

S-25 March, 2013 AC after Circulars from Circular No.153 & onwards

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:: 2 ::**Copy forwarded with compliments to :-**

- 1] The Principals, affiliated concerned Colleges,
Dr. Babasaheb Ambedkar Marathwada University.
- 2] The Director, University Network & Information Centre, UNIC, with
a request to upload the above all syllabi on University Website
[www.bamu.net].

Copy to :-

- 1] The Controller of Examinations,
- 2] The Superintendent, [Engineering Unit],
- 3] The Programmer [Computer Unit-1] Examinations,
- 4] The Programmer [Computer Unit-2] Examinations,
- 5] The Superintendent, [Eligibility Unit] ,
- 6] The Director, [E-Suvidha Kendra], in-front of Registrar's Quarter,
Dr. Babasaheb Ambedkar Marathwada University,
- 7] The Record Keeper,
Dr. Babasaheb Ambedkar Marathwada University.

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**D R. BABASAHEB AMBEDKAR
MARATHWADA UNIVERSITY,
AURANGABAD.**



Revised Syllabus of

ME

(BIOTECHNOLOGY)

[Effective from the Academic Year 2013-14 & onwards]

Dr. Babasaheb Ambedkar Marathwada University Aurangabad.

Faculty of Engineering & Technology

Rules and Regulations for M.E. & M.Tech. Courses

➤ **What is a credit system**

A credit system is a systematic way of describing an educational program by attaching credits to its components. The definition of credits in higher education systems may be based on different parameters, such as student workload, learning outcomes and contact hours.

➤ **Advantages of the Credit System**

- Represents a much-required shift in focus from teacher-centric to learner-centric education since the work load estimated is based on the investment of time in learning, not in teaching.
- Helps to record course work and to document learner work load realistically since all activities are taken into account-not only the time learners spend in lectures or seminars but also the time they need for individual learning and the preparation of examinations etc.
- Segments learning experience into calibrated units, which can be accumulated in order to gain an academic award.
- Helps self-paced learning. Learners may undertake as many credits as they can cope with without having to repeat all the courses in a given semester if they fail in one or more courses. Alternatively, they can choose other courses and continue their studies.

➤ **What is Grading?**

The word Grade derived from the Latin word gradus, meaning, step. Grading, in the educational context is a method of reporting the result of a learner's performance subsequent to his evaluation. It involves a set of alphabets which are clearly defined and designated and uniformly understood by all the stake holders. A properly introduced grading system not only provides for a comparison of the learner's performance but it

also indicate the quality of performance with respect to the amount of efforts put in and the amount of knowledge acquired at the end of the courses by the learners.

➤ **CURRICULUM:**

1.1 Curriculum:

Every program with specialization has a prescribed course structure which in general terms is known as Curriculum. It prescribes course to be studied in each semester; the relevant information containing course structure along with detail syllabus for each course of each program is updated periodically and is uploaded on the website.

1.2 Semesters:

The Faculty of Engineering & Technology implements a credit based curriculum and grade based evolution system for P.G. program is of four semesters. The academic courses are delivered in the first two semesters. Dissertation work is carried out by a student in the third and fourth semester. The first semester begins in the last week of July ends by the last week of November while the second semester begins in the first week of January and ends by the second week of May. Total duration for each semester is generally of 20 weeks including the period of examination, evaluation and grade declaration.

1.3 Course Credit:

Education is organized around the semester-based credit system of study. The prominent features of the credit system are a process of continuous evaluation of a student's performance/progress and flexibility to allow a student to progress at an optimum pace suited to his/her ability or convenience, subject to fulfilling minimum requirements for continuation.

A student's performance/progress is measured by the number of credits that he/she has earned, i.e. completed satisfactorily. Based on the course credits and grades obtained by the student, grade point average is calculated. A minimum grade point average is required to be maintained for satisfactory progress and continuation in the program. Also a minimum number of earned credits and a minimum grade point average should be acquired in order to qualify for the degree. All programmers are defined by the total credit requirement and a pattern of credit distribution over courses of different categories.

1.4 Course credits assignment

Each courses, except a few special courses, has a certain number of credits assigned to it depending upon its lecture, tutorial and laboratory contact hours in a week. This weightage is also indicative of the academic expectation that includes in-class contact and self-study outside of class hours.

Lectures and Tutorials: One lecture or tutorial hour per week per semester is assigned one credit.

Practical/Laboratory: One laboratory hour per week per semester is assigned one credit.

Example: Course: XYZ Engg: 4 credits (3-1-2)

The credits indicated for this course are computed as follows:

3 hours/week lectures = 3 credits

1 hours/week tutorial = 1 credit

2 hours/week practical = $2 \times 0.5 = 1$ credit

2 hours/week seminar = $2 \times 0.5 = 1$ credit

Dissertation seminar = $2 \times 1 = 2$ credit

(3-1-2) 3 credit course = (3 h Lectures + 1 h Tutorial + 2 h Practical) per week
= 6 Contact hours per week

1.5 Earning Credits

At the end of every course, a letter grade is awarded in each course for which a student had registered. On obtaining a pass grade, the student accumulates the course credits as earned credits. A student's performance is measured by the number of credits that he/she has earned and by the weighted grade point average.

The credit system enables continuous evaluation of a student's performance, and allows the students to progress at an optimum pace suited to individual ability and convenience, subject to fulfilling minimum requirement for continuation.

1.6 Evaluation System

1. Semester Grade Point Average (SGPA) =

$$\frac{\text{SUM (course credits in passed courses X earned grade points)}}{\text{SUM (Course credits in registered courses)}}$$

2. Cumulative Grade Point Average (CGPA) =

$$\frac{\text{SUM (course credits in passed courses X earned grade points) of all Semester}}{\text{SUM (Course credits in registered courses) of all Semester}}$$

3. At the end of M.E & M. Tech Program, student will be placed in any one of the divisions as detailed below.(According to AICTE Handbooks)

Ist Division with distinction : CGPA \geq 8.25 and aboveIst Division : CGPA \geq 6.75 and < 8.25IInd Division : CGPA \geq 6.75 and < 6.25

As per AICTE Handbook (2013-14), new gradation suggested as follows,

Table 1

Grade Point	Equivalent Range
6.25	55%
6.75	60%
7.25	65%
7.75	70%
8.25	75%

Conversion of CGPA to percentage marks for CGPA \geq 5.0 can be obtained using equations.

$$\text{Percentage marks} = (\text{CGPA} \times 10) - 7.5$$

An example of these calculations is given below:

Typically one example for academic performance calculations of semester -I

Table 2

Course No. (1)	Course Credit (2)	Grade Awards (3)	Earned Credit (4)	Grade Points (5)	Points Secured (6)=(4) x (5)
Subject 1	4	B	4	6	24
Subject 2	4	C	4	5	20
Subject 3	4	O	4	10	40
Subject 4	4	A+	4	8	32
Subject 5	4	C	4	5	20
Seminar	2	A++	2	9	18
Total	22		22	38	134

$$1. \text{ Semester Grade Point Average (SGPA)} = \frac{(134)}{(22)} = 6.09$$

$$2. \text{ Cumulative Grade Point Average (CGPA)} = \frac{\text{Cumulative points earned in all passed courses} = 134 \text{ (past semester)} + 134 \text{ (this sem.)} = 268}{\text{Total credits} = 22 \text{ (past semesters)} + 22 \text{ (this sem)} = 44} = 6.09$$

$$\frac{\sum (134 + 134)}{\sum (22 + 22)} = 6.09$$

System Evaluation Table

Table 3

Grade	Grade Points	Marks Obtained (%)			Description Performance
		Regular Semester	Re-Examination	Summer Semester Examination/Re-appear	
O	10	91-100	--	--	Outstanding
A++	09	86-90	91-100	91-100	Excellent
A+	08	76-85	86-90	81-90	Very Good
A	07	66-75	76-85	71-80	Good
B	06	56-65	66-75	61-70	Fair
C	05	46-55	56-65	51-60	Average
D	04	40-45	40-55	40-50	Poor
F	00	Below 40	Below 40	Below 40	Fail
EE					Incomplete
WW					Withdrawal
XX	--	--	--	--	Detained
ABSENT	--	--	--	--	Absent
PP	--	--	--	--	Passed (Audit Course)
NP	--	--	--	--	Not Passed (Audit Course)

Grade Awards:

- i) A ten point rating scale shall be used for the evaluation of the performance of the student to provide letter grade for each course and overall grade for the Master's Programme. Grade points are based on the total number of marks obtained by him/her in all the heads of examination of the course. These grade points and their equivalent range of marks are shown separately in Table-4.

