific recombination, transposons and insertion sequences; Retroviruses. DNA damage & Repair, Mutation, Role of recombination and transposition in evolution; gene mapping techniques.

Course Outcomes: At the end of the course the student will be able to:

- Explain replication, transcription and translation processes with underlying differences in prokaryotic and eukaryotic systems.
- Elaborate importance of genetic recombination with special reference to bacterial system.
- Outline DNA damage and repair mechanisms

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Essentials of Molecular Biology	David Freifelder	Narosa Pub. House	1990
2	Molecular Biology of the Cell	Alberts et al	Garland Publishing	2002.
3	Molecular Biology of the Gene	James D Watson et al	Pearson Education	Seventh Edition 2017
Reference Books				
1	Principles of Gene manipulation and Genomics	Primrose,	Oxford University Press	2006

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

IMMUNOTECHNOLOGY

Course Code	**18BT43**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Learn the underlying concepts of molecular and cellular mechanisms involved in the development and regulation of the immune response
- Describe the cause and treatment for Immune System Pathologies and Dysfunctions.
- Learn the important techniques of Immunodiagnosis.

Module-1

IMMUNE SYSTEM :

Cells and organs of immune system, Process of hematopoiesis and role of each cells, primary and secondary lymphoid organs, innate and acquired immunity, Humoral and Cell mediated immunity. Antigens: Chemical and biological Factors affecting antigenicity/Immunogenicity and molecular nature, Haptens, adjuvants, Antibodies: their structure and function, Immunoglobulin classes and subclasses (isotypic, allotypes, idiotypes and anti-idiotytopic antibodies).

Module-2

HUMORAL AND CELL MEDIATED IMMUNITY:

B-lymphocytes and their activation, Class switching mechanism , antibody genes and generation of diversity, production of monoclonal antibodies, polyclonal antibodies and applications, cytokines, Thymus derived lymphocytes (T cells) - their ontogeny and types, Activation of T-cells, Major histocompatibility Complex (MHC) Complex - MHC Class I and II molecules. Antigen processing and presentation process.

Module-3

IMMUNE SYSTEM IN HEALTH AND DISEASE:

Complement system and its pathways, Gell and Coombs classification of Hypersensitivity reactions and Diagnosis and treatment. Autoimmune disorders, types, animal model and treatment. Immune response to infections: immunity to viruses, bacteria, fungi and parasites, Immunodeficiency disorders: Primary and secondary (AIDS). Injury and inflammation, Vaccines and their types, classification and immunization schedule

Module-4

TRANSPLANTATION AND TUMOR IMMUNOLOGY:

Transplantation and its classification, Immunologic basis of graft rejection and its mechanism , Transplantation antigens, tissue typing role of MHC molecules in allograft rejection, Clinical transplantations, bone marrow, HSC transplantation and immune suppressive therapy. Tumors of the immune system, tumor antigens and immune response to tumors, tumor immunotherapy.

Module-5

MOLECULAR IMMUNOLOGY & IMMUNODIAGNOSIS

Antigen antibody interaction – Precipitation reactions, Agglutination reactions, ABO Blood typing principles. Principles and applications of ELISA, Radio Immuno Assay (RIA), western blot analysis, immuno-electrophoresis, Immunofluorescence, chemiluminescence assay, fluorescence activated cell sorting (FACS) analysis. Role of stem cells technology in immunology, Production of humanized monoclonal antibodies (Single chain fragment variable), immunotherapy with genetically engineered antibodies,

Course Outcomes: At the end of the course the student will be able to:

- Outline the molecular and cellular mechanisms involved in the development and regulation of the immune response,
- Describe the cause, challenges and treatment for Immune System Pathologies and Dysfunctions.
- Apply the major immunological laboratory techniques and their application to both clinical analysis and experimental research.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Immunology – an Introduction	Tizard	Thomson.	1984
2	Immunology &Immunotechnology	Ashim K Chakravarthy	Oxford University Press	2006
3	Immundiagnostics	S C Rastogi	New Age International	1996
Reference Books				
1	Essential Immunology	Roitt I. Blackwell	Scientific Publications, Oxford	13th Edition 2017
2	Immunology: A Short Course	Richard Coico, Geoffrey Sunshine	Wiley-Blackwell	7th Edition 2015
3	Understanding Immunology	Peter Wood	Pearson Education	2001

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

CELL CULTURE TECHNIQUES

Course Code	**18BT44**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn the basic structure ,organization ,scope and function of Biomolecules
- To learn the transformation of energy within the living organisms
- To learn the composition, structure and function of biological membranes
- To learn the types and functions of transport system

Module-1

CELL CULTURE LABORATORY DESIGN AND EQUIPMENTS:

Planning, construction and services; Layout; Sterile handling area; Incubation; Hot room; Air circulation; Service bench; Laminar flow; Sterilizer; Incubators; CO_2 incubator; Culture Racks, Colony Counters, Refrigerators and freezers; Centrifuge; Inverted stage microscope; Magnetic stirrer; Liquid nitrogen freezers; Slow cooling system for cell freezing; Water bath; Autoclaves and hot air oven; Pipette washers; Water purification system; Fluid handling systems and other equipments; Washing, packing and sterilization of different materials used in plants, animals and microbial cell cultures; Aseptic concepts; Maintenance of sterility; Cell culture vessels.

Module-2

MEDIA AND REAGENTS :

Types of cell culture media for plants, animals and microbial cells; Ingredients of media; Physiochemical properties; Buffers; Oxygen; Osmolarity; Temperature; Balance salt solutions; Antibiotics, growth supplements; Conditioned media; Other cell culture reagents; Preparation and sterilization of cell culture media and other reagents.

Module-3

ANIMAL CELL CULTURES TECHNIQUES:

History of animal cell culture; Different tissue culture techniques; Cell separation, disaggregation of the explants, mechanical and enzymatic disaggregation; Continuous cell lines; Organ culture, techniques, advantages, disadvantages, applications; Cell cultures, substrate culture and suspension culture; Primary cell culture; Secondary cell culture (cell lines); Development, characterization and maintenance of cell lines, Cryopreservation; Commercial scale production of animal cells; stem cells- fate mapping, application; Application of animal cell culture for in vitro testing of drugs.

Module-4

PLANT CELL CULTURE TECHNIQUES:

Cellular Totipotency, And its Applications. Organogenesis, factors affecting organogenesis. Cyto-differentiation. Somatic Embryogenesis, Synthetic Seeds**,** Techniques for production of haploids, diploidization, production of double haploids and their Applications. Triploids production - Endosperm culture and Applications. Secondary metabolite production, selection of high yielding lines, elicitation, immobilization of cultures, hairy root culture and biotransformation. Factors affecting secondary metabolites, industrial application of secondary metabolites. Molecular farming.

Module-5

MICROBIAL CELL CULTURE TECHNIQUES:

Auxotroph isolation - replica plating technique, Screening Preservation of microbial products. Production of antibiotics. Enumeration and screening of novel microbial secondary metabolites, strain improvement, Use of microbes in industrial waste treatment. Microbial leaching.

Course Outcomes: At the end of the course the student will be able to:

- Differentiate between the various sources of cells to be used in cell culture techniques
- Correlate between different biological samples and understand the importance of different media in tissue culture
- Comprehend the applications of plant, animal and microbial cell culture in industry, healthcare and environment.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Plant Cell Culture: A Practical Approach	R.A. Dixon & Gonzales	IRL Press	1994
2	Culture of animal cells-A manual of basic technique and specialized applications	R. Ian Freshney	Wiley Blackwell publishers	1983
3	Microbial Biotechnology	Alexander N Glazer, Hiroshi Nikaido	W H Freeman & Company	1995
Reference Books				
1	Living resources for Biotechnology, Animal cells	Doyle, R. Hay and B.E. Kirsop	Cambridge University Press	1990
2	Plant Tissue Culture	Sathyanarayana B N,	IK Intl. Publishers	2007
3	Principle of Microbe & Cell Cultivation	SJ Prit	Blackwell Scientific co	1975

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

BIOCHEMICAL THERMODYNAMICS

Course Code	**18BT45**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To know the basic concepts of thermodynamics in process industry.
- To understand the significance of zeroth, I, II & III laws of thermodynamics.
- To be aware of concepts of thermodynamic properties of fluids & demonstrate various equations of state & their applications.
- To illustrate the importance of partial molar properties & the concepts of phase equilibrium.

Module-1

BASIC CONCEPTS & LAWS OF THERMODYNAMICS: System, Surrounding & Processes, Closed and Open systems, State Properties, Intensive &Extensive Properties State and Path functions, Equilibrium state, enthalpy, specific heat, Reversible and Irreversible processes. Zeroth law of Thermodynamics, General statement of First law of Thermodynamics, First law for Cyclic Process, Non- Flow Process, Flow process, Heat capacity. Heat reservoir and Heat engines. General statements of the second law, Concept of entropy, Carnot principle, Calculation of entropy changes, Third law of Thermodynamics. Numericals.

Module-2

PVT BEHAVIOUR AND COMPRESSIBILITY CHARTS:
PVT Behavior of pure fluids, equations of state & ideal gas law, Processes involving ideal gas law: Constant volume, constant pressure, constant temperature, adiabatic & polytrophic processes, Equations of state for real gases: Vander Waals equation, Redlich-Kwong equation, Peng-Robinson equation, virial equation. Numericals. Principles of corresponding states, generalized compressibility charts, Heat effects accompanying chemical reactions, Standard heat of reaction, formation, combustion, Hess's law of constant heat summation, effect of temperature on standard heat of reaction. Numericals.

Module-3

PROPERTIES OF PURE FLUIDS :
Reference properties, energy properties, derived properties, work function, Helmholtz free energy, Gibbs free energy, Relationships among thermodynamic Properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, modified equations for internal energy (U) & enthalpy (H), Effect of temperature on U, H & Entropy (S). Gibbs-Helmholtz equation. Concept of Fugacity, Fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, solids and liquids, Activity: Effect of temperature and pressure on activity. Numericals

Module-4

PROPERTIES OF SOLUTIONS & PHASE EQUILIBRIA:
Partial molar properties of solution and its determination , chemical potential –effect of temperature and pressure , lewis –randall rule, Raoults law for ideal solutions, fugacity in solutions, Henry's law and dilute solutions – ideal behavior of real solutions and Henry's law, Activity in solutions, Activity coefficients – effect of temperature and pressure, Gibbs - Duhem equation, calculation of activity coefficients using Gibbs-Duhem equation. Numericals.
Criteria of phase Equilibria, criterion of stability, Duhem's theorem, Vapour-Liquid Equilibra in ideal and non-Ideal solutions, Azeotropes. Numericals.

Module-5

BIOCHEMICAL ENERGETICS:
Coupled reactions and energy rise compounds, Reaction Stoichiometry, criteria of biochemical reaction equilibrium, equilibrium constant and standard free energy change, effect of temperature, pressure on equilibrium constants and other- factors affecting equilibrium conversion – Le – chatelier's principle, liquid

phase reactions, heterogeneous bioreactionequilibria, phase rule for reacting systems, Liquid-Liquid Equilibrium diagrams. Numericals.

Course Outcomes: At the end of the course the student will be able to:

- Describe the concepts of system, surrounding, process, laws of thermodynamics & entropy.
- Explain the PVT behaviour of pure fluids & gases & derive equations of state for real gases.
- Distinguish between work function, Gibbs free energy
- Determine the partial molar properties, activity coefficients of the solution.
- Illustrate the phase rule for reacting systems and effect of temperature, pressure on equilibrium constants

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Introduction to Chemical Engineering thermodynamics	J.M. Smith , H.C. Van Ness &M.M.Abbott	MGH.	6th Ed (2003)
2	Biochemical Calculations	Irwin H.Segel	John Wiley & Sons	2nd Ed,(1976)
3	Engineering Thermodynamics	R K Singal, MridualSingal	I K Intl.	2010
Reference Books				
1	Chemical Engineering Thermodynamics	Y.V.C. Rao	New Age International	1997
2	A Textbook of Chemical Engineering Thermodynamics	K.V. Narayanan	PHI	1st Ed (2001)

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

CLINICAL BIOCHEMISTRY

Course Code	**18BT46**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- Learn the metabolic pathways of bio-molecules occurring at cellular and molecular level in living organisms.
- To learn basic principles of biochemistry and pathophysiology associated with metabolism.
- To apply the concepts in the clinical biochemistry aspects.
- Gain insight into the clinical manifestations of various metabolic disorders

Module-1

METABOLISM OF CARBOHYDRATES AND LIPIDS:

Glycolysis–metabolism. Aerobic and anaerobic pathway and regulation, TCA cycle, NADPH Cycle, Glyoxylate cycle, Pentose Phosphate Pathway. Electron transport chain and oxidative phosphorylation, energy balance sheet. Gluconeogenesis – regulation of gluconeogenesis. Biosynthesis of polysaccharides. Biosynthesis of fatty acids, cholesterol, phospholipids, glycolipids. Biodegradation of triglycerides and fatty acids.

Module-2

DISORDERS OF CARBOHYDRATE METABOLISM:

Diabetes mellitus, glycohemoglobins, hypo-glycemias, galactosemia and ketone bodies. Various types of glucose tolerance tests. Glycogen storage diseases. Physiology of lipids/lipoproteins. Lipidosis. Clinical inter-relationships of lipids (sphingolipidosis and multiple sclerosis), lipoproteins and apolipoproteins. Diagnostic tests for HDL-cholesterol, LDL-cholesterol and triglyceride disorders.

Module-3

METABOLISM OF AMINO ACIDS AND NUCLEIC ACIDS:

Biosynthesis and catabolism of essential amino acids: Lysine, Phenylalanine and Glutamine. Deamination, transamination and urea cycle. Metabolism and regulation of Purines, pyrimidine and precursors of nucleic acids (nucleosides & nucleotides).

Module-4

DISORDERS OF AMINO ACIDS AND NUCLEIC ACIDS METABOLISM AND HORMONAL DISTURBANCES:

a) Disorders of amino acid metabolism - Phenylalanemia, homocystinuria, tyrosinemia, MSUD, phenylketonuria, alkaptonuria, albinism and animoacidurias. b) Disorders of nucleic acid metabolism-Disorders in purine/ pyrimidine metabolism. c) Protein hormones (anterior pituitary hormones, posterior pituitary hormones), steroid hormones, adrenocorticosteroids, and reproductive endocrinology. Disturbances in thyroid function.

Module-5

DISORDERS OF ACID-BASE BALANCE AND THEIR RESPIRATORY AND RENAL MECHANISMS:

Evaluation of organ function tests, Assessment and clinical manifestations of renal, hepatic, pancreatic, gastric and intestinal functions. Clinical importance of bilirubin. Diagnostic enzymes: Principles of diagnostic enzymology. Clinical significance of aspartate aminotransferase, alanine aminotransferase, creatine kinase, aldolase and lactate dehydrogenase. Enzyme tests in determination of myocardial infarction. Enzymes of pancreatic origin and biliary tract.

Course Outcomes: At the end of the course the student will be able to:

- Understand the basic metabolic pathways its energetics and regulations of biomolecules.
- Discuss the biochemistry and pathophysiology associated with metabolism.
- Apply the theoretical concepts of biochemistry in diagnosis of biological samples.
- Assess the clinical manifestations of various metabolic disorders.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Clinical Biochemistry	Allan Gaw, Michael Murphy, Robert Cowan, Denis O'Reilly, Michael Stewart and James Shepherd	Churchill Livingstone	4thEdn., 2008
2	Medical biochemistry	N V Bhagavan	Academic Press	4thEdn., 2001
Reference Books				
3	Lecture Notes: Clinical Biochemistry	Geoffrey Beckett, Simon Walker, Peter Rae, Peter Ashby	John Wiley & Sons	7th Edn, 2010
4	Textbook of Medical Biochemistry	MN Chatterjea and RanaShinde	Jaypee Brothers	Eighth Edition 2011
5	Clinical Biochemistry	Richard Luxton	Scion Publishing Ltd.	Second edition 2008

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

BIOCHEMISTRY LABORATORY

Course Code	**18BTL47**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To know the basic laboratory mathematics.
- To analyze the concentration of unknown sample and interpret the results.
- To acquire means to manage experiments independently.

Sl. No.	Experiments
1	pH measurements, volume / weight measurements, concentration units, sensitivity. Specificity, precision, accuracy, preparation of buffers of constant strength.
2	Titration of amino acids with acids & bases.
3	Qualitative tests for carbohydrate and lipids.
4	Qualitative tests for amino acids and proteins.
5	Estimation of blood sugar by Folin method and by O-toluene method.
6	Estimation of inorganic phosphate by Fiske-Subbarao method.
7	Estimation of amino acid by Ninhydrin method.
8	Estimation of total cholesterol from Serum.
9	Determination of saponification value and iodine value of lipids with error analysis.
10	Determination of acetyl value of a lipid with error analysis.
11	Estimation of urea by diacetylmonooxime method with error analysis.
12	Estimation of iron from hemoglobin with error analysis.
13	Estimation of Vitamin C by titrimetric method
14	Estmation of lactose in milk by DNS method
15	Estimation of uric acid in blood by Caraway's method
16	Estimation of creatinine in serum and urine by Jaffe's method

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Demonstrate the basic laboratory mathematics necessary to perform tests, make dilutions, and prepare buffer solutions.
- Compare/contrast Qualitative and quantitative analysis of various Biomolecules.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Modern Experimental Biochemistry by Rodney Boyer, Pearson Education.
2. Practical Biochemistry by Cole, Cambridge University Press.
3. Lab Ref by Jaine Roskams & Linda Rodgers, IK Intl. Pub. House.
4. Manual of Practical Biochemistry for medical students, 2nd edition, University Press

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

IMMUNOTECHNOLOGY LABORATORY

Course Code	**18BTL48**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Learn and demonstrate the various Cell biology and Immunodiagnostic techniques
- Independently carry out research experiments in immunology and cell biology

Sl. No	Experiments
1	Agglutination Technique: ABO typing
2	Differential counting of WBC
3	Isolation of lymphocytes from peripheral blood
4	Bacterial Agglutination reaction-Widal test (Tube / slide agglutination)
5	Radial Immunodiffusion (RID)
6	Ouchterlony Double Diffusion (ODD)
7	Rocket immunoelectrophoresis (RIEP)
8	Counter-current immunoelectrophoresis (CCIEP)
9	Dot ELISA
10	Coombs test
11	Complement fixation test
12	Isolation of Chicken Immunoglobulin (IgY) from Egg Yolk
13	Immunoglobulin purification from serum by IEC
14	Western blotting

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Learn and demonstrate the various Immunodiagnostic techniques like agglutination, precipitation, immunoelectrophoresis, qualitative analysis, ELISA, separation of Lymphocytes and Immunoblot
- Independently carry out research experiments in immunology and cell biology.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Immunology by Kuby Cambridge University Press.
2. Immunology Laboratory Practices by Stryers
3. The Cell by Alberts Cambridge University Press

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

ADDITIONAL MATHEMATICS – II
(Mandatory Learning Course: Common to All Branches)
(A Bridge course for Lateral Entry students under Diploma quota to BE/B. Tech. programmes)

Course Code	**18MATDIP41**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(2:1:0)	SEE Marks	60
Credits	00	Exam Hours	03

Course Learning Objectives:

- To provide essential concepts of linear algebra, introductory concepts of second & higher order differential equations along with methods to solve them,
- To solve Laplace & inverse Laplace transforms and elementary probability theory.