Table 4: Ten point grades and grade description

Sr.No.	Equivalent Percentage	Grade Points	Grade	Grade Description
1	90.00 – 100	10	O	Outstanding
2	80.00 – 89.99	9	A++	Excellent
3	70.00 – 79.99	8	A+	Exceptional
4	60.00 – 69.99	7	A	Very Good
5	55.00 – 59.99	6	B+	Good
6	50.00 – 54.99	5.5	B	Fair
7	45.00 – 49.99	5	C+	Average
8	40.01 – 44.99	4.5	C	Below Average
9	40	4.00	D	Pass
10	<40	0.00	F	Fail

- ii) Non appearance in any examination/assessment shall be treated as the student have secured zero mark in that subject examination/assessment.
- iii) Minimum D grade (4.00 grade points) shall be the limit to clear/pass the course/subject. A student with F grade will be considered as 'failed' in the concerned course and he/she has to clear the course by reappearing in the next successive semester examinations. There will be no revaluation or recounting under this system.
- iv) Every student shall be awarded Grade points out of maximum 10 points in each subject (based on 10 Point Scale). Based on the Grade points obtained in each subject, Semester Grade Point Average (SGPA) and then Cumulative Grade Point Average (CGPA) shall be computed. Results will be announced at the end of each semester and cumulative Grade card with CGPA will be given on completion of the course.

Proposed Coding System of M.E/M.Tech Subjects

Six Digit Code for a subject (PG Course)

	Digits →	1 2 3	4	5 6
Sr. No.	Branch ↓	Branch code	Year	Subject
1	Electronics	MEX	PG I year – 6	Semester –I/III
2	Communication Engineering	MEC	PG II Year - 7	1-20 Theory
3	Electronics & Telecom.	MET		21-30 Practical
4	Digital Communications	MDC		31 Dissertation-I
5	Embedded System	MES		41-49 Electives
6	Structure Engineering	MSE		Semester –II/IV
7	Environmental Engineering	MEV		51-70 Theory
8	Water Resource Engineering	MWR		71-80 Practical
9	Computer Engineering	MCE		81 Dissertation-II
10	Computer Network	MCN		91-99 Electives
11	Software Engineering	MSW		
12	Mechanical Engineering	MME		
13	Thermal Engineering	MTE		
14	CAD/CAM	MCC		
15	Manufacturing	MMF		
16	Heat Power	MHP		
17	Machine Design	MMD		
18	M.Tech Mechanical	MTM		
19	CSE & IT	MCI		
20	Manufacturing Processing Engineering	MMP		

Note: - Kindly, Allot Same Code for same Electives/ subjects for different branches to avoid repetitions of Question papers/settings/assessments.

DEGREE OF MASTAR OF ENGINEERING
(Course with effective from academic year: 2013-2014)

I	1	The examination for the Degree of Master of Engineering will be held in four semesters, M.E. Semester-I, M.E. Semester-II, M.E. Semester-III, and M.E. Semester-IV in case of full time course.
Rules & Eligibility		
II	1	Rule for admission to P.G. Degree course in Engineering and Technology as per rules and regulation of AICTE/DTE & Dr. Babasaheb Ambedkar Marathwada University, Aurangabad.
Evaluation method		
III	1	Each theory course will be of 100 marks and be divided in to internal examination of 20 marks and semester examination of 80 marks (20+80=100 marks). Each practical course will be of 50 marks
	2	There shall be two class tests within a semester. First based on 40% syllabus taught and second based on 60% syllabus taught. The setting of question paper and assessment will be done by the concerned teacher who has taught the syllabus. Average marks obtained out of two examinations will be considered for the preparation of final sectional marks/ grade.
	3	The Question papers in theory subjects shall be set by the Examiners appointed for the purpose by the University on the recommendations of the Board of studies of the concerned PG Course.
	4	The assessment of the term work for any subject will be done by recognized post-graduate teacher.
	5	To pass the examination a candidate must obtain a minimum CGPA of 6.25 (CGPA to the scale of 10).
	6	Candidate who secures $CGPA \geq 6.25$ and $CGPA < 6.75$ declared to have passed examination in second class.
	7	Candidate who secures $CGPA \geq 6.75$ and $CGPA < 8.25$ declared to have passed examination in first class.
	8	Candidate who secures $CGPA \geq 8.25$ declared to have passed examination in first class with distinction.

IV	1	In case candidate fails to get D grade in one or more heads of passing examination, he will be allowed at his option, to reappear for only those heads of passing in which he has failed or got less than D grade at subsequent examinations.
	2	The grades obtained by the candidate in any head of passing at the examination will be carried forward unless the candidates reappear for the head of passing in accordance with ref. IV (1)
	3	In case the candidate passes in all heads of passing under M.E. Semester-I, M.E. Semester-II examination and obtained a minimum CGPA of 6.25 in M.E. Semester-I, M.E. Semester-II taken together as required under ref. II(2) above, he will not be allowed to reappear for any head of passing under M.E. Semester-I, M.E. Semester-II in accordance with ref. IV(1)
	4	A candidate will not be allowed to appear for M.E. Semester-III examination unless he passes in all heads of passing under M.E. Semester-I, M.E. Semester-II examination and obtains a minimum CGPA of 6.25 in M.E. Semester-I, M.E. Semester-II taken together under reference II(2).
	5	Whenever a candidate reappears for M.E. Semester-III and M.E. Semester-IV examinations he will have to resubmit the dissertation with suitable modification and must also reappear for oral examination on it.
	6	A candidate registered for M.E. Examination must clear his examination within five years from the date of registration.
V	Attendance Requirement	
	1	Each semester of the course shall be treated as a separate unit for calculation of the attendance
	2	A candidate shall be considered to have satisfied the attendance requirement if he/she has attended not less 75% of the class in each subject of all the semesters (Theory, Laboratory, Semester Practical training and Dissertation work) actually conducted up to the end of the semester.
	3	A Candidate, who does not satisfy the attendance required, mentioned as above, shall not be eligible to appear for the Examination of that semester and shall be required to repeat that semester along with regular students later.
	4	The Principal of the concerned College shall display regularly, the list of such candidates who fall short of attendance, on the Notice Boards.

	5	The list of the candidates falling short of attendance shall be sent to the University at least one week prior to the commencement of theory/practical examination, whichever is earlier.
VI		The following are the syllabi in the various subjects of the examination for the Degree of Master of Engineering.