Module-1

Linear Algebra: Introduction - rank of matrix by elementary row operations - Echelon form. Consistency of system of linear equations - Gauss elimination method. Eigen values and eigen vectors of a square matrix. Application of Cayley-Hamilton theorem (without proof) to compute the inverse of a matrix-Examples.

Module-2

Higher order ODE's: Linear differential equations of second and higher order equations with constant coefficients. Homogeneous /non-homogeneous equations. Inverse differential operator method for f(D)y=R(x) where R(x)= e ax, sin(ax), cos(ax), and polynomial in x only. Method of undetermined coefficients and variation of parameters.

Module-3

Laplace transforms: Laplace transforms of elementary functions. Transforms of derivatives and integrals, transforms of periodic function and unit step function-Problems only.

Module-4

Inverse Laplace transforms: Definition of inverse Laplace transforms. Evaluation of inverse transforms by standard methods. Application to solutions of Linear differential equations.

Module-5

Probability: Introduction. Sample space and events. Axioms of probability. Addition and multiplication theorems. Conditional probability – illustrative examples. Bayes's theorem-examples.

Course Outcomes: At the end of the course the student will be able to:

- Use matrix theory for solving systems of linear equations in the different areas of linear algebra.
- Solve second and higher order differential equations occurring in of electrical circuits, damped/un-damped vibrations.
- Learn the Laplace transforms of standard and periodic functions.
- Utilize the inverse Laplace transforms to determine general or complete solutions to linear ODE.
- Explore the basic concepts of elementary probability theory and, apply the same to the problems of decision theory, synthesis and optimization of digital circuits.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the	Edition and Year
Textbook				
1	Higher Engineering Mathematics,	B.S. Grewal	Khanna Publishers,	43rd Ed., 2015.
Reference Books				
1	Advanced Engineering Mathematics,	E. Kreyszig	John Wiley & Sons	10th Ed., 2015
2	Engineering Mathematics,	N.P.Bali and Manish Goyal	Laxmi Publishers,	7th Ed., 2007

****** END ******

B. E. BIOTECHNOLOGY Outcome Based Education (OBE) and Choice Based Credit System (CBCS) SEMESTER - V			
BIO-BUSINESS AND ENTREPRENEURSHIP			
Course Code	**18BT51**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn about the project management,
- To explore entrepreneurship
- To understand IPR and its implications

Module-1

BIO ENTERPREUNERSHIP:

Introduction to bio-business, from the Indian context, SWOT analysis of bio-business. Ownership, Development of Entrepreneurship; Stages in entrepreneurial process; Role of entrepreneurs in Economic Development; Entrepreneurship in India; Entrepreneurship - its barriers. Small scale industries: Definition; Characteristics; Need and rationale; Objectives; Scope; Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Global bio business and industry future trends.

Module-2

ENTREPRENEURSHIP OPPORTUNITY IN AGRI BIOTECHNOLOGY:

Business opportunity, Essential requirement, marketing, strategies, schemes, challenges and scope-with case study on Plant cell and tissue culture technique, polyhouse culture. Herbal bulk drug production, Nutraceuticals, value added herbal products. Bioethanol production using Agri waste, Algal source. Integration of system biology for agricultural applications. Biosensor development in Agri management

Module-3

ENTREPRENEURSHIP OPPORTUNITY IN INDUSTRIAL BIOTECHNOLOGY: Business opportunity, Essential requirement, marketing strategies, schemes, challenges and scope-with case study- Pollution monitoring and Bioremediation for Industrial pollutants, Pesticides, Herbicides etc. Integrated compost production- microbe enriched compost.Bio pesticide/insecticide production. Fermented products-probiotic and prebiotics. Stem cell production, stem cell bank, contract research. Production of monoclonal/polyclonal antibodies, Single cell protein and secondary metabolite production.Contact research in microbial genomics.

Module-4

PROJECT MANAGEMENT, INTELLECTUAL PROPERTY, TECHNOLOGY MANAGEMENT AND STARTUP SCHEMES:

Building Biotech business challenges in Indian context-biotech partners (BICEPS, BIRAC, DBT, Incubation centers. Etc.,), operational biotech parks in India. Indian Company act for Bio business-schemes and subsidies. Meaning of Project; Project Identification; Project Selection; Project Report; Need and Significance of Report; Contents; Formulation; Guidelines by Planning Commission for Project report; Network Analysis; Errors of Project Report; Project Appraisal. Identification of business opportunities: Market Feasibility Study; Technical Feasibility Study; Financial Feasibility Study & Social Feasibility Study. Patent expiry and Entrepreneurship opportunity, Principles of Technology leasing, licensing and transfer, Startup schemes in Indian government, Business incubation support schemes, Successful start-ups-case study.

Module-5

REGULATORY AFFAIRS, BIOETHICS & BIO-SAFETY:

Regulatory affairs in Bio business-regulatory bodies and their regulations (ex.FDA, EU, DSIR, AYUSH,

FSSAI etc.,)
Public education of the process of biotechnology involved in generating new forms of life for informed decision-making. Ethical concerns of biotechnology research and innovation-Interference with nature fear of unknown, unequal distribution of risks. Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards. Biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management.

Course Outcomes: At the end of the course the student will be able to:

- Know the importance of bioethics, biosafety and IPR
- Apply for project proposal
- Plan a project with a work plan, budget and schedule

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Principles of Management	P. C. Tripathi, P.N. Reddy	Tata McGraw Hill	Fifth Edition, 2012
2	Entrepreneurship Development	S.S. Khanka	S.Chand& Co	2006
3	Practical Approach to IPR	Rachana Singh Puri	IK Intl. Ltd	2009
4	Bioethics & Biosafety	R Rallapalli & Geetha Bali	APH Publication	2007
Reference Books				
1	Bioethics &Biosaftey	Sateesh M K	IK Publishers	2008
2	Management Fundamentals - Concepts, Application, Skill Development	Robers Lusier	Cengage Learning	1996
3	Intellectual Property Rights in the WTO and developing country	Watal Jayashree	Oxford University Press	2001

Web links and Video Lectures:

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

CHEMICAL REACTION ENGINEERING

Course Code	**18BT52**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:1:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To discuss the different models of chemical reactions and how various factors such as temperature can affect reaction rate.
- To study the performance and distinguish between the different types of ideal and non ideal reactors
- To determine the optimum pH, temperature and concentration of an enzyme's catalytic power, its substrate affinity and inhibitor role
- To describe medium requirements and medium formulation to get optimal bioprocesses model

Module-1

INTRODUCTION

Law of mass action and rate equation, definitions and examples of elementary and nonelementary reactions, theories of reaction rate and temperature dependency, analysis of experimental reactor data - evaluation of rate equation by integral and differential analysis for constant volume system . Conceptual numericals.

Module-2

BIOREACTORS

Design equations for homogeneous system - batch, stirred tank and tubular flow reactor, size comparison of single reactors, combination of reactor systems - Qualitative design for parallel and series reactors. Conceptual numerical.

Module-3

NON-IDEAL BIOREACTORS

Non-ideal reactors, residence time distribution studies for pulse and step input, Exit age distribution of fluid in reactors, RTD's for CSTR and PFR, calculations of conversions for First order reactions. Conceptual numerical.

Module-4

ENZYME KINETICS

Enzyme active site, types of enzyme specificities, enzyme kinetics, initial velocity studies, formation of ES complex, derivation of Michaelis-Menton equation, definition of Km and Vmax, Lineweaver-Burk and Eadie-Hofstee plots. Units of enzyme activity, Enzyme inhibition: competitive, uncompetitive and non-competitive. Conceptual numerical.

Module-5

KINETICS OF MICROBIAL GROWTH AND MEDIA DESIGN

Monod model; Growth of Filamentous Organisms. Growth associated (primary) and nongrowth associated (secondary) product formation kinetics; Leudeking-Piret models; substrate and product inhibition on cell growth and product formation; Conceptual numericals.

Medium requirements for fermentation processes- Carbon, nitrogen, minerals, vitamins and other complex nutrients; oxygen requirements; Medium formulation for optimal growth.

Course Outcomes: At the end of the course the student will be able to:

- Understand the mechanism and kinetics ofchemical , enzyme and microbial reactions.
- Identify and summarize the parameters from range reactions to optimize reactor design and development.
- Demonstrate the use of various scientific parameters to improve the performance of fermentation process
- Develop suitable environment for microbial growth by analysing various parameters.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Chemical Reaction Engineering	Levenspiel O	John Wiley	3rd Edition 1998
2	Elements of Chemical Reaction Engineering	Fogler, H.S	Prentice Hall	3rd Edition 2004
3	Bioprocess Engineering: Basic Concepts	FikretKargi, Matthew DeLisa, and Michael L. Shuler	Prentice Hall	Third Edition 2017
4	Enzyme Kinetics and Mechanism	Paul F Cook & W W Cleland	Garland Science	2007
Reference Books				
1	Bioenergetics	David Nicholls	Academic Press	4th Edition 2013
2	Chemical Reactor Analysis and Design	Forment G F and Bischoff K B	John Wiley	3rd Edition2010

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

ENZYME TECHNOLOGY & BIOTRANSFORMATION

Course Code	**18BT53**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:0:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To define the enzyme and its classification, catalytic action.
- To understand the mechanism of enzyme action, purification of enzymes, catalytic action of enzymes, kinetics of enzyme catalyzed reactions

Module-1

INTRODUCTION :
Introduction to enzymes, Classification, Sources, Strategies of purification of enzymes, molecular weight determination, Mechanism of enzyme catalysis (Acid-base, Covalent, Metal ion catalysis, Substrate strain & entropy effects), criteria of purity and characterization of enzymes. Advantages of Biocatalyst vs Chemical catalysts, Isolated Enzymes versus whole cell systems, Application of enzymes in different industry

Module-2

ENZYME ASSAY AND CO- ENZYMES:
Enzyme and isoenzyme measurement methods with two examples (fixed incubation and kinetic methods); Enzymes in immunoassay techniques, Methods for investigating the kinetics of Enzyme catalyzed reactions – Initial velocity studies, rapid-reaction techniques. Standardization and optimization methods, stability of enzymes. Mechanism of coenzymes (NAD/NADP, FAD/FADH2, PLP, Coenzyme A, TPP, Biotin).

Module-3

ENZYMATIC TECHNIQUES :
Techniques of enzyme immobilization; kinetics of immobilized enzymes, effect of solute, partition & diffusion on the kinetics of immobilized enzymes, design and configuration of immobilized enzyme reactors; applications of immobilized enzyme technology, Economic argument for immobilization. Biocatalysts from extremophiles microorganisms (extremozymes) and their applications

Module-4

ENZYME ENGINEERING AND MEDICAL IMPORTANCE :
The design and construction of novel enzymes, artificial enzymes, Host Guest Complexation chemistry and enzyme design using steroid templates. In vitro Biotransformation of drugs (hydroxylation of Steroids), Therapeutic enzymes, Acetylcholinesterase and pseudocholinesterase, Angiotensin converting enzyme (ACE) and Inhibitors, HMG Co A reductase inhibitors, glucose-6-phosphate dehydrogenase (GPD), Immunoreactivetrypsinogen (IRT) and amylase isoenzymes.

Module-5

APPLICATIONS :
Importance of enzymes in diagnostics, Enzyme pattern in diseases like Myocardial infarctions (SGOT, SGPT & LDH). Isoenzymes (CK, LD, ALP). Use of isozymes as markers in cancer and other diseases. Enzymes used in detergents, use of proteases in food, leather and wool industries; methods involved in production of glucose syrup from starch (using starch hydrolyzing enzymes), production of maltose and sucrose, glucose from cellulose, uses of lactase in dairy industry, glucose oxidase and catalase in food industry;

Course Outcomes: At the end of the course the student will be able to:

- Define enzymes and its catalytic action, mechanism & kinetics with few examples.
- Explain the various techniques involved in the extraction and utilization of enzymes in biotransformation.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Enzyme Technology	Martin Chaplin and Christopher Bucke	Cambridge University Press	1990
2	Enzymes	Dixon and Webb	Academic Press	2nd Edition 1964
3	Principles of Enzymology for technological Applications	Butterworth Heinemann	Oxford University Press	1993
Reference Books				
1	Purifying Proteins for Proteomics	Richard J Simpson	IK International	2003
2	Fundaments of Enzymology	Prices and Stevens	Oxford Press.	Third Edition, 1999
3	Enzymes in Industry: Production and Applications	W. Gerhartz	Wiley- VCH Publishers	3rd Edition 2007

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

GENOMICS AND PROTEOMICS

Course Code	**18BT54**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:1:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To inculcate interdisciplinary approach of learning.
- To comprehend applications of basic aspects of biotechnology
- To impart knowledge on application of software tools for biological studies

Module-1

INTRODUCTION:

Genes and Proteins, Polymorphisms – types of polymorphism, genome sequences and database subscriptions, discovery of new genes and their function. Early sequencing efforts. Extraction of DNA, Methods of preparing genomic DNA for sequencing, DNA sequence analysis methods-Maxam& Gilbert Method, Sanger Di-deoxy method, Fluorescence method, shot-gun approach. NGS – different methods and principles

Module-2

GENOMICS:

Inheritance pattern in eukaryotes, Mutations, Gene variation and Single Nucleotide Polymorphisms (SNPs), Expressed sequenced tags (ESTs), Gene-disease association, diagnostic genes and drug targets, genotyping tools - DNA Chips, diagnostic assays, diagnostic services. Functional genomic studies with model systems such as Drosophila, Yeast or *C. elegans*. Genome projects on *E.coli*., Arabidopsis and rice; Human genome project and the genetic map.

Module-3

GENOME MANAGEMENT :

Cell differentiation and gene regulation. C-Values of genomes. General architecture of prokaryotic and eukaryotic genome. Organization of eukaryotic genome within the nucleus, chloroplast and mitochondria. Regulation of transcription, transcription factors and the co-ordination of gene expression. Interference RNA, RNA silencing, SiRNA: Applications in Functional genomics, Medicine and Gene Knockdown. Gene Editing - Crispr Cas9

Module-4

GENOME ANALYSIS :

Genetic and physical maps: Breeding requirements for mapping. Molecular markers - RFLP, RAPD, AFLP, SCAR, CAPS, microsatellites and SNPs. Methods of molecular mapping, Marker assisted selection. Map-based cloning, T-DNA and transposon tagging. Differential display via RT-PCR. Micro-array in functional genomics. Bioinformatics analysis – clustering methods. FISH - DNA amplification markers; Telomerase as molecular markers. STS mapping.

Module-5

PROTEOMICS :

Introduction to proteins, Large scale preparation of proteins and peptides, Merrifield Synthesis of peptides, use of peptides as probes.proteins as drugs; two hybrid interaction screens. Mass-spec based analysis of protein expression. "Protein Chip" - interactions and detection techniques. Two dimensional PAGE for proteome analysis, Detection of proteins on SDS gels, Protein cleavage, Edman protein microsequencing, Automation in proteomics, Applications of proteome analysis to drug development and toxicology, Phage antibodies as tools for proteomics.

Course Outcomes: At the end of the course the student will be able to:

- Define structural, comparative and functional genomics and proteomics and its uses in various research fields
- Describe various methods and techniques of Genomics, high throughput DNA sequencing technology, expression profiling, proteome analysis, and its applications.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Introduction to Genomics	Arthur M Lesk	Oxford University Press	2007
2	Discovering Genomics, Proteomics & Bioinformatics	A M Campbell & L J Heyer	Pearson Education,	2007
3	Proteins and Proteomics	Richard J Simpson	IK International	2003
Reference Books				
1	Genomics & Proteomics	Sabesan	Ane Books	2007
2	Purifying Proteins for Proteomics	Richard J Simpson	IK International	2004

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

BIOANALYTICAL TECHNIQUES

Course Code	**18BT55**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To be able to select analytical technique for case study.
- To be able to design experiments and understand the instrumentation.
- To deliver the knowledge of spectroscopic, chromatographic techniques and its functions
- To provide the technical information of analytical devices for biological applications

Module-1

INTRODUCTION:

Extraction, Pre-treatment, Stabilization and preparation methods of bioproducts for analysis. Electrophoretic Techniques**:** Principle, equipment and process, Agarose gel electrophoresis, gradient electrophoresis, horizontal and vertical gel electrophoresis, electrophoresis techniques, isoelectric focusing, capillary electrophoresis and application of electrophoresis in analyzing macromolecules. Chromatography – principles, instruments and practice, adsorption, reverse phase, ion exchange, size exclusion, hydrophobic interaction, bio-affinity and pseudo affinity chromatographic techniques

Module-2

CHROMATOGRAPHY AND PURIFICATION:

Chromatography: Classification of chromatographic techniques and their principles, Theory of chromatography, band broadening, rate and plate theory factors responsible for separation. Column chromatography, TLC, Paper chromatography.

Liquid Chromatography and HPLC: Instrumentation, pumps, solvent delivery system, isocratic and gradient programming modes, sample introduction system, columns, detectors, reversed phase and normal phase chromatography.

Gas Chromatography: Instrumentation, carrier gas supply, injectors, columns, packed and capillary columns, column oven and temperature programming, different detectors.

Introduction to hyphenated techniques in chromatography, GC-MS and LC-MS.Cell fractionation and flow cytometry

Module-3

SPECTROSCOPY:

UV-Visible spectroscopy, Fluorescence spectroscopy, IR/Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy

Types of nuclear magnetic resonance Chemical shifts – spin – spin coupling – relaxation mechanisms – nuclear overhauser effect –ESR multidimensional nmr spectroscopy – determination of macromolecular structure by NMR –magnetic resonance imaging.

Module-4

SPECTROMETRY:

Ion sources sample introduction – mass analyzers and ion detectors – bimolecular mass spectrometry – peptide and protein analysis – carbohydrates and small molecules – specific applications.

X-Ray diffraction: Scattering by x- rays – diffraction by a crystal – measuring diffraction pattern – Bragg reflection –unit cell – phase problem – anomalous diffraction – determination of crystal structure – electron and neutron diffraction.

Module-5

INSTRUMENTAL METHODS OF ANALYSIS:

Advanced Microscopy: Morphology and identification of cells using microscopic studies like SEM, TEM and Confocal Microscopy.

EDAX, Elemental mapping, FTIR, UV-Visible spectrophotometer, Nanomechanical Characterization using Nanoindentation, Differential Scanning Calorimeter (DSC), Differential Thermal Analyzer (DTA), Thermo gravimetric Analysis (TGA), TEM, X-ray Photoelectron Spectroscopy (XPS), Electrochemcial Characterization measurements.

Course Outcomes: At the end of the course the student will be able to:

- Define the fundamentals of downstream processing for product recovery
- Understand the requirements for successful operations of analytical techniques
- Apply principles of various analytical devices used in in research and enhance problem solving techniques

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Analytical techniques in biochemistry and molecular biology	R. Katoch	Springer, New York,	2011
2	Biological spectroscopy	I. D. Campbell	Benjamin/Cummings Pub. Co	1984
3	Separation Processes in Biotechnology	Asenjo, Juan A.	CRC / Taylor & Francis	1990
Reference Books				
1	Modern experimental biochemistry	R. F. Boyer	Benjamin Cummings	3rd ed., 2000
2	Principles of fluorescence spectroscopy	J. R. Lakowicz	Springer, New York	2006

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

GENETIC ENGINEERING & APPLICATIONS

Course Code	**18BT56**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn about rDNA technology, vectors and enzymes used in genetic engineering.
- To learn acquire the knowledge of specific techniques like PCR, NA hybridization & libraries.
- To learn about various gene transfer techniques, applications of transgenic plants & animals and importance of gene therapy

Module-1

VECTORS & ENZYMES IN GENETIC ENGINEERING:

Vectors in rDNA technology, salient features of vectors, types of vectors-plasmids, cosmids, phagemids and viruses. Construction of rDNA& vectors (BAC, Blue script and YAC). Exonucleases and Restriction Endonculeases: classification, mode of action. Enzymes in modification - Polynucleotide phosphorylase, DNase, Methylases, phosphatases, polynucleotide Kinase, Ligases, RNase and their mechansim of action

Module-2

NUCLEIC ACID HYBRIDIZATION, AMPLIFICATION & CONSTRUCTION OF LIBRARIES:

Methods of nucleic acid detection, polymerase chain reaction (PCR), variants of PCR and applications, methods of nucleic acid hybridization, Southern, Northern & Western hybridization techniques & applications. Isolation of nucleic acids (DNA & RNA). Isolation of plasmids, construction of genomic and cDNA libraries, purification, screening and preservation

Module-3

METHODS OF GENE/DNA TRANSFER:

Overview & classification of gene transfer techniques in plants, animals and microbes – Transformation, stable & transient transformation, transfection, electroporation, microinjection, liposome mediated gene transfer, transfection of DNA by calcium phosphate coprecipitation, gene gun method. *Agrobacterium*-mediated gene transfer in plants – Ti &Ri plasmids: structure and functions, Ti plasmid based vectors – advantages, disease control of *Agrobacterium tumefaciens*. Chloroplast transformation & its applications.

Module-4

TRANSGENIC SCIENCE IN GENETIC IMPROVEMENT

Transgenic science in plant improvement, biopharming – plants as bioreactors, transgenic crops for increased yield, resistance to biotic and abiotic stresses. Techniques of gene mapping in plants. Marker-assisted selection and breeding for improvement. Transgenic science for animal improvement, biopharming - animals as bioreactors for recombinant proteins, Gene mapping in farm animals. Marker-assisted selection and genetic improvement of livestock.

Module-5

OTHER APPLICATIONS & GENE THERAPY

Microbial biotechnology - Genetic manipulation, engineering microbes for the production of antibiotics, enzymes, Insulin, growth hormones, monoclonal antibodies, clearing oil spills. Introduction to gene therapy. Methods of Gene therapy. Gene targeting and silencing. Gene therapy in the treatment of cancer, SCID, muscular dystrophy, respiratory disease (emphysema), cystic fibrosis. Challenges & future of gene therapy.

Course Outcomes: At the end of the course the student will be able to:

- Explain & compare the different vectors & enzymes used in the construction of recombinant DNA in Genetic engineering
- Choose& explain specific techniques like PCR, Blotting & construction of libraries
- Differentiate between & learn the different gene/DNA transfer techniques
- Outline the various methods of producing transgenic organisms and sub-divide/summarize the applications of genetic engineering for the welfare of mankind & society

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Principles of Gene Manipulation and Genomics	S.B. Primrose and R. M. Twyman	Blackwell Science Publications	7th edition 2006
2	Gene Cloning and DNA Analysis: An Introduction	T A Brown	Wiley – Blackwell Publications.	(6th edition)
Reference Books				
3	Recombinant DNA	Watson.J.D. et al	Scientific American Books, New York	1993
4	Plant Genetic Engineering	J. H. Dodds	Cambridge University Press	1983
5	Gene Cloning and Manipulation	Howe C. J	Cambridge University Press	2007

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - V

BIOKINETICS& ENZYME TECHNOLOGY LABORATORY

Course Code	**18BTL57**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- Describe the fundamental concepts of kinetics of reaction and the Enzyme kinetics.
- Understand the rate of reaction for different reactors, ethical responsibilities that come with conducting experiments and communicating data.
- Apply the design equations for predicting the reactor performance.
- Generate the RTD data to identify non idealities in different reactor configuration.

Sl. No.	Experiments
1	Mixed Flow Reactor
2	Plug Flow Reactor
3	Isothermal Batch Reactor
4	RTD in Mixed Flow Reactor
5	RTD in Plug Flow Reactor
6	Isolation of enzymes
7	Determination of activity, Vmax& Km of α- amylase
8	Effect of Inhibitor on α- amylase
9	Time course of Amylase activity
10	Effect of pH on α- amylase
11	Effect of temperature on α- amylase
12	Enzyme Immobilization techniques and kinetics
13	Determination of specific activity of α- amylase
14	Isolation of papain(proteases) from papaya and assay of papain using calorimetric method
15	Effect of organic solvents on enzyme activity
16	Determination of molecular weight by SDS-PAGE

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- State and define the nature of the reaction, rate of the reaction, rate constant and enzyme activity.
- Compare the rate of reaction for different reactors; know the ethical responsibilities that come with conducting experiments and communicating data.
- Use the design equations for predicting the reactor performance.
- Compose the RTD data to identify non idealitites in different reactor configuration.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Bioprocess Engineering by Shule and Kargi Prentice Hall.
2. Chemical Engineering Kinetics by Smith J.M. McGraw Hill.
3. Enzyme Technology by M.F. Chaplin and C. Bucke, Cambridge University Press, Cambridge.

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - IV

GENETIC ENGINEERING AND CELL CULTURE LABORATORY

Course Code	**18BTL58**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- To isolate, quantify and amplify nucleic acids.
- To perform genetic recombination experiments
- To isolate, maintain and culture the cells in vitro.
- Explain the nature of plant growth processes, in the tissue culture environment

Sl. No	Experiments
1	Isolation of genomic DNA (plant / microbial sources)
2	Isolation of plasmid DNA from bacteria
3	Agarose gel electrophoresis and quantification of nucleic acids (colorimetric)
4	Digestion and mapping of plasmid pUC18
5	Transformation and screeningof recombinants
6	Study of conjugation in bacteria
7	Amplification of DNA by PCR
8	Study of divisional stages in Mitosis & Meiosis.
9	Study of Polytene chromosomes
10	Isolation and fusion of plant protoplasts.
11	Callus Induction technique – Carrot/Beet root/ or any other material
12	Estimation of Lycopene from tomato fruits
13	Somatic Embryogenesis
14	Embryo/Endosperm Culture
15	Estimation of Anthocyanin from leaf /callus tissue
16	Cell viability assay- Tryphan blue

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Demonstrate/perform the basic cell culture techniques in vitro.
- To analyze the effects of physio-chemical factors and growth hormones for the growth and development of the cultures in vitro

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:

1. Experiments in Plant Tissue Culture by John H. Dodds & Lorin W. Robert.
2. Plant tissue Culture Theory and Practice by S.S. Bhojwani and M.K. Razdan, Elsevier.
3. Culture of Animal Cells. R. Ian Freshney and R. Alan., Liss. Inc. (1987).

B. E.IN CIVIL ENGINEERING(CV-2018-19)
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – V

ENVIRONMENTAL STUDIES

Course Code	18CIV59	CIE Marks	40
Teaching Hours / Week (L:T:P)	(1:0:0)	SEE Marks	60
Credits	01	Exam Hours	02

Module - 1

Ecosystems (Structure and Function): Forest, Desert, Wetlands, Riverine, Oceanic and Lake.
Biodiversity: Types, Value; Hot-spots; Threats and Conservation of biodiversity, Forest Wealth, and Deforestation.

Module - 2

Advances in Energy Systems (Merits, Demerits, Global Status and Applications)**:** Hydrogen, Solar, OTEC, Tidal and Wind.
Natural Resource Management (Concept and case-studies): Disaster Management, Sustainable Mining, Cloud Seeding, and Carbon Trading.

Module - 3

Environmental Pollution (Sources, Impacts, Corrective and Preventive measures, Relevant Environmental Acts, Case-studies)**:** Surface and Ground Water Pollution; Noise pollution; Soil Pollution and Air Pollution.
Waste Management & Public Health Aspects: Bio-medical Wastes; Solid waste; Hazardous wastes; E-wastes; Industrial and Municipal Sludge.

Module - 4

Global Environmental Concerns(Concept, policies and case-studies):Ground water depletion/recharging, Climate Change; Acid Rain; Ozone Depletion; Radon and Fluoride problem in drinking water; Resettlement and rehabilitation of people, Environmental Toxicology.

Module - 5

Latest Developments in Environmental Pollution Mitigation Tools (Concept and Applications): G.I.S. & Remote Sensing, Environment Impact Assessment, Environmental Management Systems, ISO14001; Environmental Stewardship- NGOs.
Field work: Visit to an Environmental Engineering Laboratory or Green Building or Water Treatment Plant or Waste water treatment Plant; ought to be Followed by understanding of process and its brief documentation.

Course Outcomes: At the end of the course, students will be able to:

- CO1: Understand the principles of ecology and environmental issues that apply to air, land, and water issues on a global scale,
- CO2: Develop critical thinking and/or observation skills, and apply them to the analysis of a problem or question related to the environment.
- CO3: Demonstrate ecology knowledge of a complex relationship between biotic and a biotic components.
- CO4: Apply their ecological knowledge to illustrate and graph a problem and describe the realities that managers face when dealing with complex issues.

Question paper pattern:

- The Question paper will have 100 objective questions.
- Each question will be for 01 marks
- Student will have to answer all the questions in an OMR Sheet.
- The Duration of Exam will be 2 hours.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year

Textbook/s				
1	Environmental Studies	Benny Joseph	Tata Mc Graw – Hill.	2nd Edition, 2012
2.	Environmental Studies	S M Prakash	Pristine Publishing House, Mangalore	3rd Edition, 2018
3	Environmental Studies – From Crisis to Cure	R Rajagopalan	Oxford Publisher	2005
Reference Books				
1	Principals of Environmental Science and Engineering	Raman Sivakumar	Cengage learning, Singapur.	2nd Edition, 2005
2	Environmental Science – working with the Earth	G.Tyler Miller Jr.	Thomson Brooks /Cole,	11th Edition, 2006
3	Text Book of Environmental and Ecology	Pratiba Sing, AnoopSingh& PiyushMalaviya	Acme Learning Pvt. Ltd. New Delhi.	1st Edition

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B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

PROCESS CONTROL & AUTOMATION

Course Code	**18BT61**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:1:0)	SEE Marks	60
Credits	04	Exam Hours	04

Course Learning Objectives: This course will enable students
- To understand the basics of process dynamics principles and instrumentation
- To Study various types of input functions and its response
- To perform computational modeling to study different types of controllers
- To analyse different control algorithms.

Module-1

INSTRUMENTATION

Instrumentation - principles, Introduction to flow, pressure, temperature and liquid level measurements, measurement of important physico-chemical and biochemical parameters, methods of on-line and off-line biomass estimation, flow injection analysis for measurement of substrates, products and other metabolites. On-line data analysis for state and parameter estimation techniques for biochemical processes.

Module-2

FIRST ORDER SYSTEMS

Process characteristics, Laplace transforms, first order systems – examples, mercury in glass thermometer, liquid level system, response of first order system for step, impulse and sinusoidal changes in input, conceptual numerical. Interacting and non-interacting systems and their dynamic response to step, inputs; conceptual numerical.

Module-3

SECOND ORDER SYSTEMS

Second order systems with transfer functions (spring-damper, control valve, U-tube manometer), response of second order system to step, impulse and sinusoidal input – Overdamped,underdamped and critically damped condition of second order system, transportation lag.

Module-4

CONTROLLERS AND FINAL CONTROL ELEMENTS

Actuators, Positioners, Valve body, Valve plugs, Characteristics of final control elements, controllers – two position control, proportional control, derivative control, integral control, P-I (proportional-integral) control, P-D (proportional- derivative) control, P-I-D (proportional-integral-derivative) control, Block diagrams for servo and regulatory problems , conceptual numericals

Module-5

CONTROLLER DESIGN AND STABILITY

Criteria for stability, Routh test; Root locus (basics), Introduction to frequency response, Qualitative discussion about Bode criteria and Nyquist criteria; Conceptual numericals

Course Outcomes:
- Understand the basics of process dynamics principles and instrumentation
- Study various types of input functions and its response
- Perform computational modelling to study different types of controllers
- Analyse different control algorithms

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Process System analysis and Control	Donald R Coughanowr	McGraw-Hill	2013
2	Chemical Process Control	George Stephanopoulos	Prentice-Hall of India	1982
3	Process equipment design	M V Joshi	Macmilan Indian Limited.	2003
Reference Books				
1	Bioprocess Engineering Principles	Pauline M. Doran	Academic Press	2011
2	Biochemical Engineering Fundamentals	Bailey and Ollis	Mcgraw Hill	2nd Edition, 2001
3	Essentials of Process Control	Luyben and Luyben	McGraw-Hill Education	2005
Web links and Video Lectures: -				

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

BIOPROCESS EQUIPMENT DESIGN & CAED

Course Code	**18BT62**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:2:0)	SEE Marks	60
Credits	04	Exam Hours	04

.**Course Learning Objectives:**

- To learn about the design procedures of process equipment double pipe heat exchanger,
- To learn about the design procedures of shell & tube heat exchanger,
- To learn about the design procedures of condenser, fermenter, packed column distillation.

Module-1

PROCESS DESIGN OF DOUBLE PIPE HEAT EXCHANGER:

Introduction to heat exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter counter), Heat transfer coefficients (inside, outside & overall), area, length, number of hair pins, diameter of tube. Pressure drop calculations.Detailed drawing of sectional front view of Heat exchanger.

Module-2

PROCESS DESIGN OF SHELL & TUBE HEAT EXCHANGER:

Introduction to Heat Exchanger, Functional design – Energy balance equation, log mean temperature difference (co-current, counter current), Heat transfer coefficients (inside, outside and overall), area, length, number of tubes, tube sheet diameter, pitch type, diameter of tube sheet.Mechanical design – baffle, thickness of shell, thickness of tube sheet, thickness of head, pressure drop calculations – tube side and shell side.Detailed drawing of sectional front view of Heat exchanger (1-1, 1-2) with tube sheet layout.

Module-3

PROCESS DESIGN OF VERTICAL CONDENSER:

Heat balance, shell side heat transfer coefficient, tube side heat transfer coefficient, overall heat transfer coefficient for condensation (Uc), clean surface area, over all coefficient for sub-cooling, area for sub-cooling, total clean surface area, overall heat transfer coefficient(Ud) and pressure drop calculations. Detailed drawing of sectional front view.

Module-4

PROCESS DESIGN OF FERMENTER:

Functional design- Based on the type of bioreactor (batch reactor& MFR) and cell growth kinetics and performance equation, determines the volume of the reactor, according to H/D ratio determine height and diameter.

Mechanical design- Thickness of the shell (cylindrical, spherical), thickness of top & bottom cover, flange calculations – width and thickness of gasket, number of bolts, bolts circle diameter and bolt diameter.

Module-5

PROCESS DESIGN OF PLATE COLUMN DISTILLATION COLUMN:

Functional design- material balance, energy balance, height of the packed column using McCabe Thiele's method, Mass transfer coefficients, Diameter of columns (Top and bottom), top and bottom free space.

Detailed drawing for the above design (showing clearly inlets, outlets liquid distributors, packing support).