**DR BABASAHEB AMBEDKAR MARATHWADA UNIVERSITY,
AURANGABAD**

**Proposed Teaching / practical / Examination scheme for 2013-2014 for M.E.
(Biotechnology Engg.)**

1st Year

Semester I

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-111	Molecular Cell Biology (MCB)	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-112	Biological Engineering	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-113	Bioinformatics and Research Methodology	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-114	Biomaterial Science	3	1	--	4	20	80	---	--	100	3hrs	4
MEB-115	Bioreactor design, operation and control	3	1	--	4	20	80	---	--	100	3hrs	4
MEB 1110	Molecular Cell Biology (MCB) Lab	-	--	4	4	--	--	---	50	50	--	2
MEB 1140	Biomaterial Science Lab	-	--	2	2	---	--	---	50	50	--	1
MEB 1150	Bioreactor design, operation and control Lab	-	--	2	2	---	--	--	50	50	--	1
Total of SEM-1		15	05	8	28	100	400	---	150	650	---	24

L: Lecture hours per week

P: Practical Hours Per week

T: Tutorials Hours per week

CT: Class Test

TH: University Theory Examination

P: Practical / Oral Examination

TW: Term work

SEM: Semester

1st Year**Semester II**

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-121	Genetic Engineering and Bioinformatics	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-122	Advances in biological engineering	3	1	--	4	20	80	---	--	100	3hrs	4
MEB-123	Protein, cell and tissue engineering	3	1	---	4	20	80	--	---	100	3hrs	4
MEB-124	Synthetic biology design and engineering—1	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-125	Upstream and down stream processing	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-1210	Genetic Engineering and Bioinformatics Lab	--	--	4	4	--	--	--	50	50	--	2
MEB-1230	Protein, cell and tissue engineering Lab	--	--	2	2	---	--	---	50	50	--	1
MEB-1250	Upstream and down stream processing Lab	--	--	2	2	--	--	---	50	50	--	1
Total of SEM-2		15	5	8	28	100	400	--	150	650	--	24

L: Lecture hours per week
P: Practical Hours Per week

T: Tutorials Hours per week
CT: Class Test

TH: University Theory Examination
P: Practical / Oral Examination

TW: Term work
SEM: Semester

2nd Year**Semester III**

Course Code	Subjects	Teaching scheme Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P/ Viva	Total		
MEB-231	Dissertation part-1 ****	--	--	12	12	---	---	---	50	50	---	12
Total of SEM -III		--	--	12	12	---	---	--	50	50	---	12

L: Lecture hours per week**P: Practical Hours Per week****T: Tutorials Hours per week****CT: Class Test****TH: University Theory Examination****P: Practical / Oral Examination****TW: Term work****SEM: Semester**

Dissertation—It includes review of literature, project planning, synopsis submission, Project Diary maintenance,

Pre-project presentation, every 15 days project progress report submission, timely project submission, final project report

Term work Include

Bioinformatics learning, research methodology learning

Note: Project viva with two external examiners, pre-project report should submit to department with HOD sign

2nd Year**Semester IV**

Course Code	Subjects	Teaching scheme Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credits
		L	T	P	TOTAL	CT	TH	TW	P/viva	Total		
MEB-241	Dissertation part-2 ****	--	--	20	20	--	--	50	200	250	--	20
Total Of SEM --IV		--						50	200	250		20
Grand Total Of SEM I,II,III & IV		24+24+12+20									80	
Total Contact Hours of SEM I,II,III & IV		28+28+12+20==88 hrs										

L: Lecture hours per week
P: Practical Hours Per week

T: Tutorials Hours per week
CT: Class Test

TH: University Theory Examination
P: Practical / Oral Examination

TW: Term work
SEM: Semester

Dissertation

To Maintain Laboratory Notebook with Guide sign and finally sign by HOD
 Execute proper experimental and project planning
 Every 15 days project progress report should submit to HOD
 After completion of project, there is viva on it with three external examiners

Course Code detail:

MEB—M.E. Biotechnology
 111----- 1-year 1—Semester 1---Subject Code
 1110-----1 Year 1---Semseter 1—Subject Code 0-Practical

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
FACULTY OF ENGINEERING AND TECHNOLOGY
First Year Engineering
Semester-I

MEB-111 Molecular Cell Biology

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-111	Molecular Cell Biology (MCB)	3	1	--	4	20	80	--	--	100	3hrs	4

The Dynamic Cell, Evolution: At the Core of Molecular Change, The Molecules of Life, The Architecture of Cells, The Life Cycle of Cells, Cells into Tissues, Molecular Cell Biology: An Integrated View of Cells at Work

Chemical Foundations, Covalent Bonds, Noncovalent Bonds, Chemical Equilibrium, Biochemical Energetics, Activation Energy and Reaction Rate

Protein Structure and Function, Hierarchical Structure of Proteins, Folding, Modification, and Degradation of Proteins, Functional Design of Proteins, Membrane Proteins, Purifying, Detecting, and Characterizing Protein, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Nucleic Acids, the Genetic Code, and the Synthesis of Macromolecules, Structure of Nucleic Acids, Synthesis of Biopolymers: Rules of Macromolecular Carpentry, Nucleic Acid Synthesis, The Three Roles of RNA in Protein Synthesis, Stepwise Formation of Proteins on Ribosomes, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Biomembranes and the Subcellular Organization of Eukaryotic Cells, Microscopy and Cell Architecture, Purification of Cells and Their Parts, Biomembranes: Structural Organization and Basic Functions, Organelles of the Eukaryotic Cell, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Manipulating Cells and Viruses in Culture, Growth of Microorganisms in Culture, Growth of Animal Cells in Culture, Viruses: Structure, Function, and Uses, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Unit 2

Genetic Analysis in Cell Biology, Mutations: Types and Causes, Isolation and Analysis of Mutants, Genetic Mapping of Mutations, Molecular Cloning of Genes Defined by Mutations, Gene Replacement and Transgenic Animals, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Molecular Structure of Genes and Chromosomes, Molecular Definition of a Gene, Chromosomal Organization of Genes and Noncoding DNA, Mobile DNA, Functional Rearrangements in Chromosomal

DNA, Organizing Cellular DNA into Chromosomes, Morphology and Functional Elements of Eukaryotic Chromosomes, Organelle DNAs, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Regulation of Transcription Initiation, Bacterial Gene Control: The Jacob-Monod Model, Bacterial Transcription Initiation, Eukaryotic Gene Control: Purposes and General Principles, Regulatory Sequences in Eukaryotic Protein-Coding Genes, Eukaryotic Transcription Activators and Repressors, RNA Polymerase II Transcription-Initiation Complex, Molecular Mechanisms of Eukaryotic Transcriptional Control, Other Transcription Systems, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

RNA Processing, Nuclear Transport, and Post-Transcriptional Control, Transcription Termination, Processing of Eukaryotic mRNA, Regulation of mRNA Processing, Signal-Mediated Transport through Nuclear Pore Complexes, Other Mechanisms of Post-Transcriptional Control, Processing of rRNA and tRNA, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

DNA Replication, Repair, and Recombination, General Features of Chromosomal Replication, The DNA Replication Machinery, The Role of Topoisomerases in DNA Replication, DNA Damage and Repair and Their Role in Carcinogenesis, Recombination between Homologous DNA Sites, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Regulation of the Eukaryotic Cell Cycle, Overview of the Cell Cycle and Its Control, Biochemical Studies with Oocytes, Eggs, and Early Embryos, Genetic Studies with *S. pombe*, Molecular Mechanisms for Regulating Mitotic Events, Genetic Studies with *S. cerevisiae*, Cell-Cycle Control in Mammalian Cells, Checkpoints in Cell-Cycle Regulation, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Gene Control in Development, Cell-Type Specification and Mating-Type Conversion in Yeast, Cell-Type Specification in Animals, Anteroposterior Specification during Embryogenesis, Specification of Floral-Organ Identity in *Arabidopsis*, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Transport across Cell Membranes, Diffusion of Small Molecules across Phospholipid Bilayers, Overview of Membrane Transport Proteins, Uniporter-Catalyzed Transport, Intracellular Ion Environment and Membrane Electric Potential, Active Transport by ATP-Powered Pumps, Cotransport by Symporters and Antiporters, Transport across Epithelia, Osmosis, Water Channels, and the Regulation of Cell Volume, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cellular Energetics: Glycolysis, Aerobic Oxidation, and Photosynthesis, Oxidation of Glucose and Fatty Acids to CO₂, Electron Transport and Oxidative Phosphorylation, Photosynthetic Stages and Light-Absorbing Pigments, Molecular Analysis of Photosystems, CO₂ Metabolism during Photosynthesis, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Protein Sorting: Organelle Biogenesis and Protein Secretion, Synthesis and Targeting of Mitochondrial and Chloroplast Proteins, Synthesis and Targeting of Peroxisomal Proteins, Overview of the Secretory Pathway, Translocation of Secretory Proteins across the ER Membrane, Insertion of Membrane Proteins into the ER Membrane, Post-Translational Modifications and Quality Control in the Rough ER, Protein Glycosylation in the ER and Golgi Complex, Golgi and Post-Golgi Protein Sorting and Proteolytic