Course Outcomes:

- Differentiate between different types of heat exchangers
- Do detailed design and drawing of DPHE, STHE and condenser,
- Design and draw the fermenter, packed column distillation

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Chemical Engineers Handbook	R. H. Perry & D. W. Green	McGraw Hill	7thEdn
2	Process Heat Transfer	Donald Q. Kern	McGraw Hill	1997
3	Process Design of Equipment	S.D Dawande	Central Techno Publications	3rd edition, 2003
Reference Books				
1	Process Equipment Design – Vessel Design	Brownell & Young	John Willey	1951
2	Chemical Engineering	J. M. Coulson & J. F. Richardson	Pregman Press	1993
Web links and Video Lectures: -				

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

BIOINFORMATICS

Course Code	**18BT63**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:0:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives:

- To use online resources, databases related to biological data.
- To learn the underlying concepts of Bioinformatics
- To learn the various tools in bioinformatics to manipulate and analyse biological data

Module-1

DATABASES & SEQUENCE ALIGNMENT TOOLS:

Introduction to Bioinformatics, Need for informatics tools and exercises, Bioinformatics resources: NCBI, EBI, ExPASy, RCSB. Significance of databases towards informatics projects. Databases and classifications. GenBank, DDBJ, EMBL, PIR, Uniprot-KB, SWISS-PROT, TrEMBL. Gene bank flat file. Protein Data Bank (PDB) flat file; FASTA Format, PIR Format; Structure file formats. the Modular Nature of proteins, Optional Alignment Methods, Substitution scores, substitution matrices, PAM, BLOSUM, Gap penalties, Statistical significance of Alignments, BLAST and its different types and function, Practical Aspect of Multiple Sequence Alignment, Progressive Alignment Methods, MUSCLE, Motifs and Patterns, PROSITE, Hidden Markov Models (HMMs), and Threading methods. Conceptual numericals.

Module-2

PHYLOGENETIC ANALYSIS AND GENOME BIOINFORMATICS

Introduction to Phylogenetic analysis, rooted and unrooted trees, Elements of phylogenetic Models, Phylogenetic Data Analysis: Alignment, Substitution Model Building, Tree Building, and Tree Evaluation, Tree - Building Methods-Distance based and character based methods, Evaluating Trees and Data- Boot strapping (parametric and non-parametric), Phylogenetic softwares (CLUSTAL -omega, PHYLIP etc), Conceptual numericals.

Bioinformatics tools and automation in Genome Sequencing, analysis of raw genome sequence data, Utility of EST database in sequencing, Bioinformatics in detection of Polymorphisms, SNPs and their relevance**,** Bioinformatics tools in microarray data analysis. Tools for comparative genomics: BLAST2, Vista, MUMmer, COG, VOG.

Module-3

PREDICTIVE METHODS:

Predictive Methods using Nucleotide sequences: Framework, Masking repetitive DNA, Databasesearches, Codon Bias Detection, Detecting Functional Sites in the DNA (promoters, transcription factor binding sites, translation initiation sites), Integrated Gene Parsing, finding RNA Genes, Web based tools (GENSCAN, GRAIL, GENEFINDER).

Predictive Methods using Protein sequences: Protein Identity based on composition, Physicalproperties Based on sequence, secondary structure and folding classes, specialized structures or features, tertiary structure. Related web based software (JPRED, NNPREDICT, SOPMA, DSSP, STRIDE).

Module-4

MOLECULAR MODELING & VIZUALIZATION:

Concepts in Molecular Modeling: Coordinate Systems, concept of energy minimization, different types of interactions and formulation of force fields. Basic MD algorithm, its limitations, treatment of long range forces. Comparative modeling, Constructing an initial model, refining the model, manipulating the model; molecular superposition and structural alignment,. Structure Visualization: small molecules (low molecular weight – peptides, nucleotides, disaccharides, simple drugs molecules) and macromolecules (high molecular weight molecules - proteins, DNA, RNA, membranes). Usages of visualization software available in public domain like VMD, Rasmol, Pymol, SpdbViewer, and Cn3D.

Module-5

PLASMID MAPPING, PRIMER DESIGN AND INSILICO DRUG DESIGN:

Restriction mapping, Utilities, DNA strider, MacVector and OMIGA, gene construction KIT, Vector NTI, Web based tools (MAP, REBASE); Primer design – need for tools, Primer design programs and software (PRIME3). Molecular modeling in drug discovery, molecular docking, quantitative structure-activity relationship (QSAR), deriving the Pharmacophoric Pattern, Receptor Mapping, Estimating Biological Activities, Ligand - Receptor Interactions: Docking softwares (AUTODOCK, HEX), Energy Calculations (no derivation). Conceptual numericals.

Course Outcomes:

- Know the relevant online resources, databases and software tools
- Understand the underlying concepts of Bioinformatics
- Apply alignment and modelling tools
- Analyse biological data using phylogenetic, predictive and comparative methods
- Design in silico various biomolecules

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Computational methods for macromolecular sequence analysis:	R F Doolittle.	Acad. Press.	1996
2	Bioinformatics: Methods And Applications	P aragRastogi and S.C. Rastogi	PHI	Fourth Edition 2004
Reference Books				
1	Computational methods in Molecular Biology.	S.L.Salzberg, D B Searls, S Kasif,	Elsevier Science	1998
Web links and Video Lectures: -				

PROFESSIONAL ELECTIVE -1

B. E. BIOTECHNOLOGY **Outcome Based Education (OBE) and Choice Based Credit System (CBCS)** **SEMESTER - VI**			
FOOD PROCESS ENGINEERING			
Course Code	**18BT641**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To explain the concept of food and its physiological characteristics.
- To understand the role of beneficial microorganisms in food processing and preservation and to list the major food spoilage microorganisms and the detection techniques.
- To apply the principles and procedures to process and preserve food.
- To analyze the food sample for microbial contamination.

Module-1

FOOD SCIENCE & FOOD NUTRITION

Introduction, history, constituents of food, Regulation of food intake colloidal systems in food, stability of colloidal systems, Carbohydrates, Starches, Proteins, Fats in food, sugars in food, Minerals, Aroma compounds and flavors in food, Browning reactions, anti-nutritional factors in foods, Rancidity of food factors affecting rancidity, preventive measures. Metabolism in starvation and malnutrition, Diet and nutrition in India, Food faddism and faulty food habits.

Module-2

MICROBIAL SPOILAGE, DETECTION

Intrinsic and extrinsic factors influences the growth of microorganism in food, primary sources of microorganisms found in foods, Synopsis of common food-borne bacteria, genera of molds, genera of yeasts, Food borne infection and intoxication. Brief discussions on food borne gastroenteritis caused by Salmonella, Shigella, Listeria, Staphylococcus, Clostridium, Vibrio, Yersinia and Campylobacter Microbial detection in food: Culture, Microscopic & sampling methods, Conventional SPC, Membrane filters, microscope colony Counts, Agar droplets, Dry films, Most probable nos. (MPN), Dye-reduction, roll tube, microscopic count (DMC).

Module-3

FOOD FERMENTATION& PRESERVATION

Fermented foods – Production of Bread, Cheese and Sauerkraut. Fermentation of wines, distilled liquor, vinegar, Fermented Dairy products. Principles underlying preservation of food. Food preservation using chemical preservatives, irradiation, high temperature, low temperature and dehydration.

Module-4

FOOD INDUSTRY AND BIOTECHNOLOGY IN FOOD

Characteristics of food industry. Food manufacturing and processing, objectives of food processing, effect of food processing on food constituents, methods of evaluation of food, proximate analysis of food constituents, Nutritional value, labeling of constituents, (Soya foods, organic foods, dietary foods, (for individuals, for specific groups),nutritional food supplements, Food packaging, edible films, Factors influencing food product development, marketing and promotional strategies. Applications of Biotechnology in food industry, Nutraceuticals, flavonoids, antioxidants, vitamins, enzymes in food industry, economic aspects, enzyme generation of flavor and aroma compounds.

Module-5

FOOD TECHNOLOGY

Properties of foods and processing theory, Process control, Raw material processing, Thermal properties of frozen foods, Prediction of freezing rates, Food freezing equipments: Air blast freezers, plate freezers and immersion freezers. Food dehydration: estimation of drying time, constant rate period and falling rate period. Equipments: fixed tray dehydration, cabinet drying, tunnel drying. Equipments related to pulping, fruit juice

extraction, dehulling and distillation, Food safety (HACCP and FSO systems), good manufacturing practice and quality assurance. Current technologies and Future Scope.

Course Outcomes:

- Display a solid foundation in understanding the biochemical, nutritional, physiological, ethical and safety aspect of food.
- Understand the factors influencing microbial growth, its intoxication and diagnostic system used in fo industry to detect the microbial spoilage.
- To illustrate the different processing, preservative techniques to enhance the shelf life and production of food by fermentation processes using biotechnological approach.
- To analyse the different food sample for microbial contamination.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Food microbiology	William C Frazier and Westhoff Dennis C	Tata McGraw Hill publication	5th Edn 2013
2	Food Biotechnology	KalidasShetty	CRC Press	2nd Edn 2005
3	Food Biotechnology	J Polak, J Tramper and S Bielecki	Elsevier Science	2000
Reference Books				
1	The technology of food preservation	Desrosier, Norman W; Desrosier, James N.	Westport, Conn. : AVI Pub. Co.	1977
2	Essentials of Food Sciences	Vickie A. Vaclavik, Elizabeth W. Christian	Springer	1998

Web links and Video Lectures: -

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

PHYTO-CHEMISTRY AND PHYTO-HARMONES

Course Code	**18BT642**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To explore the structural complexity and diversity of pharmaceutically relevant plant metabolites and its different classes.
- To learn the principles underlying plant secondary metabolism.
- To introduce basic concepts related to discovery and physiological effectsof plant growth regulators.
- To understand of control of various physiological and developmental mechanisms by hormones.

Module-1

OVERVIEW OF PLANT SECONDARY METABOLITES

Drugs from plants - Insecticides and rodenticides- Industrially important Plant products Essential Oils, Fatty Oils & Waxes, Fibers&Fiber Plants, Forest Products: Wood and Cork, Forest Resources, Gums & Resins, Rubber and Other Latex Products, Tanning, Dye & Processing Materials.

Module-2

EXTARCTION OF PHYTO CHEMICALS

Brief introduction about extraction process (solvent system used) ,Pre-extraction preparation of plant samples (Fresh vs. dried samples, Grinded vs. powdered samples, Air-drying, microwave-drying, oven-drying and freeze-drying (lyophilisation) of plants samples). Extraction methods (Maceration, infusion, percolation and decoction, Soxhlet extraction or hot continuous extraction, Microwave assisted extraction (MAE), Accelerated solvent extraction, Supercritical fluid extraction). Recovery of solvents.

Module-3

PATHWAY DERIVED METABOLITES

Metabolites Derived From The ShikmateChorismate Pathway: Plant acids, fatty acids and lipids, alkanes and related hydrocarbons, polyacetylenes, sulphur compounds. Nitrogen compounds-amino acids, amines, alkaloids, cyanogenic glycosides, inoles, purines, pyrimidines and cytokinins, chlorophylls.

Metabolites Derived From The Malonic And Mevalonic Acid Pathways: Phenols and phenolic acids, phenylpropanoids, flavonoid pigments, anthocyanins, flavaonols and flavones, tanins, quinones. Essential oils, diterpenoids and gibberellins, triterpenoids, steroids and catotenoids.

Module-4

AUXINS & GIBBERELLINS

Introduction – The emergence of the auxin concept, biosynthesis and metabolism of auxin, auxin transport, physiological effects of auxin, developmental effects of auxin – auxin receptors and signal transduction pathways of auxin.

The discovery of the gibberellins, effects of gibberellin on growth anddevelopment, Biosynthesis and metabolism of gibberellin, physiological mechanisms of gibberellin-induced growth, signal transduction -cereal aleuronic layers.

Module-5

CYTOKININS, ETHYLENE & ABSCISIC ACID

The discovery, identification and properties, Biosynthesis, metabolism and transport of cytokinins, biological roles of cytokinins, cellular and molecular modes of cytokinin action.

Structure, biosynthesis and measurement of ethylene, developmental and physiological effects, cellular and molecular modes of ethylene action- Ethylene receptors

Occurrence, chemical structure and measurement of ABA, developmental and physiological effects of ABA,

ABA Receptors - cellular and molecular modes of ABA action.

Course Outcomes:

- Have knowledge of secondary metabolites.
- Describe different pathways and the metabolites derived from the pathway.
- Understand several important Phyto hormones.
- Analyze different mode of action of Phyto hormones.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Phytochemical Method-- A guide to modern techniques of plant analysis	Harbone J. B.,	Chapman and Hall	Third edition. 2005
2	Plant Physiology	Lincoln Taiz and Eduardo Zeiger	PanimaPublishing corporation	Third edition , 2003
3	Plant Hormones - Biosynthesis, Signal Transduction, Action	Davies, P. J.	Springer	Third Edition, 2010
Reference Books				
1	Methods in Biotechnology – Natural Product Isolation	Sarker, S. D., Latif, Z. and Gray,A.I.	Humana Press	Second Edition 2006
2	Auxin Molecular Biology	Perrot-Rechenmann, C. and Hagen, G	Springer	2002
3	Gibberellins	Takahashi, N., Phinney, B., MacMillan, J.,	Springer	1990.

Web links and Video Lectures: -

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

HUMAN PHYSIOLOGY

Course Code	**18BT643**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives:

- To learn the structure ,organization and function of tissues and skeletal & muscular system
- To learn the major organs and their functions of the digestive and excretory systems
- To learn the major organs and components of the nervous, respiratory and circulator system and understand their functions
- To learn the major endocrine glands and explain the interrelationships between endocrine glands.

Module-1

TISSUES, SKELETAL & MUSCULAR SYSTEM:

Epithelial tissue, Connective tissues (Blood, Bones, cartilages), Muscular tissues, Nervous tissue,
Cartilage and bone; Comparison between cartilage and bone; Functions of skeletal system; Joints; Muscles of limb movement. Principal types of muscles; General properties of muscles; Mechanism of muscle contraction and relaxation, Red and white muscle fibers.

Module-2

DIGESTIVE & EXCRETORY SYSTEM:

Overview of digestive system, functional anatomy of digestive system: mouth, pharynx, oesophagus, the stomach the small and large intestine. Digestive glands, Enzymes; Physiology ofDigestion and Absorption.

Methods of excretion; Physiological processes involved in excretion; Kidneys; Anatomy andphysiology, Nephron and its structure. Functions of nephron; Nephron physiology and mechanism of urine formation; Regulation of urine formation; Osmoregulation by kidney

Module-3

RESPIRATORY & CIRCULATORY SYSTEM:

Introduction; structure of respiratory organs; Mechanism of breathing; pulmonary air volumes, Gas exchange in the lungs. Kinds of respiration; Transport of respiratory gases in the blood
Structure, Composition and functions of blood. Blood Groups and Rh factor. Blood clotting mechanism, Basic anatomy of the heart, Physiology of heart, blood vessels and circulation. Basic understanding of Cardiac cycle, electrocardiogram. Blood pressure and its regulation. Brief outline of cardiovascular disorder like hypertension, hypotension, arteriosclerosis, angina, myocardial infarction, congestive heart failure and cardiac arrhythmias

Module-4

NERVOUS SYSTEM:

Introduction; Role of nervous system; Types of neurons. Types of glial cells and its function. Main properties of nervous tissue Mode of action of nerves; Conduction of nerve impulses; Central nervous system; The brain; The spinal cord; Peripheral nervous system.

Module-5

ENDOCRINE SYSTEM:

Introduction; Endocrine systems of vertebrates; Pituitary gland; Thyroid gland; Parathyroid gland; Pancreas; Adrenal or suprarenal glands; Sex glands; Gastrointestinal mucosa; Thymus gland; Pineal gland; Summary of different endocrine glands; their hormones and influence; Summary of the effect of hyper secretion and hyposecretion of some important endocrine glands.

Course Outcomes:

- Understand the anatomy and physiology relationship of the various tissues in the human body
- Identify the major organs and components of different systems and understand their functions and regulations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbooks				
1	Ross and Wilson Anatomy and Physiology in Health and Illness	Anne Waugh Allison Grant Anne Waugh Allison Grant	Churchill Livingstone	11th Edition 2010
2	Fundamentals of Human Physiology	Lauralee Sherwood	Brooks/Cole, Belmont	4thEdn 2012
3	Essentials of Medical Physiology	Sembulingam K &Prema S	Jaypee Publications,	6th Edn.2012
Reference Books				
1	Essentials of human physiology for pharmacy	Laurie Kelly Mccorry	CRC Press	2nd Edn 2008
2	Concise Medical Physiology	Sujit K Chaudhari	New Central Book Agency Pvt. Ltd	5th Edn 2003
Web links and Video Lectures: -				

ANNEXURE -1

REVISED CONTENTS FOR THE OPEN ELECTIVES -1

	OpenElective –A
Course code under 18BT65X	**Course Title**
18BT651	BIOLOGY FOR ENGINEERS (syllabus Modified)
18BT652	BIOMATERIALS (syllabus Modified)
18BT653	NANOBIOTECHNOLOGY (syllabus Modified)

B.E BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

BIOLOGY FOR ENGINEERS

Course Code	**18BT651**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Objectives:

- To know the fundamentals of biological cellular systems and related class of biomolecules involved.
- To learn about the various bioengineering applications as case studies.
- To explore solving biological problems with engineering knowledge and tools.

Module-1

BASIC CELL BIOLOGY:

Introduction to Biology and Bioengineering concepts, The cell structure (Prokaryotes and Eukaryotes), Cell types (microbial, plant, animal) and their Cell Organelles (Nucleus, Endoplasmic reticulum, Golgi apparatus, Mitochondria, Chloroplast, Lysosome, Peroxisome etc.), Cell cycle and cell division (Mitosis and Meiosis), Factors affecting cell growth (Prokaryotes - Bacteria and Eukaryotes – Somatic Cells), Stem cells - types and their applications. Cancer and its types (carcinoma, sarcoma, melanoma, lymphoma, and leukemia), Cell staining and imaging (Gram staining, Fluorescence staining), cell sorting and counting (FACS – its principle and instrumentation).