Processing, Receptor-Mediated Endocytosis and the Sorting of Internalized Proteins, Molecular Mechanisms of Vesicular Traffic, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cell Motility and Shape I: Microfilaments, The Actin Cytoskeleton, The Dynamics of Actin Assembly, Myosin: The Actin Motor Protein, Muscle: A Specialized Contractile Machine, Actin and Myosin in Nonmuscle Cells, Cell Locomotion, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cell Motility and Shape II: Microtubules and Intermediate Filaments, Microtubule Structures, Microtubule Dynamics and Associated Proteins, Kinesin, Dynein, and Intracellular Transport, Cilia and Flagella: Structure and Movement, Microtubule Dynamics and Motor Proteins during Mitosis, Intermediate Filaments, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cell-to-Cell Signaling: Hormones and Receptors, Overview of Extracellular Signaling, Identification and Purification of Cell-Surface Receptors, G Protein-Coupled Receptors and Their Effectors, Receptor Tyrosine Kinases and Ras, MAP Kinase Pathways, Second Messengers, Interaction and Regulation of Signaling Pathways, From Plasma Membrane to Nucleus, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Nerve Cells, Overview of Neuron Structure and Function, The Action Potential and Conduction of Electric Impulses, Molecular Properties of Voltage-Gated Ion Channels, Neurotransmitters, Synapses, and Impulse Transmission, Neurotransmitter Receptors, Sensory Transduction, Learning and Memory, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Integrating Cells into Tissues, Cell-Cell Adhesion and Communication, Cell-Matrix Adhesion, Collagen: The Fibrous Proteins of the Matrix, Noncollagen Components of the Extracellular Matrix, The Dynamic Plant Cell Wall, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cell Interactions in Development, Dorsoventral Patterning by TGF β -Superfamily Proteins, Tissue Patterning by Hedgehog and Wingless, Molecular Mechanisms of Responses to Morphogens, Reciprocal and Lateral Inductive Interactions, Overview of Neuronal Outgrowth, Directional Control of Neuronal Outgrowth, Formation of Topographic Maps and Synapses, Cell Death and Its Regulation, PERSPECTIVES for the Future, PERSPECTIVES in the Literature

Cancer, Tumor Cells and the Onset of Cancer, Proto-Oncogenes and Tumor-Suppressor Genes, Oncogenic Mutations Affecting Cell Proliferation, Mutations Causing Loss of Cell-Cycle Control, Mutations Affecting Genome Stability, PERSPECTIVES for the Future

Reference

1. "Essential Cell Biology" (2nd or 3rd edition) by Alberts et al. Garland Publishing.
2. "The Molecular Biology of the Cell", Alberts et al.
3. Molecular Biology: Principles and Practice, 1st edition, by Cox et al.
4. Karp, Gerald. 2008. Cell and Molecular Biology: Concepts and Experiments., John Wiley and Sons, Inc. 5th Ed.
5. Molecular and Cell Biology For Dummies by René Fester Kratz
6. Molecular Cell Biology (Lodish, Molecular Cell Biology) by Harvey Lodish, Arnold Berk, Chris A. Kaiser and Monty Krieger
7. Molecular Cell Biology by Harvey Lodish, Arnold Berk, Chris A. Kaiser and Monty Krieger

8. Cell and Molecular Biology: Concepts and Experiments (Karp, Cell and Molecular Biology) by Gerald Karp
9. Molecular Cell Biology Solutions Manual by Harvey Lodish
10. The Cell: A Molecular Approach, Fifth Edition by Geoffrey M. Cooper and Robert E.
11. Molecular Biology of the Gene (6th Edition) by James D. Watson, Tania A. Baker, Stephen P. Bell and Alexander Gann
12. Working with Molecular Cell Biology, Fifth Edition: A Study Companion and Solutions Manual by Brian Storrie, Eric Wong, Rich Walker and Glenda Gillaspay
13. Cell Biology: A Short Course by Stephen R. Bolsover, Elizabeth A. Shephard, Hugh A. White and Jeremy S. Hyams

Theory Examination

Theory Examination is like other ME courses

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
FACULTY OF ENGINEERING AND TECHNOLOGY
First Year Engineering
Semester-I

MEB-112 Biological Engineering

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-112	Biological Engineering	3	1	--	4	20	80	--	--	100	3hrs	4

What Is Bioengineering? Engineering versus Science, Bioengineering, Career Opportunities, Further Consideration of the Ethical Dimensions of Bioengineering

Cellular, Elemental, and Molecular Building Blocks of Living Systems--Origins and Divergence of Basic Cell Types, Elemental and Molecular Composition of a Cell, Molecules That Contain Information, Unique versus Interchangeable Parts Leads to Molecular-Based Classification, Cellular Anatomy, Cellular Physiological Lifestyles, Viruses, Prion

Mass Conservation, Cycling, and Kinetics-Open versus Closed Systems, Steady State versus Unsteady State, Approaches to Performing Mass Balances, Recycle, Bypass, and Purge, Kinetics, Unsteady-State Mass Balances, Review of Moles, Molecular Formulas, and Gas Compositions

Requirements and Features of a Functional and Coordinated System--Chemical Reaction Rate Acceleration, Energy Investment to Provide Driving Forces for Nonspontaneous Processes, Control and Communication Systems

Bioenergetics--Bioenergetic Units, Sensible versus Latent Heat, The First Law of Thermodynamics Works on All Scales, Using the First Law in Energy Balancing, Bioenergetics at the Human Scale, How Energy Is Produced, Stored, and Transduced at the Cellular Level, Representative Energetic Values at the Cellular Level, More Sophisticated Chemical Energy Accounting, Electrochemical Potential Calculation Examples

and Applications, Why Coupling between Energy Evolving Reactions and ATP Formation Is Imperfect,
Biological and Medical Applications of Membrane Energetization

Molecular Basis of Catalysis and Regulation, Binding in the Biological Context, Binding Is Dynamic,
Different Venues in Which Binding Operates

Analysis of Molecular Binding Phenomena--General Strategy for Problem Formulation and Solution,
Analysis of a Single Ligand-Single Binding Site System, How to Decide What the Free Ligand
Concentration Is, Examples of Binding Calculations, Analysis of Binding When Enzyme Catalysis Occurs,
A Protein with Multiple Binding Sites, Further Thoughts on How Living Systems Are Designed and
Function

Applications and Design in Biomolecular Technology

Binding Applications, Enzyme Catalysis Application, Using Enzymes in Food Processing, Bioresource
Engineering, Immobilized Enzymes in Chemical Weapon Defense and Toxic Chemical Destruction 139

Cellular Technologies and Bioinformatics Basics-Microbial Metabolic Engineering, Tissue Engineering,
Gene Therapy and DNA Vaccines, An Experimental Facet of Bioinformatics, Computational Component to
Bioinformatics: Eigenvalue-Based Methods , Future Studies