Module-2

BIOMOLECULES:

Qualitative information about Biomolecules (Carbohydrates, Lipids, Amino acids and Proteins, Nucleic acids – classification, source and their functions. Vitamins and Hormones – types and functions (qualitative). Bonds in Biomolecules (covalent and non-covalent); basic unit of life: double helical structure of DNA, Central dogma of biology: DNA to RNA to Protein; DNA Replication (qualitative), Protein synthesis - Transcription and translation as a flow diagram, Protein architecture (primary, secondary, tertiary and quaternary with examples) and their specific functions.

Module-3

ENZYMES AND APPLICATIONS:

Enzymes and classification (6 classes), comparison of chemical catalysts and enzymes, Active site, Enzyme action (Lock & key and Induced fit hypothesis), Catalysis - factors affecting (temperature, pH, substrate concentration, Enzyme concentration and inhibitors – reversible and irreversible), Enzyme Immobilization and their applications, Applications of enzymes (cellulases in textile and paper industry, amylases food and baking industry, proteases in food and leather industry, lipases in detergents and biofuels, carbonic anhydrase in fermentation industry, restriction enzymes in genetic engineering). Enzymes in glucose biosensor and urea biosensor.

Module-4

BIOMATERIALS AND BIOMECHANICS:

Introduction, Biomaterials and its properties, scaffolds and body implants. Collagen, silk fibroin, heparin and heparin-like polysaccharides, proteoglycans, microbial glycosaminoglycan, Gelatin - their

applications. Surface immobilization of biomaterials. Biomaterials in cell growth and culture, biomaterials in wound healing. Protein as biological motors/molecular machines (rotatory – ATP synthase complex and Flagella and linear – kinesin, Dynein and myosin).

Module-5

BIOENGINEERING APPLICATIONS:

Basics concepts of Biodesigns/Biomimicry/Biomimetics (learning from spider, gecko feet, flight of birds, shape of beaks), Qualitative correlation of Eye as a Camera, Heart as a pump, Kidney as a filtration system, Lungs as purification system. Bioprinting techniques, 3D printing of ear, cornea, bone and skin. Biosensors - Electrical tongue and electrical nose, DNA origami and superconducting nanowires, Robotic arms for prosthetics / spastics. ECG monitoring and heart related issues, EEG and its monitoring in neurological disorders (Alzheimer's, Parkinson's, paralysis, and epilepsy). Examples related to Bioconcrete (production of calcium carbonate through bio mineralization) and Bioremediation (for removal of heavy metals like Lead, Cadmium, Mercury and Arsenic).

Course outcomes:

- To understand the fundamentals of biological cellular systems and related class of biomolecules involved.
- To analyze the various bioengineering applications and their merits, in the domains like biomechanics, biomaterial sciences, bio-design, biosensors, bioremediation etc.
- To apply bioengineering knowledge and tools for solving societal relevant problems.

Question paper pattern:

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions (with a maximum of four sub- questions) from each module.
4. Each full question will have sub- question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Sl. No.	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
Text Books				
1.	Biology for Engineers	ThyagaRajan.S., Selvamurugan. N., Rajesh.M.P.,Nazeer.R.A., Richard W. Thilagaraj, Barathi.S., and Jaganthan.M.K	Tata McGraw Hill	2012
Reference Books				
1.	Biochemistry	Jeremy M. Berg, John L. Tymoczko and LubertStryer	W.H. Freeman and Co. Ltd.	6th Ed., 2006.
2.	Robert Weaver	Molecular Biology	MCGraw-Hill	5th Edition, 2012.
3.	Biosensors - A Practical Approach	Jon Cooper	Bellwether Books	2004
4.	Biodegradation and Bioremediation	Martin Alexander	Academic Press,	1994
5.	Biomaterials - Science and Engineering	J B Park	Plenum Press	1984
6.	Fundamental of Biomechanics	Duane Knudson	Springer	2007
Web links and Video Lectures				

B.E BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

BIOMATERIALS

Course Code	**18BT652**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Objectives:

- To learn about various biomaterials and its properties,
- To learn about the manufacturing methods of some of the biomaterials
- To learn about the applications of biomaterials

Module - 1

INTRODUCTION:
Introduction, Historical developments, Implants and implant materials, Performance, thermal treatments, surface improvements, sterilization and applications of metallic, composites, ceramics, biodegradable polymers and hydrogels, carbon materials. Examples include Stainless steel, Cobalt-Chromium alloys, Titanium based alloys, Nitinol, other metals, Carbons, Alumina, Yttria stabilized zirconia.

Module-2

BIOPOLYMERS:
Polymers as biomaterials, microstructure, mechanical properties – effects of environment on elastic moduli, yield strength and fracture strengths, Biocompatibility of polymers, heparin and heparin-like polysaccharides, proteoglycans, heparin like substances from non-glycosaminoglycan polysaccharides and microbial glycosaminoglycan, surface immobilized heparins..

Module-3

SYNTHETIC POLYMERS:
Polymers in biomedical use, polyethylene and polypropylene, perfluorinated polymers, acrylic polymers, hydrogels, polyurethanes, polyamides, biodegradable synthetic polymers, silicone rubber, plasma polymerization, micro-organisms in polymeric implants, polymer sterilization.

Module-4

BIOCOMPATIBILITY:
Definition, Wound healing process-bone healing, tendon healing. Material response: Function and Degradation of materials in vivo. Tissue response to biomaterials, Methods of test for biological performance, In vitro implant tests, Qualification of implant materials. Tissue replacement biomaterials (soft and hard).

Module-5

CARDIOVASCULAR BIOMATERIALS:
Tissue properties of blood vessels, Treatments of atherosclerosis; Biomechanical design issues pertaining to stents, balloon angioplasty, and pacemakers. Soft Tissue Reconstruction; Natural and Synthetic. Wound healing. Tissue ingrowths: Stability; Biofixation, Foreign Body response, Soft implants. Case Studies. Tissue Engineering: Current issues and Future Directions

Course outcomes:

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Question paper pattern:

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions (with a maximum of four sub- questions) from each module.
4. Each full question will have sub- question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Sl. No.	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
Text Books				
1	Biomaterials Science : An Introduction to materials in Medicine	Buddy D Ratner	Academic Press	1996
2.	Biomaterials, Medical Devices and Tissue Engineering	Frederick H	Chapman and Hall	1994
3.	Biomaterials	Sujata V. Bhat	Narosa Publishing House	2002
Reference Books				
1.	Biomaterials - Science and Engineering	J B Park	Plenum Press	1984
2.	Polymeric Biomaterials	Piskin and A S, Hoffmann, MartinusNijhoff	Springer	1986
Web links and Video Lectures				

B.E BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

NANOBIOTECHNOLOGY

Course Code	**18BT653**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Objectives:

- To understand the field of nano-biotechnology,
- To learn the principles behind nanobiotechnology
- To comprehend the current applications of nanobiotechnology and its scope

Module - 1

INTRODUCTION:

A Brief History, Definition of nanotechnology, Nano*bio*technology v/s Bionanotechnology, Bottom-Up versus Top-Down approaches; Methods of synthesis of nanoparticles – Physical (bead mill, laser ablation) chemical (sol-gel, precipitation, chemical reduction) and biological (use of microbes, enzymes, plant materials), parameters affecting nanoparticle growth, shape, size and structure. Structure-property relationships in materials, Nanolithography-UV and electron beam. Fabrication in Soft Materials: Hydrogels/PDMS/other polymers for biological applications.

Module-2

NANOMATERIALS AND THEIR CHARACTERIZATION

Fullerenes - Buckyballs, carbon nanotubes, Carriers, Dendrimers, Nanoparticles, Nanocomposites, Nanoshells, Quantum Dot, Principle, Instrumentation and applications of UV, FTIR, Raman shift, Surface Plasmon resonance (SPR), SEM, TEM, Atomic force microscopy Dynamic light scattering (DLS), XRD.

Module-3

NANOMOLECULAR DIAGNOSTICS:

Rationale of Nanotechnology for molecular diagnostics, Bio-functionalization methods,Nanoparticles like Gold, Quantum Dots, and Magnetic Nanoparticles in diagnostics, Bio-nanohybrids-with relevant applications. Nanopore technology, Nano arrays. Nanobiosensors: cantilever, carbon nanotube, nanowires. Pathogen detection by magnetic nanoparticle-based techniques. Nanobiotechnological applications in Environment and Food - detection and mitigation of pollutants and adultrants. Miniaturized devices in nanobiotechnology - types and applications, lab on a chip concept.

Module-4

BIOMEDICAL AND LIFE SCIENCES APPLICATIONS:

Introduction to nanomedicine, nanocapsules, nanorobots, nanopharmacology. Use of micro needles and nanoparticles for local highly controlled drug delivery. Nanotechnology products and applications in ocular, oncology, neurology and cardiology. Functions and applications of DNA based nanostructures, Biomimetic fabrication of DNA based metallic nanowires and networks, Biomolecularnanomotors (ATP synthase complex and flagella).

Module-5

ETHICS, SAFETY AND REGULATORY ASPECTS

Introduction, ethical, legal and social implications of Nano medicine, and nano-bio-products, Safety concerns - Health Risks, and Challenges. Assessment of the toxic effects of nanoparticles based on *in-vitro & In-Vivo experiments.* Case studies. Environmental effects, public perceptions, Guidelines and regulatory aspects and evaluation of Nano pharmaceuticals in India, Europe and USA, challenges and risks associated with Markets for Nano medicine. Trends in Research and education.

Course outcomes:

- Define nano-biotechnology as an emerging field and its scope.
- Understand the principles and applications of the technology in various fields

Question paper pattern:

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions (with a maximum of four sub- questions) from each module.
4. Each full question will have sub- question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Sl. No.	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
Text Books				
1	Nanobiotechnology: Concepts, Applications and Perspectives	Niemeyer, C.M. and Mirkin C A	Wiley-VCH	2004
2	Nanobiotechnology Protocols	Rosenthal, Sandra J and Wright, David W.,	Humana Press.	2005
3	Biological molecules in Nanotechnology	Stephen Lee and Lynn M Savage	International Business Communications, Inc.	1998
Reference Books				
1.	Nanobiotechnology: Bioinspired devices and materials	Shoseyov, O. and Levy, I.,	Humana Press	2007
2.	Nanobiotechnology Human Health and the Environment	AlokDhawan, Sanjay Singh, Ashutosh Kumar, Rishi Shanker	CRC Press	2018
Web links and Video Lectures				

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

PROCESS CONTROL & AUTOMATION LABORATORY

Course Code	**18BTL66**	CIE Marks	40
Teaching Hours/Week	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: This course will enable students to
• Understand the basics of process dynamics principles and instrumentation
• Study various types of input functions and its response
• Perform computational modelling to study different types of controllers
• Learn various sensors, and their control using computer that are industrially important.
• Study of properties of control systems will be dealt.

Sl. No.	Experiments
1.	Dynamics of First order system (mercury thermometer) for step input and impulse input
2.	Non-interacting system responses to step input
3.	Non-interacting system responses to pulse input
4.	Interacting System responses to step input
5.	Interacting System responses to pulse input
6.	Characteristics of Transducers (Temperature)
7.	Characteristics of Transducers (Pressure)
8.	Characteristics of Transducers (Flow)
9.	Temperature controller – responses to set point / load change
10.	pH controller – responses to set point / load change
11.	Control of DO (Dissolved Oxygen)level
12.	Control of Agitation (to monitor DO since they are interlinked)

Course Outcomes: After studying this course, students will be able to:

- Understand the basics of instrumentation , classification, various input function of automatic process control system
- Classify and characterize the transducers based on critical process parameters
- Demonstrate the working of First order systems and controllers.
- Calculate and Analyze the output obtained from different systems and perform theoretical validation

Conduct of Practical Examination:
1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

Reference Books:
1. Process System analysis and Control by Donald R Coughanowr, McGraw-Hill.
2. Chemical Process Control by George Stephanopoulos, Prentice-Hall of India
3. Process dynamics and control by D E Seborg, T F Edger, John Wiley.

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

BIOINFORMATICS LABORATORY

Course Code	**18BTL67**	CIE Marks	40
Teaching Hours/Week	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives:

- describe the fundamental concepts of bioinformatics
- explain the uses of various biological databases
- apply online resource tools

Sl. No.	Experiments
1	Bibliographic search and Sequence retrieval from Nucleic acid and Protein databases. (Retrieval of homologs, paralogs, orthologs, and xenologs)
2	Pair wise comparison of sequences – Analysis of parameters affecting alignment
3	Multiple alignments of sequences and pattern determination using PROSITE
4	Evolutionary studies / Phylogenetic analysis – Analysis of parameters affecting trees
5	Identification of functional sites in Genes / Genomes
6	Secondary structure prediction of proteins and nucleic acid (DNA/RNA)
7	Study of posttranslational modifications using relevant tools
8	Restriction mapping: Analysis of maps for suitable molecular biology experiment
9	Primer Design: Factors affecting primer design.
10	PDB structure retrieval and visualization: Analysis of homologous structures + Superposition of structures – Calculation of RMSD
11	Comparative Modeling of homologous sequences and validation of modeled structures
12	Determination of ligand-protein interactions using SPDBV/ LIGPLOT
13	Docking studies – Analysis of substrate / ligand binding using homologous structures
14	Derivation of pharmacophore patterns for selective ligands

NOTE: Minimum 12 Experiments

Course Outcomes: After studying this course, students will be able to:

- understand fundamental concepts of bioinformatics
- apply online resource tools
- solve sequence alignment problems
- design primers and peptide sequence

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.■

REFERENCE BOOKS:

1. Bioinformatics by Andreas D Boxevanis. Wiley Interscience.
2. Bioinformatics by David W Mount, cold spring harbor.
3. Bioinformatics: A biologist's guide to biocomputing and the internet. Stuart M Brown, NYU Medical Center, NY USA.

****** END ******

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

BIOPROCESS ENGINEERING

Course Code	**18BT71**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:1:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: This course will enable students to

- Define the fundamentals of downstream processing for biochemical product recovery.
- Understand the concepts of secondary metabolite production, the strategies for biochemical process synthesis, biochemical product recovery.
- Assess the impact of change in unit's operations and the impact on the process.
- Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future.

Module-1

FERMENTATION TECHNOLOGY:

Introduction to Fermentation technology: Types of fermentation Process – submerged and solid state fermentation. Modes of fermentation – Batch, continuous and fed-batch, Principle components of fermentor. Microbial growth kinetics and Optimization of fermentation process. Strategies to optimize product yield. Production of primary and secondary metabolites. Process design criteria for various classes of byproducts (high volume, low value products and low volume, high value products), Microbiology of brewing (Distilled and non-distilled beverages with examples).

Module-2

PRODUCTION OF SECONDARY METABOLITES:

Enumeration and screening of novel microbial primary and secondary metabolites, strain improvement strategies. Preservation of microbial culture. Secondary metabolite production-strategies for optimizing product yield, culture conditions, selection of high yielding lines, elicitation. Factors affecting secondary metabolites, industrial application of secondary metabolites. Production of antibiotics.

Module-3

DOWNSTREAM PROCESSING AND PRIMARY SEPARATION TECHNIQUES :

Role and importance of downstream processing. Problems and requirements of byproduct purification. Economics of downstream processing and cost cutting strategies,

Cell disruption methods for intracellular products, removal of insoluble, biomass (and particulate debris) separation techniques; flocculation and sedimentation, Centrifugation (ultra and differential) , filtration methods andPrecipitation methods with salts, organic solvents, and polymers, extractive separations. Aqueous two phase extraction, supercritical extraction; In situ product removal / integrated bioprocessing.

Module-4

MEMBRANE SEPARATION & ENRICHMENT OPERATIONS :

Membrane – based separations theory; Design and configuration of membrane separation equipment; Solute polarization and cake formation in membrane ultra-filtration – causes, consequences and control techniques; Use of membrane diffusion as a tool for separating and characterizing naturally occurring polymers; separation by solvent membranes; reverse osmosis.

Module-5

PRODUCT IDENTIFCATION AND RECOVERY :

Principle and Applications of Electrophoresis - their types. Chromatographic separation processes:Principles and protocols of Chromatographic techniques: Thin layer chromatography: Single dimensional (Both Ascending and Descending) and two dimensional chromatography, Adsorption column chromatography. Ion Exchange Chromatography, Affinity Chromatography Gel Filtration Chromatography, Gas Chromatography, High Performance liquid chromatography (HPLC) – analytical and preparative.

Course Outcomes: At the end of the course the student will be able to

- Study and design various statistical problems

- Describe the factors affecting secondary metabolite production and its industrial importance.
- Identify and summarize the effect of change in unit's operations and its impact on the process.
- Illustrate how emerging technologies would benefit the bio chemical product recovery and show the likely benefits it would have over the traditional operations.
- Analyzing both analytical and process validation issues that are critical to successful manufacturing.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Principles of fermentation Technology	P.F. Stanbury and A. Whitaker	Pergamon Press	3rd edition, 2016
2	Animal Cell Technology	AshokMukhopadaya y	IK Intl. Ltd	1st edition, 1994
3	Downstream Process Technology – A new horizon in Biotechnology	Nooralabetta Krishna Prasad	PHI Learning Private Limited	2010
4	Bioseparation – Downstream processing for biotechnology	Belter P.A., Cussier E. and Wei Shan Hu	Wiley Interscience Pub	1987
5	Separation Processes in Biotechnology	Asenjo J. *et al.*,	Marcel Dekker Publications	1st edition, 1990
Reference Books				
1	Animal Cell biotechnology	R.E. Spier and J.B. Griffiths	Academic press	1985
2	Bioprocess Engineering	Shule and Kargi	Prentice Hall	1992
3	Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression	Wolf R. Vieth	Wiley – Interscience Publication	1st edition, 1994
4	Bioseparation Engineering	Ajay Kumar	IK Intl.Ltd	2006

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

CLINICAL & PHARMACEUTICAL BIOTECHNOLOGY

Course Code	**18BT72**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(4:0:0)	SEE Marks	60
Credits	04	Exam Hours	03

Course Learning Objectives: This course will enable students

- to learn about drug design, formulation
- to understand importance of pharmacokinetics & pharmacodynamics study
- To list the applications & advantages of Pharmaceutical & Clinical Biotechnology

Module-1

DRUG MANUFACTURE AND FORMULATION:

Introduction to pharma industry, Biotechnology and Drug design, Basic concepts and applications, composition, preparation, physicochemical considerations in manufacture of current biotech products & herbal medicines. Need of formulation and formulation development considerations. Concept & testing of preformulation& their parameters. Tablets: compressed, granulation, coatings, pills, capsules. Parental preparations, herbal extracts, Oral liquids, Ointments. Analytical methods and tests for various drugs, packaging techniques- Glass containers, plastic containers, film wrapper, bottle seals; storage and stability of biotech products.