Primer on Organs and Function--Basic Parameters and Inventories in the Human Body, Digestive System,
Circulatory Systems, Heart Structure and Function, Removal versus Preservation of Substances in the
Blood, Activity Coordination: Endocrine System, Follow-On Biomedical Engineering Considerations 188

Biomechanics --Power Expenditure in Walking, Optimization Illustration: Least Power Expenditure, Stride
Length, Scaling the Result in an Ergonomic Analysis, Using the Solution to Solve a Larger Problem

Biofluid Mechanics--Mechanics of Fluid Flow, Blood versus Water, Example: How Much Force Is Needed
to Injecta Drug? Example: How Does the Heart Compare to a LawnMower Engine in Horsepower?
215Example: What Is the Stress on a Red Blood Cell? Operation and Design of the Circulatory System,
Biomedical Engineering Applications, Accomplishments, and Challenges

Biomaterials--Three Basic Quantifiable Features of Biomaterials, Body Response to Wounding, Immune System Defense, Examples of the Role of Mechanical Properties of Biomaterials, Examples of Biomaterials Engineering Strategies That Attempt to Minimize Clotting Through Surface Modification, Examples of Immune System Links to Biomaterials 246

Pharmacokinetics--Pharmacokinetic Modeling Basics, Limits of Pharmacokinetic Models and Gaining, More Predictive Power, Solution of Pharmacokinetic Model

Noninvasive Sensing and Signal Processing--Physics of NMR, Signal Processing: Converting Raw Signal into Useful, Information, NMR Applications

Text/ References Books

1. Introduction to Biomedical Engineering, Third Edition by **John Enderle and Joseph Bronzino**
2. Bioengineering Fundamentals by **Ann Saterbak, Ka-Yiu San and Larry V McIntire**
3. An Introductory Text to Bioengineering (Advanced Series in Biomechanics) by **Shu Chien, Peter C Y. Chen and Y C. Fung**
4. Introduction to Bioengineering by **S. A. Berger, W. Goldsmith and E. R. Lewis**
5. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB (Cambridge Texts in Biomedical Engineering) by **Michael R. King and Nipa A. Mody**
6. Bioengineering: Principles, Methodologies and Applications (Biotechnology in Agriculture, Industry and Medicine) by **Audric Garcia and Ciel Durand**
7. Statistics for Bioengineering Sciences: With MATLAB and WinBUGS Support (Springer Texts in Statistics) by **Brani Vidakovic**
8. Handbook of Bioengineering by **Richard Skalak and Shu Chien**
9. Bioengineering of the Skin by **Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach**
10. Methods in Bioengineering: Stem Cell Bioengineering (The Artech House Methods in Bioengineering Series) (Methods in Bioengineering (Artech House)) by **Biju Parekkadan and Martin L. Yarmush**
11. Bioengineering of the Skin by **Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach**

Theory Examination

Theory Examination is like other ME courses

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First Year Engineering
Semester-I

MEB-113 Bioinformatics and Research Methodology

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-113	Bioinformatics and Research Methodology	3	1	--	4	20	80	--	--	100	3hrs	4

Sequence-alignment methodologies.--Sequence databases; Similarity matrices; Pairwise alignment: Features of dynamic Programming, alignment by Bayesian Statistical Methods, multiple sequence alignment: local multiple sequence alignment: MEME, PSSM, HMM(algorithms and applications) Progressive methods for global multiple sequence alignment: CLUSTALW, PILEUP, T COFFEE; Statistical significance of alignment results.

Pattern analysis in sequences--- Motif representation: consensus, regular expressions; PSSMs; Markov models; Regulatory sequence identification using Meme; Gene finding: composition based finding, sequence motif-based finding.

Pattern analysis in sequences and Phylogenetic tree construction methods

Motif representation, Markov models; .Distance Based methods: clustering based methods, optimality based methods: Fitch -Margoliash and Minimum evolution methods, Neighbor joining and related neighbor methods Character Based methods: Maximum parsimony methods, Maximum likely hood method, , genetic algorithm, Phylogenetic tree evaluation: Boot strap analysis; dendrogram and applications.

Structure-Prediction of Biomolecules with applications in Bioinformatics----

Structure classification of proteins (SCOP, CATH); Secondary structure prediction of various protein

categories (e.g transmembrane proteins and helical proteins), RNA secondary structure prediction methods. Patterns, motifs and Profiles in sequences: Derivation and search methods; Derived Databases of patterns, motifs and profiles e.g Prosite, Blocks, Prints- S, Pfam. Overview of tertiary structure prediction methods; algorithms for modeling protein folding; algorithms for 3D structure prediction with representative examples. Protein structure prediction by comparative modelling approaches (homology modeling and foldrecognition); ab initio structure prediction methods. Bioinformati

Molecular Modelling and drug design

Force fields and their evaluation (e.g MM2, AMBER) Monte Carlo and molecular dynamics simulations (e.g. GROMACS); simulation approaches towards protein and nucleic acid conformation determination; Energy minimization techniques; Structure comparison using database formalisms(DALI, VAST etc.); CASP for dry-wet structure comparisons. Classification of drug targets, Target discovery and validation methodologies Types of drug targets and characterization of drugs, Structure based drug design methods including computer-aided drug design (pharmacophore development) and recent technology developments; Target selection, Ligand(lead compound) design ,optimization and analysis; Protein-ligand docking; QSAR; physico-chemical molecular descriptors; ADME parameters and their optimization; drug deliverability, metabolism, toxicity and pharmacokinetics; molecular diversity and Combichem;; discussion of drug design to drug discovery to drug development with pharmaceutical/biotech drug case studies.

Introduction to Research methodology: Development of hypothesis. Logical reasoning and analytical thinking. Planning and scientific strategy. Designing research methods. Setting up of scientific goals. Introduction to scientific statements Dimensions and properties Comparison and Models of research.

Critical reading of scientific paper Outline of scientific paper – planning of parts. Title, Introduction and Summary/abstract Materials and methods – importance of measurements, reproducibility, statistics, confidence. Results: Text, data presentation, methodology: Tables, graphs, histograms, photographic plates, legends. Discussion: Logical presentation and critical analysis of ideas and data, conclusions Citations: How

to find references from journals, books etc

Testing of Hypothesis and Experimental design Specific search for similar hypothesis. Designing methods in order of simple to complex methodologies. Reverse testing of data by alternative methods. Double blind and randomization of protocol. Unbiased analysis. Data interpretation at multiple levels and integrating the broad idea. Reproducibility of data. Significance and correlation analysis.

Theory Examination

Theory Examination is like other ME courses

Texts/References Books:

1. David W. Mount. Bioinformatics: Sequence and Genome Analysis ,2nd Edition, CSHL Press, 2004.
2. Baxevanis and F. B. F. Ouellette, Bioinformatics: a practical guide to the analysis of genes and proteins, 2nd Edition, John Wiley, 2001.
3. Jonathan Pevsner, Bioinformatics and Functional Genomics, 1st Edition, Wiley-Liss, 2003.
4. P. E. Bourne and H. Weissig. Structural Bioinformatics. Wiley. 2003.
5. C. Branden and J. Tooze, Introduction to Protein Structure, 2nd, Edition, Garland Publishing, 1999.
6. W.B. Pratt and P. Taylor, Principles of Drug Action, Churchill Livingstone by W.O. Foye, T.J. Lemke and D.A. Williams, Principles of Medicinal Chemistry, Williams and Williams
7. Andrew Leach, Molecular Modelling: Principles and Applications, Pearson Education
8. Scolnick.J.; Drug Discovery and Design, Academic Press, London,2001
9. N. R. Cohen, Editor, Guidebook on Molecular Modeling in Drug Design. Academic Press, San Diego, 1996