Module-2

PHARMACOKINETICS AND PHARMACODYNAMICS:

Pharmacodynamics and Pharmacokinetics of protein based drugs. Disease target identification and selection, receptor-based approaches, agonists, antagonists, enzyme inhibitors Basic concepts, ADME definitions, Need of pharmacokinetic study; Interpretations from pharmacokinetics parameters, Examples of Pharmacodynamic parameters of various drugs; Evolution of Drug Metabolism Phase I Metabolism (microsomal oxidation, hydroxylation, dealkylation) Phase II Metabolism (Drug conjugation pathway) CYP Families- case study

Module-3

PHARMACOTHERAPY

Classification of drugs based on therapeutic actions using suitable examples Special emphasis on Vitamins, cold remedies, laxatives, analgesics, non-steroidal contraceptives, external antiseptics, antacids, antibiotics, biologicals, herbal products. Pharmacotherapy of migraine, cancer, TB, diabetes and male sexual dysfuntion. Hormone replacement therapy.

Module-4

BIOTHERAPEUTICS AND STEM CELLS

Clinical importance of Therapeutic Proteins and Enzymes; Hormones and Growth Factors used as therapeutics (erythropoietin & insulin as examples). Interferons, Interleukins, Preservation and clinical use of blood and blood components, principles and safety guide lines for blood transfusion. Advanced Sustained Release, Advanced drug Delivery Systems: Liposomes and Nanoparticles, biodegradable drug delivery system (hydrogel based).

Module-5

CLINICAL RESEARCH:

The philosophy behind and organization of clinical research. Pre-clinical development to support testing in humans: In vitro and in vivo testing of new compounds, Relationship between animal and human pharmacology. Safety testing – acute, sub acute toxicology, immunotoxicology, Concepts of pharmacovigilance, General principles and guide to data sources, types of epidemiology study designs, ecological (correlation) studies, case reports, prevalence surveys or cross-sectional studies, case control studies, Clinical trials-informed consent, Placebo Responses, Clinical Registries. Clinical Research Institutes, Data Management, Clinical Research from Pharmaceutical Industry.

Course Outcomes: At the end of the course the student will be able to:

- Explain the significance of pharmaco-kinetic models, pharmaco-dynamic principles, various dosage forms and formulation.

- Understand the specific techniques used in biotherapy & clinical Biotechnology
- Comprehend specific applications of pharmaceutical & clinical Biotechnology

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Biochemistry and Biotechnology	Gary Walsh	John Wiley & Sons Ltd	2002
2	Principles and Practice of Clinical Research	J. I. Gallin and F. P. Ognibene	Elsevier Publication	4th Edition 2017
3	Current Trends in Pharmacology	Arunabha Ray &KavithaGulati	IK Intl	2007
4	An Introduction to Synthetic Drugs	Singh &Rangnekar	Himalaya publishing House	1980
Reference Books				
1	Biopharmaceuticals, Biochemistry and Biotechnology	Gary Walsh	Wiley Pub	1998
2	Principles of Medicinal Chemistry	Foye	Lippincott Williams & Wilkins Publishers	Sixth Edition 2008
3	Industrial Pharmaceutical Biotechnology	Heinrich Klefenz	Wiley-VCH edition	2002

PROFESSIONAL ELECTIVE - 2

B. E. BIOTECHNOLOGY **Outcome Based Education (OBE) and Choice Based Credit System (CBCS)** **SEMESTER - VII**			
PROCESS EQUIPMENT& PLANT DESIGN			
Course Code	**18BT731**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students

- To understand the basic concepts of flow sheeting, material and energy balances and process development.
- To understand the factors necessary for feasibility of the process,
- To estimate capital investment, total product costs, depreciation, cash flows, and profitability,
- Analyze capital investment based on cash flows and breakeven chart

Module-1

PROCESS DESIGN DEVELOPMENT & GENERAL DESIGN CONSIDERATIONS:
Design project procedure, design information from the literature and other sources of information, flow diagrams, and comparison of different processes, firm process design, equipment design and specialization, scale up in design, safety factors specifications, materials of construction, detailed study of general design considerations. Optimum design and design strategy.

Module-2

CAPITAL INVESTMENTS, MANUFACTURING COSTS AND PLANT OVERHEADS:
Factors involved in project cost estimation, Fixed capital investments including land, building, equipment and utilities, installation costs, working capital investments. Manufacturing Costs: Direct Production costs, fixed charges.
Plant Overheads**:** Administration, safety and other auxiliary services, payroll overheads, warehouse and storage facilities etc.

Module-3

COST ANALYSIS:
Methods employed for the estimation of the capital investment. Estimation of working capital.

Module-4

DEPRECIATION, TAXES AND FINANCIAL STATEMENTS:
Depreciation calculation methods. Equivalence after Taxes. Cost comparison after taxes. Cash flow diagrams. Break-even analysis**.** Conceptual numericals.

Module-5

PROFITABILITY ANALYSISAND TIME VALUE OF MONEY:
Methods for the evaluation of profitability. Return on original investment, interest rate of return, accounting for uncertainty and variations and future developments. Replacement and Alternative Investments. Opportunity costs. Time value of money and equivalence. Conceptual numericals.

Course Outcomes: At the end of the course the student will be able to

• Understand concepts of process design and project management
• Understand the factors of general design considerations
• Synthesize feasible and optimum flow-sheet
• Estimation of capital investment, total product costs, and profitability

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Text Book/s				
1.	Bioprocess Engineering Principles	Pauline M. Doran	Academic Press	2nd Edition 2012
2.	Chemical Engineering Vol. VI - An introduction to Chemical Engineering Design	Coulson J.M. and Richardson	J.F Pergamon Press	6th Edition 1999
3.	Process Equipment Design	Joshi M.V	MacMillan India Ltd	1976
4.	Plant Process Simulation	B V Babu	Oxford University Press	2004
Reference Books				
1	Plant Design and Economics for Chemical Engineers	Peters and Timmerhaus	McGraw Hill	fifth edition 2002
2	Process Plant Design	Frank Peter Helmus	Wiley-VCH	2008
3	Process Plant Design	J.R Backhurst& J. H Harker	Heieman Educational Books	1973

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

BIOREACTOR DESIGN CONCEPTS

Course Code	**18BT732**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to

- Understand the fundamentals of reactor design,
- Specify design criteria for medium sterilization
- Understand the design a complete bioreactor based on targets, constraints and physical properties.
- Apply mass and heat transfer correlations to bioreactor design.
- Identify suitable process instrumentation for monitoring and control of bioreactors.

Module-1

FUNDAMENTALS OF REACTOR DESIGN & MEDIA REQUIREMENTS:

Microbial growth and product formation kinetics, Thermal death kinetics of microorganisms, Heterogeneous reaction kinetics, Enzyme kinetics, Multiple reactions – series, parallel and mixed. Basic Design Equations/ Mole Balances: Batch, Fed Batch and Repetitive Batch Reactors, Continuous: Stirred tank and tubular flow reactors

Microbial death kinetics. Design criterion for sterilization. Batch and continuous sterilization of medium. Air sterilization

Module-2

BIOREACTOR REQUIREMENTS & NON ISOTHERMAL REACTORS:

Fermentation Process – General requirements; Basic design and construction of fermenters and its ancillaries; Material of construction, Vessel geometry, Bearing assemblies, Motor drives, Aseptic seals; Flow measuring devices, Valves, Agitator and Sparger Design, Sensors.

Bioprocess and bioreactor design considerations for plant and animal cell cultures. Effect of media on reactor design.

Non-isothermal homogeneous reactor systems. Adiabatic reactors, batch and continuous reactors, optimum temperature progression

Module-3

MASS TRANSFER EFFECTS:

External mass transfer limitations, correlations for stirred tank, packed bed and fluidized bed reactors. Internal mass transfer limitations, correlations for stirred tank, packed bed and fluidized bed reactors. Combined effect of heat and mass transfer effects Mass transfer in heterogeneous biochemical reaction systems; Oxygen transfer in submerged fermentation processes; Oxygen uptake rates and determination of oxygen transfer coefficients (kL_a); role of aeration and agitation in oxygen transfer. Heat transfer processes in biological systems. Conceptual numericals.

Module-4

DESIGN OF FERMENTORS:

Process and mechanical design of fermenters, volume, sparger, agitator – type, size and motor power, heat transfer calculations for coil and jacket, sterilization system.

Module-5

NOVEL BIOREACTORS DESIGN:

Design of Immobilized enzyme packed bed Reactor. Fluidized bed reactors, Slurry Reactors, Air lift & Loop reactors, Packed bed and Hollow fiber membrane bioreactors, Bioreactors for waste treatment processes; Scale-up of bioreactors, SSF bioreactors. Conceptual numericals.

Course Outcomes: After studying this course, students will be able to:

• Design culture medium based on nutritional requirements of microbial cells.

• Specify design criterion for medium sterilization and solve problems involving both batch and continuous sterilization.

• Understand the bioreactor performance.

• Apply mass and heat transfer correlations to bioreactor design. • Design a complete bioreactor based on targets, constraints and physical properties.
Question paper pattern: • The question paper will have ten full questions carrying equal marks. • Each full question will be for 20 marks. • There will be two full questions (with a maximum of four sub- questions) from each module. • Each full question will have sub- question covering all the topics under a module. • The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Bioprocess Engineering – Kinetics, Mass Transport, Reactors and Gene Expression	Wolf R. Vieth	A Wiley – Interscience Publication	1994
2	Chemical Kinetic Methods: Principles of relaxation techniques	Kalidas C	New Age International	1996
3	Chemical Reactor Analysis and Design	Forment G F and Bischoff K B	John Wiley	1990
Reference Books				
1	Biochemical Engineering Fundamentals	Bailey and Ollis	McGraw Hill	1986
2	Elements of Chemical Reaction Engineering	Fogler, H.S	Prentice Hall.	3rd edn 2004
3	Chemical Reaction Engineering	Levenspiel O	John Wiley	1979

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

TRANSPORT PHENOMENA

Course Code	**18BT733**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students

- To understanding of the conservation laws that govern mass, momentum and heat transfer.
- To derive and solve the ordinary and partial differential equations that result from the application of the conservation laws to specific systems.
- To formulate and solve mathematical models for physical situations

Module-1

MOMENTUM TRANSFER AND OVERALL BALANCES

Fluid Statics, General molecular transport equations for momentum, heat and mass transfer, Viscosity of fluids, Overall balances: mass balance/continuity equation, energy balance, momentum balance, shell momentum balance and velocity distribution in laminar flow, design equation for laminar and turbulent flow in pipes, compressible flow of gases.

Module-2

MOMENTUM TRANSFER – PRINCIPLES AND APPLICATIONS

Flow past immersed objects, packed and fluidized beds, Non-Newtonian fluids, Differential equations of continuity, momentum transfer (motion), use of these equations, other solution methods for differential equation of motion, boundary layer flow and turbulence, dimensional analysis in momentum transfer.

Module-3

STEADY STATE HEAT TRANFER

Mechanisms of heat transfer, conduction – through solids in series, steady state conduction and shape factors, Forced convection - heat transfer inside pipes, heat transfer outside various geometries, natural convection heat transfer, boiling and condensation, heat exchangers, radiation heat transfer (basic and advanced), heat transfer to non-Newtonian fluids, special heat transfer coefficients, dimensional analysis in heat transfer, numerical methods for steady state heat transfer in two dimensions.

Module-4

UNSTEADY STATE HEAT TRANSFER

Derivation of basic equation, simplified case for systems with negligible internal resistance, unsteady state heat transfer in various geometries, finite difference methods, differential equation of energy change, boundary layer flow and turbulence in heat transfer.

Module-5

MASS TRANSFER

Mass transfer and diffusion, molecular diffusion in gases, liquids, biological solutions and gels,and solids, numerical methods for steady state molecular diffusion in two dimensions. Unsteady state diffusion, convective mass transfer coefficients, for various geometries, masstransfer to suspensions of small particle, molecular diffusion plus convection and chemicalreaction, diffusion of gases in porous solids and capillaries, numerical methods for unsteady statemolecular diffusion, dimensional analysis in mass transfer, boundary layer flow and turbulencein heat transfer.

Course Outcomes:

- Understand the conservation laws that govern mass, momentum, and heat transfer.
- Derive and solve the ordinary and partial differential equations that result from the application of the conservation laws to specific systems.
- Formulate and solve mathematical models for physical situations.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.

- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Transport Processes and Separation Process Principles	C. J. Geankoplis	Prentice Hall	1978
2	Momentum, Heat and Mass Transfer	Bennett and Myers	Tata Mcgraw Hill	1982
3	Transport Phenomena	Bird, Stewart, Lightfoot	JWI	2nd Edn 2002
4	Fundamentals of Fluid Mechanics	Sawhney GS	IK Publishers	2008
Reference Books				
1	Unit Operations of Chemical Engg	McCabe & Smith	M G H Publications	2004
2	Transport Processes and Unit Operations	CHRISTIE J. GEANKOPLIS	Prentice Hall	3rd Edn 1993
3	Fluid Mechanics	K L Kumar	S.Chand Publishers	2008

PROFESSIONAL ELECTIVE - 3

B. E. BIOTECHNOLOGY **Outcome Based Education (OBE) and Choice Based Credit System (CBCS)** **SEMESTER - VII**			
BIOETHICS , BIOSAFETY & IPR			
Course Code	**18BT741**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: : This course will enable students

- To introduce the biosafety regulations
- To understand the ethical concepts in biotechnology
- To emphasize on IPR issues and need for knowledge in patents in biotechnology

Module-1

BIOTECHNOLOGY AND SOCIETY

Introduction to science, technology and society, issues of access-Case studies/experiences from developing and developed countries. Ownership, monopoly, traditional knowledge, biodiversity, benefit sharing, environmental sustainability, public vs. private funding, biotechnology in international relations, globalization and development divide. Public acceptance issues for biotechnology: Biotechnology and hunger: Challenges for the Indian Biotechnological research and industries.

Module-2

BIOETHICS & LEGAL ISSUES:

Principles of bioethics: Legality, morality and ethics, autonomy, human rights, beneficence, privacy, justice, equity etc. The expanding scope of ethics from biomedical practice to biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

The legal, institutional and socioeconomic impacts of biotechnology; biotechnology and social responsibility, Public education to increase the awareness of bioethics with regard to generating new forms of life for informed decision making – with case studies.

Module-3

BIOSAFETY CONCEPTS AND ISSUES:

Ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, Rational vs. subjective perceptions of risks and benefits, relationship between risk, hazard, exposure and safeguards, Biotechnology and biosafety concerns at the level of individuals, institutions, society, region, country and the world. The Cartagena protocol on biosafety. Biosafety management. Ethical implications of biotechnological products and techniques.

Module-4

REGULATIONS:

Biosafety assessment procedures in India and abroad. International dimensions in biosafety, bioterrorism and convention on biological weapons. Social and ethical implications of biological weapons. Biosafety regulations and national and international guidelines with regard to recombinant DNA technology. Guidelines for research in transgenic plants. Good manufacturing practice and Good lab practices (GMP and GLP). National and international regulations for food and pharma products.

Module-5

IPR, PATENTS AND PATENT LAWS:

Intellectual property rights-TRIP- GATT International conventions patents Methods of application of patents Legal implications Biodiversity and farmer rights

Objectives of the patent system Basic principles and general requirements of patent law Biotechnological inventions and patent law .Legal development-Patentable subjects and protection in biotechnology .The patenting of living organisms.

Course Outcomes: At the end of the course the student will be able to

- Describe the rules governing manufacture, use/import/export and storage of hazardous microorganisms/genetically engineered organisms or cells.
- Describe the ethical issues related to biotechnology research

- Explain the various forms of IPR, methods of application of Patents, Protection of Plant varieties and farmer rights
- Overview of the Indian Patent Law, knowledge on patentability requirements, patenting biotechnological inventions and innovations

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Biotechnology and Safety Assessment	Thomas J.A., Fuch R.L	Academic Press	3rd Edition 2002
2	Biological safety Principles and practices	Fleming D.A., Hunt D.	ASM Press	3rd. ed. 2000
3	Bioethics	Ben Mepham	Oxford University Press	2008
4	Bioethics & Biosafety	R Rallapalli & Geetha Bali	APH Publication	2007
Reference Books				
1	Bioethics &biosaftey	Sateesh MK	IK Publishers	2008
2	Biological Warfare in the 21st century	M.R. Dando	Brassies London	1994
3	Biosafety Management	P.L. Traynor	Virginia polytechnic Institute Publication	1999

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

AGRICULTURAL BIOTECHNOLOGY

Course Code	**18BT742**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: : This course will enable students

- To know about chronology and importance of ancient Indian agriculture techniques
- To gain knowledge on basic concepts of plant nutrition, maturity indices and post harvest losses
- To learn and apply the fundamental aspects of organic farming
- To understand concepts involved in nitrogen fixation and apply knowledge of molecular farming for production of industrial important plant products.

Module-1

INTRODUCTION TO AGRICULTURAL BIOTECHNOLOGY:
Origin of cultivated plants and plant indication, Introduction to Indian Agriculture heritage; Soil management and its relevance in Pre-modern India. Review of plant cell structure and function; Review of water uptake; Introduction to plant nutrition; Mineral availability- uptake of minerals; Methods of breeding self-pollinated and vegetatively propagated plants; Seed Germination and Seedling Growth; Photoperiodism and its significance; Vernalization and hormonal control. Heterosis – Genetic and Molecular basis, Apomixis – Mechanism and significance in crop improvement.