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Semester-I

MEB-114 Biomaterial Science

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-114	Biomaterial Science	3	1	--	4	20	80	----	--	100	3hrs	4

Materials for Biomedical Applications, Chemical Structure of Biomaterials, Physical Properties of Biomaterials, Mechanical Properties of Biomaterials, Biomaterial Processing, Surface Properties of Biomaterials, classes of materials used in Medicine,

The role of adsorbed proteins in tissue response to biomaterials, cells and cell injury, Tissues- the extracellular Matrix and cell- Biomaterial interactions, mechanical forces on cells, Protein Interactions with Biomaterials, Cell Interactions with Biomaterials, Biomaterial Implantation and Acute Inflammation, Wound Healing and the Presence of Biomaterials, Immune Response to Biomaterials, Biomaterials and Thrombosis, Infection, Tumorigenesis and Calcification of Biomaterials, the complement system, systemic toxicity and hypersensitivity, blood coagulation and blood- materials interaction

Testing Biomaterials-introduction, in vitro assessment of tissue compatibility, in vivo assessment of tissue compatibility, testing of blood- materials interaction, large animal models in cardiac and vascular biomaterials research and testing, microscopy for biomaterials science

Degradation of materials in the biological environment—introduction, degradation of materials in the biological environment, degradation effects of the biological environment on metals and ceramics, pathological calcification of biomaterials

The world wide burden of diseases, global population aging and the burden of disease, the global economic impact of disease, the role of novel biomaterials in alleviating disease, practical consideration for modern biomaterials, coronary artery disease—historical perspective on coronary artery disease, pathology of coronary artery disease, biomaterials as bioactive stents, biomaterials as degradable stents, biomaterials for cardiac regeneration, stroke—pathology of stroke, biomaterials for brain imaging, biomaterials for nerve regeneration, pneumonia- historical perspective on pneumonia, pathology of pneumonia, biomaterials as novel antibiotic carriers

COPD-historical perspective on COPD, pathology of COPD, Biomaterials for lung regeneration, diarrheal disease—pathology of diarrhea, complexity and cost of current diagnostic methods, biomaterials as low-cost diagnostic devices, HIV/AIDS-pathogenesis of HIV/AIDS, biomaterials as vaccine adjuvants, tuberculosis—pathology of tuberculosis, biomaterials for sustained drug release, lung cancer—pathology of lung cancer, biomaterials for passive target drug delivery, biomaterials for active target drug delivery

Traumatic injuries—clinical necessity for wound closure technologies, fibrin based biomaterials for wound closure, cyanoacrylate-based biomaterials as tissue glues, crosslinked protein- based biomaterials as tissue glues, polyethylene glycol (PEG)- based biomaterialsfor wound closure, emerging biomaterials for wound closure, prematurity lung surfactant and respiratory distress in infants, biomaterials as synthetic surfactants for the lung

Artificial red blood cell substitute, extracorporeal artificial organs, clinical aspects of orthopedic biomaterial performance, dental implantation, adhesives and sealants, ophthalmological applications, intraocular lens

implant—a scientific perspective, burn dressings and skin substitutes, sutures, drug delivery systems, bioelectrodes, cochlear implants, biomedical sensors and biosensors, diagnostics and biomaterials and medical applications of silicones

Theory Examination

Theory Examination is like other ME courses

Text/ Reference Books

1. Biomaterials: The Intersection of Biology and Materials Science by Johnna S. Temenoff and Antonios G. Mikos
2. Biomaterials Science: An Introduction to Materials in Medicine, Second Edition by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons
3. Biomaterials: An Introduction by Joon Park and R. S. Lakes
4. Biomaterials by Joyce Y. Wong and Joseph D. Bronzino
5. Advanced Biomaterials: Fundamentals, Processing, and Applications by Bikramjit Basu, Dharendra S. Katti and Ashok Kumar
6. Biomaterials Science, Third Edition: An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons
7. Mechanics of Biomaterials: Fundamental Principles for Implant Design (Cambridge Texts in Biomedical Engineering) by Lisa A. Pruitt and Ayyana M. Chakravartula
8. Biomaterials: A Nano Approach by Seeram Ramakrishna, Murugan Ramalingam, T.S. Sampath Kumar and Winston O. Soboyejo
9. Biomaterials Science: An Introduction to Materials in Medicine by Buddy D. Ratner, Allan S. Hoffman, Frederick J. Schoen and Jack E. Lemons
10. A Laboratory Course in Biomaterials by Wujing Xian
11. An Introduction to Tissue-Biomaterial Interactions by Kay C. Dee, David A. Puleo and Rena Bizios
12. An Introduction to Biomaterials, Second Edition (Biomedical Engineering) by Jeffrey O. Hollinger
13. Biomaterials for Clinical Applications by Sujata K. Bhatia
14. Integrated Biomaterials in Tissue Engineering (Biomaterials Science, Engineering and Technology) by Murugan Ramalingam, Ziyad Haidar, Seeram Ramakrishna and Hisatoshi Kobayashi

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Semester-I

MEB-115 Bioreactor design, operation and Control

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB-115	Bioreactor design, operation and control	3	1	--	4	20	80	---	--	100	3hrs	4

Inoculums development

Introduction to fermentation process, Microbial growth kinetics and media for Industrial fermentation, design of industrial nutrient media. Sterilization: Thermal death kinetics of micro –organisms – Batch and continuous Heat sterilization of liquid media – filter sterilization of liquid Media and Air. Inocula Development: Introduction – criteria for the transfer of inoculums – Development of inocula for: Yeast processes, Bacterial processes and mycelial processes – The Aseptic inoculation of plant fermenters.

Bioreactors

a. Batch and continuous culture: Chemostat: General principle, Balance equations critical dilution rate, Biomass productivity, comparison with batch cultures, residence time distribution, Test of validity, imperfect mixing, wall growth Transient state analysis,

Turbidostat, Chemostat in series Applications. Fed batch operation, Perfusion system, Bioreactor consideration in immobilized cell system.

b. Advanced Bioreactor: Stirred vessel reactors, Bubble column reactors, biochemical loop reactors and its applications, Biological wastewater treatment in reciprocating jet bioreactors, tower-shaped reactors for aerobic biological wastewater treatment. Membrane bioreactors.

c. Modeling and Scale Up of Bioreactor: Introduction, Modeling of bioreactors, the model cycles, kind of models, complexity of the model, solving equations, parameter sensitivity, experimental design / parameter optimization / testing of the model. Scale up of bioreactors: Introduction, scale up methods in use, fundamental methods, semifundamental methods, dimensional analysis, Rules of thumb, trial and error, Mechanistic background of dimensional analysis, the use of dimensionless groups for scaling up, heterogeneous systems, generation of dimensionless groups and some examples, regime analysis, method of regime analysis. Power input requirement, scale translation, types of fermenter, scale up of CSTR, design correlations, bulk mixing, scale up methods.

Bioreactor Instrumentation and Control

a. Measurement of physical and chemical parameters in bioreactors: monitoring and control of dissolved oxygen, pH, impeller speed and temperature in stirred tank fermenter.

b. Transport Phenomenon in Bioreactor: Oxygen demand, solubility, measurement of D.O.T. Redox potential, oxygen transfer, measurement of K_La (different methods). Agitation and mixing, Baffled, vortex and airlift systems, Effect of stirring, sparging and other parameters, Power requirements for gassed and ungassed system, Rheology, O_2 Transfer.

Biochemical aspects of production

a. Product Formation in Microbial Cultures: Growth associated and nongrowth associated Kinetics, Energy Requirements: Electron transfer concept; Maintenance energy, magnitude and control of maintenance energy, Effect of maintenance.

b. Effect of Inhibition and Activation of Growth: Competitive and noncompetitive inhibition, Product and substrate inhibition, activators, Effect on batch and continuous systems.

Plant and Animal Cell Bioreactor

Plant cell bioreactors: characteristics of plant cell suspensions, plant cell bioreactor requirements, plant cell bioreactor design, plant cell bioreactor operation, alternative cultures for plant cells. Animal cells: Animal cell bioreactors, animal cell bioreactor operation, and animal cell bioreactor design.

Theory Examination

Theory Examination is like other ME courses

Texts/Reference Books:

1. James E. Bailey and David F. Ollis, "Biochemical Engineering Fundamentals", 2nd Edn., McGraw Hill International Edition, New York, 1986.
2. "Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985) Schuler & Kargi, Bio-process Eng. PHI
3. Aiba S. and Nancy F. Millis, "Biochemical Engineering", 2nd Edn., Academic Press, New York, 1973.
4. Web F.C, "Biochemical Engineering", Van Nostrand, London, 1964 Pauling M. Doran, Bioprocess engineering principles
5. Biotechnology Series edited by H. Bauer,
6. Biochemical Engineering, S.Aiba
7. Animal Cell Culture edited by John R.W. Master.

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 Semester-I

MEB-1110 Molecular Cell Biology (MCB) Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB 1110	Molecular Cell Biology (MCB) Lab	-	--	4	4	--	--	---	50	50	--	2

Practicals: with reference to theory syllabus

Student should understand their self Practical and Perform individually

Practical Examination

Lab Experiment with viva on it in presence of One External Examiner

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 Semester-I

MEB-1140 Biomaterial Sciences Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB 1140	Biomaterial Science Lab	-	--	2	2	---	--	---	50	50	--	1

Practicals: with reference to theory syllabus

Minimum 12 practical should conduct in laboratory

Practical Examination

Lab Experiment with viva on it in presence of One External Examiner

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 First Year Engineering
 Semester-I

MEB-1150 Bioreactor design Operation and Control (Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks						Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total	Duration of Theory Examination	
MEB 1150	Bioreactor design, operation and control Lab	-	--	2	2	---	--	--	50	50	--	1

Practicals: with reference to theory syllabus
Minimum 12 practical should conduct in laboratory

Practical Examination

Lab Experiment with viva on it in presence of One External Examiner

1st Year**Semester II**

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-121	Genetic Engineering and Bioinformatics	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-122	Advances in biological engineering	3	1	--	4	20	80	---	--	100	3hrs	4
MEB-123	Protein, cell and tissue engineering	3	1	--	4	20	80	--	---	100	3hrs	4
MEB-124	Synthetic biology design and engineering--1	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-125	Upstream and down stream processing	3	1	--	4	20	80	--	--	100	3hrs	4
MEB-1210	Genetic Engineering and Bioinformatics Lab	--	--	4	4	--	--	--	50	50	--	2
MEB-1230	Protein, cell and tissue engineering Lab	--	--	2	2	---	--	---	50	50	--	1
MEB-1250	Upstream and down stream processing Lab	--	--	2	2	--	--	---	50	50	--	1
Total of SEM-2		15	5	8	28	100	400	--	150	650	--	24

L: Lecture hours per week
P: Practical Hours Per week

T: Tutorials Hours per week
CT: Class Test

TH: University Theory Examination
P: Practical / Oral Examination

TW: Term work
SEM: Semester

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Semester-II

MEB-121 Genetic Engineering and Bioinformatics

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-121	Genetic Engineering and Bioinformatics	3	1	--	4	20	80	--	--	100	3hrs	4

Basics tools of Genetic Engineering

DNA Structure and properties; Restriction Enzymes; DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatase; Cohesive and blunt end ligation; Linkers; Adaptors; Homopolymeric tailing; Labeling of DNA: Nick translation, Random priming, Radioactive and non-radioactive probes, Hybridization techniques: Northern, Southern and Colony hybridization, Fluorescence in situ hybridization; Chromatin Immunoprecipitation; DNA-Protein Interactions-Electromobility shift assay; DNaseI footprinting; Methyl interference assay; Chemical Synthesis of oligonucleotides.

Cloning Vectors

Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda vectors; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/baculo & retroviral vectors; Expression vectors; pMal; GST; pET-can be omitted vectors; Protein purification; His-tag; GST-tag; MBP-tag etc.; Intein-based vectors; Inclusion bodies; Methodologies to reduce formation of inclusion bodies; Baculovirus and pichia vectors system.

Cloning Methodologies

Insertion of Foreign DNA into Host Cells; Transformation; Construction of libraries; Isolation of mRNA

and total RNA; cDNA and genomic libraries; cDNA and genomic cloning; Expression cloning; Jumping and hopping libraries; Southwestern and Far-western cloning; Protein-protein interactive cloning and Yeast two hybrid system; Phage display; Principles in maximizing gene expression.

PCR and Its Applications

Primer design; Fidelity of thermostable enzymes; DNA polymerases; Types of PCR – multiplex, nested, reverse transcriptase, real time PCR, touchdown PCR, hot start PCR, colony PCR, cloning of PCR products; T-vectors; Proof reading enzymes; PCR in gene recombination; Deletion; addition; Overlap extension; and SOEing; Site specific mutagenesis; PCR in molecular diagnostics; Viral and bacterial detection; PCR based mutagenesis, Mutation detection: SSCP, DGGE, RFLP, Oligo Ligation Assay (OLA), MCC (Mismatch Chemical Cleavage, ASA (Allele-Specific Amplification), PTT (Protein Truncation Test), Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing.

Applications of Genetic Engineering

Introduction of DNA into mammalian cells; Transfection techniques; Gene silencing techniques; Introduction to siRNA; siRNA technology; Micro RNA; Construction of siRNA vectors; Principle and application of gene silencing; Gene knockouts and Gene Therapy; Creation of knockout mice; Disease model; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Gene replacement; Gene targeting; Transgenics; cDNA and intragenic arrays; Differential gene expression and protein array.

Theory Examination == Theory Examination is like other ME courses

Text/Reference Book

1. S.B. Primrose, R.M. Twyman and R.W.Old; Principles of Gene Manipulation. 6th Edition, S.B.University Press, 2001.
2. J. Sambrook and D.W. Russel; Molecular Cloning: A Laboratory Manual, Vols 1-3, CSHL, 2001.
3. J. D. Watson et al.; Recombinat DNA, W.H. Freeman and Company
4. B. R. Glick and J.J. Pasternak ; Mlecular Biotecnology: Principles and Applications of Recombinant DNA, ASM press
5. D. M. Glover and B.D. Hames; DNA cloning: A Practical Approach, IRL Press.
6. Brown TA, Genomes, 3rd ed. Garland Science 2006
7. Selected papers from scientific journals.
8. Technical Literature from Stratagene, Promega, Novagen, New England Biolab etc.