Module-2

POST HARVEST BIOTECHNOLOGY:
Importance of post harvest physiology; Stages of growth; Maturity indices; Fruit ripening- changes during ripening; Post harvest losses-types; Technologies to control post harvest losses; Respiration and transpiration loss, methods to measure respiration and transpiration losses; Spoilage of fruit and vegetable, Microbial contaminants and post-harvest pathology; Potential application of biotechnology to reduce post harvest losses; Enzymatic browning and its control.

Module-3

BIOTIC AND ABIOTIC STRESS BIOLOGY:
Introduction to biotic stresses, types. Application of plant transformation – bt genes, Structure and function of Cry proteins – mechanism of action, critical evaluation. Non bt like protease inhibitors, alpha amylase inhibitor, Transgenic technology for development of virus, bacterial and fungal resistance plants. Concept of plasticity in plant development; Abiotic stress – Introduction to drought and salinity stresses, transgenic strategies for development of drought resistant plants, case studies.

Module-4

BIOTECHNOLOGY IN ORGANIC FARMING:
Organic farming, principles and its scope in India; Organic ecosystem and their concepts; Role of Biotechnology in organic nutrient resources and its fortification; Restrictions to nutrient use in organic farming; Choice of crops and varieties in organic farming; Biotechnology in fundamentals of insect, pest, disease and weed management under organic mode of production; Integrated compost production- microbe enriched compost; Important industries producing Biopesticides.

Module-5

MOLECULAR FARMING AND NITROGEN FIXATION:
Molecular farming for the production of industrial enzymes, biodegradable plastics, polyhydroxybutyrate, antibodies, edible vaccines; Use of mutants in crop improvement and polyploidy; Metabolic engineering of plants for the production of fatty acids, industrial oils, flavonoids etc., Engineering of carotenoid and provitamin biosynthetic pathways.
Nitrogen fixation and biofertilizers – Diazotrophic microorganisms, nitrogen fixation genes; Two component regulatory mechanisms; Transfer of nif genes and nod genes – structure, function and role in nodulation; Hydrogenase - Hydrogen metabolism. Genetic engineering of hydrogenase genes; Plant response to nutrients;

Phytohormones - Roles of auxins, cytokinins, gibberillins, abscisic acid and ethylene.

Course Outcomes: At the end of the course the student will be able to

- Understand Basic concepts in plant growth and physiology
- Define the problems in post harvest losses and will investigate more solution for betterment.
- Understand the importance of organic farming and role of biotechnology in development of organic farming
- Understand the techniques in molecular farming and concepts in nitrogen fixation.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Biotechnology in Agriculture, a Dialogue	MS Swamynathan	McMillian India Ltd	1991
2	Plant biotechnology in Agriculture	K. Lindsey and M.G.K. Jones	Prentice hall, New Jersey	1989
3	Arun K. Sharma	A Hand book of organic farming	Agrobios, India	2002
4	Plant Biotechnology and Agriculture	Arie Altman Paul Hasegawa	Academic Press	1st Edition 2011
Reference Books				
1	Molecular Approaches to Crop Improvement	Dennis Liwelly Eds. Kluwer	Academic Publishers	1991
2	Post Harvest Technology of Fruits and vegetables (Volume 1 and 2)	L.R. Verma and V.K. Joshi	Indus Publishing Company, New Delhi. 2006	2000

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

TISSUE ENGINEERING

Course Code	**18BT743**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: : This course will enable students

- To learn the fundamentals of tissue engineering and tissue repairing
- To acquire knowledge on clinical applications of tissue engineering
- To understand the basic concept behind tissue engineering focusing on the stem cells, biomaterials and its applications

Module-1

INTRODUCTION:

Introduction to tissue engineering: Basic definition; current scope of development; use in therapeutics, cells as therapeutic agents, cell numbers and growth rates, measurement of cell characteristics morphology, number viability, motility and functions. Measurement of tissue characteristics, appearance, cellular component, ECM component, mechanical measurements and physical properties.

Module-2

TISSUE ARCHITECTURE:

Tissue types and Tissue components, Tissue repair, Engineering wound healing and sequence ofevents. Basic wound healing Applications of growth factors: VEGF/angiogenesis, Basic properties, Cell-Matrix and Cell-Cell Interactions, telomeres and Self-renewal, Control of cell migration in tissue engineering.

Module-3

BIOMATERIALS:

Biomaterials: Properties of biomaterials, Surface, bulk, mechanical and biological properties. Scaffolds & tissue engineering, Types of biomaterials, biological and synthetic materials ,Biopolymers, Applications of biomaterials, Modifications of Biomaterials, Role of Nanotechnology

Module-4

BASIC BIOLOGY OF STEM CELLS:

Stem Cells: Introduction, hematopoietic differentiation pathway Potency and plasticity of stem cells, sources, embryonic stem cells, hematopoietic and mesenchymal stem cells, Stem Cell markers, FACS analysis, Differentiation, Stem cell systems- Liver, neuronal stem cells, Types &sources of stem cell with characteristics: embryonic, adult, haematopoetic, fetal, cord blood, placenta, bone marrow, primordial germ cells, cancer stem cells induced pleuripotent stem cells.

Module-5

CLINICAL APPLICATIONS

Stem cell therapy, Molecular therapy, In vitro organogenesis, Neurodegenrative diseases, spinal cord injury, heart disease, diabetes, burns and skin ulcers, muscular dystrophy,orthopedicapplications, Stem cells and Gene therapy Physiological models, issue engineeredtherapies, product characterization, components, safety, efficacy. Preservation –freezing anddrying. Patent protection and regulation of tissue-engineered products, ethical issues.

Course Outcomes: At the end of the course the student will be able to

- Ability to understand the components of the tissue architecture
- Opportunity to get familiarized with the stem cell characteristics and their relevance in medicine
- Awareness about the properties and broad applications of biomaterials
- Overall exposure to the role of tissue engineering and stem cell therapy in Organogenesis.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Tissue Engineering	Bernhard O.Palsson, SangeetaN.Bhatia	Pearson Publishers	2009
2	Fundamentals of Tissue Engineering and Regenerative Medicine	Meyer U, Meyer Th, Handschel J, Wiesmann H.P	Springer	**2009**
Reference Books				
1	Stem cell transplantation, tissue engineering, and cancer applications	Bernard N. Kennedy	Nova Science Publishers	2008
2	Stem cell-based tissue repair	Raphael Gorodetsky, Richard Schafer	RSC Publishing	2011
3	Stem Cell Repair and Regeneration	Naggy N. Habib, M.Y. Levicar, , L. G. Jiao,.and N. Fisk	Imperial College Press	Volume-2, 2007
4	Essential of Stem Cell Biology	R. Lanza, J. Gearhart et al	Elsevier Academic press	2006

OPEN ELECTIVE - 2

B. E. BIOTECHNOLOGY **Outcome Based Education (OBE) and Choice Based Credit System (CBCS)** **SEMESTER - VII**			
BT FOR SUSTAINABLE ENVIRONMENT			
Course Code	**18BT751**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: : This course will enable students

- The underlying concepts of Environment and its pollution.
- Treatment of waste water and solid waste.
- The importance of Biofuels against conservative fuels

Module-1

WATER POLLUTION AND TREATMENT OF WASTEWATER:

Water as Resource, Drinking water quality, water consumption standards, Types of Water Pollutants and sources, State and central wastewater quality and its various discharge standards. Wastewater Sampling and Characteristics - Physical, Chemical and Biological characteristics of wastewater: Solving numerical on the sampling, characteristics and estimation of wastewater flow rates. Biotechnological approach for water purification.

Module-2

TERTIARY/ADVANCED WASTEWATER TREATMENT:

Secondary/Biological treatment process, aerobic/anaerobic attached and suspended growth process, Sludge treatment & Disposal. Ultrafiltration, Filtration, Adsorption on Activated Carbon, Ion Exchange, Reverse Osmosis, Electro dialysis cell. Wastewater treatment in Industries: Paper and Pulp, distillery, Leather, Food processing such dairy and fruit processing and Textile processing.

Module-3

AIR POLLUTION AND NOISE POLLUTION

Sources, Classification, Properties of air pollutants, and Effects of air pollution on health, vegetation and materials. Air pollution sampling: Ambient sampling and Stack sampling, Analysis of air pollutants, Control methods and Equipment for particulates and gaseous pollutants, Applications to Industries: Thermal power plants, Metallurgical and Cement industries. Sources, Effects of Noise, Equipment for Noise Measurement, and Approaches for Noise Control.

Module-4

BIOFUELS:

Renewable and non-renewable resources. Conventional fuels and their environmental impacts. Animal oils. Modern fuels and their environmental impacts. Biotechnological inputs in producing good quality natural fibres. Plant sources like Jetropha, Pongamia etc. Waste as an energy core, energy recovery systems for urban waste, technology evaluation, concept of gasification of wastes with molten salt to produce low-BTU gas; pipeline gas from solid wastes by syngas recycling process; conversion of feedlot wastes into pipeline gas; fuels and chemicals from crops, production of oil from wood waste, fuels from wood waste, methanol production from organic wastes.

Module-5

SOLID WASTE MANAGEMENT:

Definitions, Characteristics and perspectives, Types of solid wastes, Sources of Solid waste, Properties of solid waste –Numerical problems, Solid waste Management – An Overview:- Material flow in society, Reduction in raw material usage, Solid waste generation, and reuse with materials, energy recovery. Solid waste management through Biotechnological processes involving Hazardous wastes, Biomedical wastes, Dairy wastes, Pulp industry wastes, Textile industry wastes, leather industry wastes and pharmaceutical industry wastes, petroleum wastes treatment.

Course Outcomes:

- Apply reasoning to identify the components of environmental eco systems and effect of pollutant on environment.
- Characterize the various parameters for treatment of water, waste water and solid waste from their sources to provide valid conclusions.
- Understand the impact of recovery, recycle of the useful resources from the wastes by adopting advanced techniques to demonstrate the need for sustainable development.
- Identify and demonstrate the knowledge to use suitable equipment for abatement and control of air & noise pollution

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Environmental Engineering	Howard S. Peavey, Donald R. Rowe, George Tchobanolous	McGraw-Hill International	1985
2	Wastewater Engineering – Treatment, Disposal and Reuse	Metcalf and Eddy	Tata McGraw-Hill Pub	3rd Edition
3	Environmental Biotechnology	Foster C.F., John ware D.A	Ellis Horwood Limited.	1987
Reference Books				
1	Fuels from Waste	Larry Anderson and David A Tillman	Academic Press	1977
2	Biotechnology, Economic & Social Aspects : Issues for Developing Countries	E.J. Dasilva, C Ratledge& A Sasson	Cambridge Univ. Press	1992
3	Environmental Biotechnology	Pradipta Kumar Mahopatra	I K Internationa	2007

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VII

FORENSIC SCIENCE

Course Code	**18BT752**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: : This course will enable students

- To know about the various areas of forensic science.
- To understand the steps involved in forensic analysis
- To understand about the techniques in forensic analysis
- To know about the legal issues and ethics related to forensic science

Module-1

INTRODUCTION:

Introduction, Definition and Scope, History and Development of Forensic science, Legal procedures and use of court. Types of Evidence. Organization of a crime Laboratory services of the crime laboratory, Basic services provided by full service crime laboratories, Physical Science unit, Biological unit, Firearms unit, Document Examination unit. Functions and duties performed by each unit and lab.

Module-2

FORENSIC ANALYSIS AND IMAGING:

Analysis of Physical evidence, Expert unit men, specially trained evidence collection technician, Analytical technician. Digital cameras and forensic imaging, Uses of digital imaging, Maintaining chain of control with digital images, digital videos, scanners, presenting pictures in courtroom, Detecting compression and forgeries and Maintaining Records.

Module-3

FORENSIC BIOLOGY:

Forensic Pathology: Rigor mortis, Lovor mortis, Algor mortis. Forensic Anthropology, Forensic Entomology, Forensic Psychiatry, Forensic Odontology, Foresnsic Engineering, DNA Analysis, Dactyloscopy, Fingerprints: Classification and patterns. Characterization of blood stains, stain patterns of blood, preservation of blood evidence, characterization of semen, role of toxicologist, toxicology of alcohol, techniques used in toxicology, role of toxicological findings and drug recognition experts.

Module-4

FORENSIC APPLICATIONS:

Probability population and sampler, weight of evidence and the Bayesian likelihood ratio, Transfer evidence application of statistics to particular areas of forensic science, Knowledge base systems, Quality base of system General concepts and tools, Arithmetic and logical operation, Developing an algorithm to solve problem, Modularization, Function and procedures, Arrays, File processing , Reports and control breaks, Processing the date.

Module-5

ETHICS IN FORENSICS:

The importance of professional ethics to science practitioners, Development of a code of conduct and code of ethics for forensic science, Application of codes and ethics, How ethical requirement, impact the daily work of a forensic scientist, ethical dilemmas and their resolution.

Course Outcomes: At the end of the course the student will be able to

- List the various types of forensic branches of science.
- Explain the various applications of techniques and usage of technology to gain knowledge and insight that have legal implications

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.

- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl. No.	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Criminalistics : An Introduction to Forensic Science	Richard Saperstein	Prentice Hall	11th edition
2	Introduction to Forensic Sciences	William G Eckert	CRC Press	2nd edition, 2002
3	Principles of Forensic Toxicology	Barry Levine	AACC Press	1999
4	Textbook of Forensic Medicine and Toxicology	V.V. Pillay	Paras Medical Publishers	18th Ed.2017
Reference Books				
1	Principles of Forensic Medicine	ApurbaNandy	New central book agency Ltd.,	2010
2	Computer forensics: evidence collection and management	Robert C. Newman	Auerbach Publications	2007.
3	Forensic Computer Crime Investigation	Thomas A Johnson,	CRC Press	2005
4	Introduction to Statistics for Forensic Scientists	David Lucy	Wiley publications	2005

Open Elective –B	
Course code under 18BT75X	**Course Title**
18BT751	BT for sustainable Environment (No Change in Syllabus)
18BT752	Forensic Science(No Change in Syllabus)
18BT753	Food, Nutrition and Human Health **(Change in Title and Syllabus)**

B.E BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VI

FOOD, NUTRITION AND HUMAN HEALTH

Course Code	**18BT753**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Objectives:

- To familiarize students with fundamentals of food, nutrients and their relationship to health.
- To create awareness with respect to deriving maximum benefit from available food resources.

Module - 1

Basic aspects in Food and Nutrition

Concept of Health, related terminologies. Terms used in study of food and nutrition, Relationship between foods, nutrition and health, Functions of food - Physiological, psychological and social.

Micro and Macro-Nutrients**:** Functions, dietary sources and clinical manifestations of deficiency/excess of the following nutrients: Carbohydrates and dietary fibre, lipids and proteins Fat soluble vitamins - A, D, E and K, Water soluble vitamins – thiamin, riboflavin, niacin, pyridoxine, folate, Vitamin B12 and Vitamin Minerals – calcium, iron and iodine, Recommended Dietary Allowances,

Module-2

Balanced diet and Nutrition

Dietary guidelines for Indians, Food pyramid, Balanced Diet and the factors affecting the planning of diets, Dietary Pattern, Physiological considerations and nutritional concerns for the following life stages: pediatrics and infant meal plans, Preschool children, Adolescent children, Adult man / woman, Pregnant and lactating women, meal plan for geriatrics. Role of dieticians. Nutrition for physical fitness and sports, Techniques of measuring body composition, BMI, BMR, work capacity, physical fitness lung capacity. Nutritional demands of sports and dietary, recommendations.

Module-3

Nutritional deficiency and diseases

Nutritional deficiency diseases, Protein Energy Malnutrition, Biological Value, Protein Efficiency ratio, Vitamin A Deficiency (VAD), Iron Deficiency Anemia (IDA), Iodine Deficiency Disorders (IDD), Zinc Deficiency, Fluorosis. Pathophysiology of insulin resistance. Obesity - etiology, clinical assessment, treatment approaches, consequences of obesity and its prevention. Diabetes mellitus, aims of dietary treatments, special dietary consideration for type I and II diabetics, complications of diabetes. Diseases of the heart and blood vessels - etiology, symptoms and diagnosis; atherosclerosis, lipids and other dietary factors responsible for coronary heart diseases (CHD). Dietary habits during CHD, hypertension, congestive heart failure and hyperlipidemia.

Module-4

FOOD PROCESSING

Nutrient Losses during processing, preventive measures; Selection, nutritional contribution and changes during cooking of the following food groups: Cereals, Pulses, Fruits and vegetables, Milk & milk products, Eggs, Meat, poultry and fish, Fats and Oils. Methods of cooking/baking: Dry, moist, frying and microwave cooking; Advantages, disadvantages and the effect of various methods of cooking on nutrients, methods to minimize nutrient losses.

Module-5

Food product development and Entrepreneurship

New food products & food product development- Concepts, definitions & characteristics. Factors to

consider for food product development (external and internal factors); Reasons for food product development- market concerns, consumer demands, societal changes, technological concerns, corporate influences, governmental influences; Types of new food products - Line extensions, "me too", new to world products, innovative/creative products, existing products- repositioned, reformulated, new forms, new size and new package, FSSAI, HACCP - standards and guidelines.

Course outcomes:

- To understand the correlation between Food, nutrition and Health
- To apply the knowledge towards managing health and diseases
- To know about the methods of food processing with minimal nutritional losses.
- To related the aspects of food product development and prospects of entrepreneurial opportunities.

Question paper pattern:

1. The question paper will have ten full questions carrying equal marks.
2. Each full question will be for 20 marks.
3. There will be two full questions (with a maximum of four sub- questions) from each module.
4. Each full question will have sub- question covering all the topics under a module.
5. The students will have to answer five full questions, selecting one full question from each module

Sl. No.	Title of the Book	Name of the Authors	Name of the Publisher	Edition and Year
Text Books				
1	Essentials of Foods and Nutrition	M. Swaminathan	Ganesh & Company Madras	Vol-I and Vol-II, 1995
2	Fundamentals of Foods, Nutrition and Diet Therapy	Mudambi, S.R and Rajagopal, M V	New Age International Publishers	Fifth Ed; 2012
3	A Manual for Entrepreneurs: Food Processing Industry	Awasthi D, Jaggi R and Padmanand V.	Tata McGraw-Hill Publishing Limited	2006
Reference Books				
1.	Chemical changes in Food during Processing	Richardson T and Finley JW	CBS Publishers & Distributors	1997
2.	Diet Planning through the Life Cycle: Part 1 Normal Nutrition. A Practical Manual.	Seth V and Singh K	Elite Publishing House Pvt. Ltd. New Delhi	2006
Web links and Video Lectures				

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER – VII

BIOPROCESS ENGINEERING LABORATORY

Course Code	**18BTL76**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(0:2:2)	SEE Marks	60
Credits	02	Exam Hours	03

Course Learning Objectives: This laboratory course will enable students:

- Define the fundamentals of downstream processing for biochemical product recovery.
- Assess the impact of change in unit's operations and the impact on the process.
- Examine traditional unit operations, as well as new concepts and emerging technology that is likely to benefit biochemical product recovery in the future.

Sl. No.	Experiments
1	Cell disruption techniques.
2	Solid-liquid separation methods: Filtration
3	Solid-liquid separation methods: Sedimentation
4	Solid-liquid separation methods: Centrifugation.
5	Product enrichment operations: Precipitation – (NH4)2 SO4 fractionation of a protein.
6	Product drying techniques.
7	Separation of Amino acids / Carbohydrates by TLC.
8	Column Chromatographic Studies
9	Preparation of the fermenter
10	Production of Ethanol in fermenter - Study of growth, product formation kinetics, end substrate utilization
11	Estimation of % of ethanol from fermented broth.
12	Production and estimation of citric acid from Aspergillusniger
13	Estimation of Citric acid from fermented broth
14	Shake flask studies; Comparison of biomass yield in defined & complex media

Note: Minimum 12 experiments are to be conducted

Course Outcomes: At the end of the course the student will be able to:

- Describe the factors affecting secondary metabolite production and its industrial importance.
- Describe the basic requirements of downstream processing for biochemical product recovery.
- Identify and summarize the effect of change in unit's operations and its impact on the process.

Conduct of Practical Examination:

1. All laboratory experiments are to be included for practical examination.
2. Breakup of marks and the instructions printed on the cover page of answer script to be strictly adhered by the examiners.
3. Students can pick one experiment from the questions lot prepared by the examiners.
4. Change of experiment is allowed only once and 15% Marks allotted to the procedure part to be made zero.

Reference Books:

1. Protein Purification- Principles and Practice, Scopes, Robert K, Springer Advanced Texts in Chemistry, 1994.
2. Rate-controlled separations, Phillip C. Wankat, Elsevier Applied Science, 1991.
3. Bioseparations Science and Engineering, Roger G. Harrison, Paul W. Todd, Scott R. Rudge, and Demetri P. Petrides, 2nd edition, 2015
4. Product Recovery in Bioprocess Technology (Biotol Biotechnology by Open Learning) 1st Edition
5. Separation Process in Biotechnology, Juan A Asenjo, CRC press, 1st edition,1990.

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VIII

REGULATORY AFFAIRS IN BIOTECH INDUSTRY

Course Code	18BT81	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to

- Learn about the regulatory rules and guidelines that specify parameters of the safety
- Understand the quality standards in the biotech industry

Module-1

INTRODUCTION:

Validation and Regulatory Affairs in Bio (Pharmaceutical) Manufacturing: An Introduction to FDA Operations & Industry Compliance Regulations, The Fundamentals of Regulatory Compliance with respect to Good Clinical Practice (GCP), Good Manufacturing Practice (GMP) & Good Laboratory Practice (GLP). An Introduction to the Basic Concepts of Process Validation & how it Differs from Qualification (IQ, OQ & PQ) Procedures, A Review of Prospective, Concurrent, Retrospective Validation & Revalidation. ISO 9000 Series & International Harmonization & their effect upon GMP's.

Module-2

VALIDATION:

Validation of Water & Thermal Systems, including HVAC Facilities & Cleaning Validation. Validation of Active Pharmaceutical Ingredients (APIs) & Aseptic Processes. Validation of Non-Sterile Processes (used in the manufacture of Solids, Liquids, & Semisolid Dosage Forms). Overview of method evolution, FDA and ICH guidelines, Development and validation, Basic statistical concepts, Outliers, Specificity: sample preparation, Specificity: separations, Specificity: detectors, Linearity, Accuracy, Precision, Limits of detection (LOD) and quantification (LOQ), Minimum detectable amount (MDA), Sample stability and method robustness, Window diagrams, System suitability, Statistical process control for HPLC, Sustainable validation, Troubleshooting out-of control systems, case studies.

Module-3

STANDARDS:

Introduction, ISO 9000 Series of Standards, Management Responsibility, Quality System, Contract Review, Design Control, Document and Data Control, Preservation and Delivery, Control of Quality Records, Internal Quality Audits, Training, Servicing, Statistical Techniques, ISO-9001-2000, Scope, Normative Reference, Terms and Definitions, Quality Management, System, Documents Requirements, Management's Responsibility, Resource Management, Infrastructure, Product Realization, Handling, Storage, Packaging, Measurement, Analysis and Improvement, ISO-14001, Environmental Management Systems

Module-4

QUALITY AND IMPLEMENTATION:

Terminology Relating to Quality, Quality Requirement, Customer Satisfaction, Capability; Terms Relating to Management, Management System, Quality Management System, Quality Policy, Quality Objectives, Quality Planning, Quality Control, Quality Assurance, Quality Improvement, Continual Improvement, Effectiveness, Efficiency, Terms relating to Characteristics, Quality Characteristics; Terms Relating to Conformity, Non-Conformity, Defect, Preventive Action, Corrective Action, Correction, Rework, Repair, Scrap, Concession, Deviation Permit, Release; Objective Evidence, Inspection, Test, Metrological Confirmation. Final Inspection and Testing,

Module-5

QUALITY MANAGEMENT

The development of regulatory requirements for validation, The V model and Life Cycle model approach to validation and documentation, Risk Analysis Techniques: Impact Assessment; Failure Mode and Effects Analysis (FMEA), Validation Master Plans, Contamination Control, Risk Management in the Pharmaceutical Industry, Solid Dose Manufacture Principles and Practices, Liquid and Cream Manufacture Principles and Practices, Good Laboratory Practices (for Non-Clinical Laboratories), Computer Systems Validation Principles and Practices, Good Aseptic Practices and Sterile Products, Clinical Trials Quality Assurance Management,

Pharmaceutical Engineering – Facility, Equipment and Process Design, Fundamentals of Process Analytical Technology, Quality and Continuous Improvement in the Biotech Industry.

Course Outcomes: At the end of the course the student will be able to

- Outline the importance of the quality and compliance in the biotech industry.
- Comprehend the various regulatory guidelines and rules as well as the organizations governing the same

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Pharmaceutical Process Validation	Robert Nash and Alfred Wachter, Marcel Dekker	New York : Marcel Dekker,	2003.
2	Good Manufacturing Practices for Pharmaceuticals: A Plan for Total Quality Control from Manufacturer to Consumer	Sidney J. Willig, Marcel Dekker	New York : Marcel Dekker,	2001
3	Validation of Pharmaceutical Processes: Sterile Products	Frederick J. Carlton and James Agalloco	New York : Marcel Dekker,	3rd Edition 2008
4	Validation Standard Operating Procedures: A Step by Step Guide for Achieving Compliance in the Pharmaceutical, Medical Device, and Biotech Industries	Syed ImtiazHaider	Saint Lucie Press	2001
Reference Books				
1	Pharmaceutical Equipment Validation: The Ultimate Qualification Handbook	Phillip A. Cloud	Interpharm Press	1998
2	Commissioning and Qualification,	--	ISPE Pharmaceutical Engineering Baseline Guides Series.	--
3	ICH guideline Q6B	---	Freelance Publishing	--

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VIII

ENVIRONMENTAL BIOTECHNOLOGY

Course Code	**18BT821**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students

- To finding and implementing scientific, technological, economic and political solutions to environmental problems.
- To study the interrelationship between living organism and environment.
- To appreciate the importance of environment by assessing its impact on the human world; envision the surrounding environment, its functions and its value.
- To study the integrated themes and biodiversity, natural resources, pollution control and waste management.

Module-1

INTRODUCTION TO ENVIRONMENTAL POLLUTANTS:
Water, Soil and Air: their sources and effects. Removal of Specific Pollutants: Sources of Heavy Metal Pollution, Microbial Systems for Heavy Metal Accumulation, Biosorption& detoxification mechanisms

Module-2

MICROBIOLOGY AND BIOCHEMISTRY OF WASTE WATER TREATMENT:
Biological Treatment of anaerobic and aerobic; methanogenesis, methanogenic, acetogenic, and fermentative bacteria- technical process and conditions; Use of Genetically Engineered Organisms. emerging biotechnological processes in waste - water treatment; Applications include treatment of municipal and industrial wastewaters.

Module-3

SOCIAL ISSUES AND THE ENVIRONMENT:
From unsustainable to sustainable development – urban problems related to energy –3 water conservation, Water conservation, rain water harvesting, watershed management, resettlement and rehabilitation of people; its problems and concerns, case studies – role of non-governmental organization- environmental ethics: Issues and possible solutions – climate change, global warming, acid rain, ozone layer depletion, nuclear accidents and holocaust, case studies. – wasteland reclamation – consumerism and waste products. Different Environmental Acts and policies.

Module-4

NATURAL RESOURCES:
Forest resources: Use and over-exploitation, deforestation, case studies- timber extraction, mining, dams and their effects on forests and tribal people, Food resources: World food problems, changes caused by agriculture and overgrazing, effects of modern agriculture, fertilizer-pesticide problems, water logging, salinity, case studies – Energy resources: Growing energy needs, renewable and non renewable energy sources, use of alternate energy sources. case studies – Land resources: Land as a resource, land degradation, man induced landslides, soil erosion and desertification – role of an individual in conservation of natural resources – Equitable use of resources for sustainable lifestyles. Field study of local area to document environmental assets – river / forest / grassland / hill / mountain. Non Timer Forest Products. Biofuels.

Module-5

BIO LEACHING:
Biooxidation – Direct and Indirect Mechanisms – Biooxidation Kinetics; Bacterial oxidation of Sphalerite, Chalcopyrite and Pyrite.; Extraction of metals from ores; Recovery of metals from solutions; Microbes in petroleum extraction; Microbial desulfurization of coal, gene closing - use of genetically altered microorganisms for field biodegradation of hazardous materials.

Course Outcomes: At the end of the course the student will be able

- To gain knowledge on the importance of environmental education and ecosystem.
- To acquire knowledge about environmental pollution- sources, effects and control measures of

environmental pollution.

- To understand the treatment of wastewater and solid waste management.
- To acquire knowledge with respect to biodiversity, its threats and its conservation and appreciate the concept of interdependence.
- To be aware of the national and international concern for environment for protecting the environment.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Environmental Microbiology	W.D. Grant & P.E. Long, Blakie	Glassgow and London	1981
2	Microbial Gene Technology	H. Polasa (ED.)	South Asian Publishers, New Delhi	1991
3	Environmental Biotechnology: Principles and Applications	Bruce Rittmann and Perry McCarty	Tata McGraw-Hill Education	2012
4	Introduction to Environmental Engineering and Science	Gilbert M.Masters	Pearson Education	2nd edition, 2004
5	Environmental Science and Engineering	Benny Joseph	Tata McGraw-Hill, New Delhi	2004
Reference Books				
1	Biotreatment Systems	D. L. Wise (Ed.),	CRC Press, INC.	1988
2	Standard Methods for the Examination of Water and Waste Water	American Public Health Association	APHA	1985
3	Textbook of Environmental Studies	ErachBharucha	Universities Press(I) Pvt. Ltd., Hyderabad	2015
4	Environmental Studies-From Crisis to Cure	Rajagopalan R	Oxford University Press	2005
5	Environmental Science	G. Tyler Miller and Scott E. Spoolman	Cengage Learning India PVT, LTD, Delhi	2014

B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VIII

INDUSTRIAL MICROBIOLOGY

Course Code	**18BT822**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students to

- To understand the details of microbial techniques for growth, cultivation and characterization of microorganisms with industrial importance.
- To appreciate the recent developments in the area of medical microbiology, environmental microbiology, industrial microbiology, etc.

Module-1

INTRODUCTION:
The era of the discovery of Microbes,Scope of Industrial Microbiology and fermentation technology. Growth of Industrial Fermentations .Study of industrially important micro-organisms and their preservation. Criteria for selection and strategies for strain improvement; maintenance and containment of recombinant organisms.

Module-2

FERMENTATION PROCESS:
Characteristics of an Ideal Production Media, Raw materialsfor production. Batch culture: growth kinetics; effect of environment: temperature, pH, nutrient concentration; monitoring microbial growth in culture: cell number, direct and indirect methods. Continuous culture: concepts of Newtonian and Non- Newtonian fluid, plastic fluids, apparent viscosities; anti-foam agents.

Module-3

FERMENTORS:
Basic features, design & components – Typical fermentor. Sterilization of fermentor, medium, air supply; aseptic inoculation and sampling methods; scale up of fermentation process (parameters used in scale up, problems associated). Merits & demerits. Fermentation media: Media formulation strategies, sources of carbon, nitrogen, vitamins and minerals; role of buffers, precursors, inhibitors and inducers. Specialized bioreactors (Photobioreactors, Membrane, Fluidised bed, Tubular and Packedbed bioreactor).

Module-4

MICROBIOLOGICAL ASSAY AND SOLID STATE FERMENTATION (SSF):
Introduction and History of Assay, Microbiological assay of: Vitamins and Amino Acids, Antibiotics, Trace elements. Advantages and Disadvantages of Microbiological Assay.
Estimation of growth in SSF, concept of sterility.
Comparison of SSF with SmF. Factors influencing SSF, kinetics, design of fermentor in SSF(Koji fermentor). Production of commercially important products by SSF (cellulases, penicillin, gibberillic acid).

Module-5

DOWNSTREAM PROCESSING:
Objectives and criteria, foam separation, precipitation methods, filtration, centrifugation, cell disruption methods, liquid extraction, membrane filtration, chromatography, drying devices, crystallization. Solvent recovery. Effluent treatment. Quality control of fermented products, Process economics.

Course Outcomes: At the end of the course the student will be able to

- Understand the techniques used for the isolation, growth, identification, disinfection and sterilization of microorganisms used in the Industries.
- Define the role of microorganisms towards environmental protection, industrial applications.
- Out-line industrial fermentation processes leading to the production of antibiotics, organic acids, enzymes, vitamins and therapeutic products.

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Microbiology	Michael J PelczarJr Chan ECS, Noel R Krieg	Tata McGraw Hill	5th Edn.
2	Microbiology	Prescott, Harley, Klein	McGraw Hill	2008
3	Industrial Microbiology Palynology and its applications	Samuel C Prescott, Cecil G Dunn	Agro bios (India)	1962
4	Microbiology: Principles and Explorations	Jacquelyn G. Black	John Wiley & Sons	8th Edition, ,2012
Reference Books				
1	The Air Spora: A manual for catching and identifying airborne biological particles	Phillip A. Cloud Maureen E. Lacey and Jonathan S. West	Springer	2006
2	Palynology and its applications	ShripadN.Agashe	Oxford and IBH publishing Pvt. Ltd	2006
3	Text Book of Microbiology	Anantahnarayan and JayaramPanicker	Universities Press	7 Edn.

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B. E. BIOTECHNOLOGY
Outcome Based Education (OBE) and Choice Based Credit System (CBCS)
SEMESTER - VIII

MARINE BIOTECHNOLOGY

Course Code	**18BT823**	CIE Marks	40
Teaching Hours/Week (L:T:P)	(3:0:0)	SEE Marks	60
Credits	03	Exam Hours	03

Course Learning Objectives: This course will enable students

- To understand the economically important marine animals and their potency as toxins and drugs.
- To learn the knowledge on the degradation process for discharged wastes.
- To know the diseases of aquaculture animals and its management.

Module-1

ECONOMICAL IMPORTANCE OF MARINE RESOURCES:
Wealth of the sea - Economically important marine animals – fin fishes, shrimp, crab, edible oysters and pearl oysters.

Module-2

TOXINS AND THEIR ACTION:
Marine toxins from animals – sources and pharmacological potentials of tetrodotoxins, conotoxins and ciguateratoxins.

Module-3

POTENTIAL BIOACTIVE COMPOUNDS :
Bioactive compounds from the sea - source and benefits of antioxidants, collagen, gelatin, heparin, chitosan, omega- 3- fatty acids and carotinoids.

Module-4

OIL AND SOLID WASTE DEGRADATION :
Oil spillage – methods of degradation in coastal waters, Algal blooms- Biodegradation of pesticides and heavy metals discharged coastal waters- Management of solid wastes disposed into coastal waters.

Module-5

DISEASE AND WATER QUALITY MANAGEMENT:
Diseases associated with cultured shrimps and fishes-disease management - antibiotics, Immunostimulants, diagnostic kits. Water quality management in hatcheries and grow out ponds.

Course Outcomes: At the end of the course the student will be able to

- Provide an adequate knowledge of the wealth of marine and aquaculture resources.
- Understand the techniques on the resource management

Question paper pattern:

- The question paper will have ten full questions carrying equal marks.
- Each full question will be for 20 marks.
- There will be two full questions (with a maximum of four sub- questions) from each module.
- Each full question will have sub- question covering all the topics under a module.
- The students will have to answer five full questions, selecting one full question from each module.

Sl No	Title of the Book	Name of the Author/s	Name of the Publisher	Edition and Year
Textbook/s				
1	Recent Advances in Marine Biotechnology (Series) Biomaterials and Bioprocessing	Milton Fingerman and RachakondaNagabhushanam	Science Publishers	2009
2	Marine Biotechnology I & II: Advances in Biochemical Engineering/Biotechnology	Le Gal, Y., Ulber, R	Springer-Verlag Berlin Heidelberg	Vol. 96 & 97, 2005
Reference Books				

1	Marine Biotechnology: Volume I, Pharmaceuticals and Bioactive Natural Products	Attaway D.H. and Zaborsky O.R	New York: Plenum	1993
2	New frontiers in marine biotechnology: Opportunities for the 21st century	Powers D.A	Marine Biotechnology in the Asian Pacific Region	1993

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