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Semester-II

MEB-122 Advances in Biological Engineering

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-122	Advances in biological engineering	3	1	--	4	20	80	---	--	100	3hrs	4

TRANSCRIPTION NETWORKS, BASIC CONCEPTS, Introduction, The Cognitive Problem of the Cell, Elements of Transcription Networks, Dynamics and Response Time, of Simple Gene Circuits

AUTO-REGULATION, A NETWORK MOTIF, Introduction, Patterns, Randomized, Networks and Network Motifs, Auto regulation is a Network Motif, Negative Auto, Regulation Speeds the Response Time of Gene Circuits, Negative Auto-Regulation, Promotes Robustness to Fluctuations in Production, Positive auto-regulation speeds responses and widens cell-cell variability, Summary

THE FEEDFORWARD LOOP NETWORK MOTIF—Introduction, The Number of Appearances of a Sub graph in Random Networks, The Feed forward Loop (FFL) is a, Network Motif, The Structure of the Feed forward Loop Circuit, Dynamics of the, Coherent FFL with AND-Logic, The C1-FFL is a Sign-Sensitive Delay Element, The, Incoherent FFL: a pulse generator and response accelerator, Why Are Some FFL Types Rare? Convergent Evolution of FFLs, Summary

TEMPORAL PROGRAMS AND THE GLOBAL STRUCTURE OF TRANSCRIPTION NETWORKS---Introduction, The Single-Input Module (SIM) Network Motif, SIMs Can Generate Temporal Expression Programs, Topological, Generalizations of Network Motifs, The Multi-Output FFL

Can Generate FIFO Temporal Order, Signal Integration and Combinatorial Control: Bi-Fans and Dense-Overlapping Regulons, Network Motifs and the Global Structure of Sensory, Transcription Networks

NETWORK MOTIFS IN DEVELOPMENTAL, SIGNAL-TRANSDUCTION AND NEURONAL NETWORKS—Introduction, Network Motifs in Developmental, Transcription Networks: Positive feedback loops and bistability, Motifs in Signal, Transduction Networks, Information Processing Using Multi-Layer Perceptrons, Composite Network Motifs: Negative Feedback and Oscillator, Motifs, Network Motifs in the Neuronal Network of *C. Elegans*, Summary

ROBUSTNESS OF PROTEIN CIRCUITS, THE EXAMPLE OF BACTERIAL CHEMOTAXIS--The Robustness Principle, Bacterial Chemotaxis, or How Bacteria, 'Think', The Chemotaxis Protein Circuit of *E. coli*, Two Models Can Explain Exact, Adaptation, One is Robust and the Other Fine Tuned, The Barkai-Leibler model

Individuality and Robustness in Bacterial Chemotaxis

ROBUST PATTERNING IN DEVELOPMENT--Introduction to Morphogen Gradients, Exponential Gradients Are Not Robust, Increased Robustness by Self-Enhanced Morphogen, Degradation, Network Motifs That Provide Robust Patterning, The Robustness Principle Can Distinguish Between, Mechanisms of Fruit Fly Patterning

KINETIC PROOFREADING—Introduction, Kinetic Proofreading of the Genetic Code Can Reduce Error, Rates of Molecular Recognition, Recognition of Self and Non-Self by the Immune System, Kinetic Proofreading May Occur in Diverse Recognition, Processes in the Cell

OPTIMAL GENE CIRCUIT DESIGN—Introduction, Cost and Benefit Analysis of Gene circuits, Optimal Expression Level of a Protein Under Constant, Conditions

To Regulate or Not to Regulate: Optimal Regulation in Variable, Environments, Environmental Selection of the Feedforward Loop Network Motif, Summary

RULES FOR GENE REGULATION BASED ON ERROR MINIMIZATION, Introduction, The Savageau Demand Rules, Rules for Gene Regulation Based on Minimal Error Load, Demand Rules for Genes with Multiple Regulators, Summary

Theory Examination ==Theory Examination is like other ME courses

Text /References

1. Introduction to Biomedical Engineering, Third Edition by John Enderle and Joseph Bronzino
2. Bioengineering Fundamentals by Ann Saterbak, Ka-Yiu San and Larry V McIntire
3. An Introductory Text to Bioengineering (Advanced Series in Biomechanics) by Shu Chien, Peter C.Y. Chen and Y C. Fung
4. Introduction to Bioengineering by S. A. Berger, W. Goldsmith and E. R. Lewis
5. Numerical and Statistical Methods for Bioengineering: Applications in MATLAB
6. Cambridge Texts in Biomedical Engineering by Michael R. King and Nipa A. Mody
7. Bioengineering: Principles, Methodologies and Applications (Biotechnology in Agriculture, Industry and Medicine) by Audric Garcia and Ciel Durand
8. Statistics for Bioengineering Sciences: With MATLAB and WinBUGS Support (Springer Texts in Statistics) by Brani Vidakovic
9. Handbook of Bioengineering by Richard Skalak and Shu Chien
10. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach
11. Methods in Bioengineering: Stem Cell Bioengineering (The Artech House Methods in Bioengineering Series) (Methods in Bioengineering (Artech House)) by Biju Parekkadan and Martin L. Yarmush
12. Bioengineering of the Skin by Klaus-Peter Wilhelm, Peter Elsner, Enzo Berardesca and Howard I. Maibach

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
FACULTY OF ENGINEERING AND TECHNOLOGY
First Year Engineering
Semester-II

MEB-123 Protein, Cell and Tissue Engineering

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-123	Protein, cell and tissue engineering	3	1	--	4	20	80	--	---	100	3hrs	4

The History and Scope of Tissue Engineering The Challenge of Imitating Nature, Moving into the Clinic ,Future Perspectives , BASIS OF GROWTH AND DIFFERENTIATION -Molecular Biology of the Cell, Organization of Cells into Higher-Ordered Structures , Dynamics of Cell-ECM, Interactions, Matrix Molecules and Their Ligands, Morphogenesis and Tissue, Engineering, Gene Expression, Cell Determination and DifferentiationIN VITRO CONTROL OF TISSUE DEVELOPMENT

Engineering Functional Tissues, Principles of Tissue Culture and Bioreactor Design R, Regulation of Cell Behavior by Extracellular Proteins , Growth Factors, Mechanochemical Control of Cell Fate Switching

IN VIVO SYNTHESIS OF TISSUES AND ORGANS , In Vivo Synthesis of Tissues and Organs, MODELS FOR TISSUE ENGINEERING -Models as Precursors for, Prosthetic Devices , Quantitative Aspects , PBIOMATERIALS IN TISSUE ENGINEERING --Micro-Scale Patterning of Cells and Their Environment, Cell Interactions with Polymers , Matrix Effects, Polymer Scaffold Fabrication, Biodegradable Polymers, Micro- and Nanofabricated, Scaffolds, Three-Dimensional Scaffolds,

TRANSPLANTATION OF ENGINEERED CELLS AND TISSUES Tissue Engineering and Transplantation in the Fetus Immunomodulation, Immunoisolation, Engineering Challenges in Immunobarrier Device Development , STEM CELLS, Embryonic Stem Cells , Adult Epithelial Tissue Stem Cells, Embryonic Stem Cells as a Cell Source for Tissue Engineering, Postnatal Stem Cells, GENE

THERAPY, Gene Therapy Ronald, Gene Delivery into Cells and Tissues, BREAST-Breast Reconstruction, CARDIOVASCULAR SYSTEM-Progenitor Cells and Cardiac Homeostasis, Cardiac-Tissue Engineering, Blood Vessels, Heart Valves

ENDOCRINOLOGY AND METABOLISM-Generation of Islets from Stem Cells, Bioartificial Pancreas, Engineering Pancreatic Beta-Cells, Thymus and Parathyroid Organogenesis , GASTROINTESTINAL SYSTEM--Adult Stem Cells in Normal Gastrointestinal Function and Inflammatory Disease, Alimentary Tract, Liver Stem Cells, Liver, HEMATOPOIETIC SYSTEM --Hematopoietic Stem Cells, Red Blood Cell Substitutes, Lymphoid Cells, KIDNEY AND GENITOURINARY SYSTEM-Stem Cells in Kidney Development and Regeneration, Renal Replacement Devices, Genitourinary System

MUSCULOSKELETAL SYSTEM--Mesenchymal Stem Cells, Bone Regeneration, Bone and Cartilage Reconstruction, Regeneration and Replacement of the Intervertebral Disc, Articular Cartilage Injury, Tendons and Ligaments Francine, Mechanosensory Mechanisms in Bone, Skeletal-Tissue Engineering, NERVOUS SYSTEM, Neural Stem Cells, Spinal Cord Injury, Protection and Repair of Audition , OPHTHALMIC APPLICATIONS--Stem Cells in the Eye, Corneal-Tissue Replacement, Vision Enhancement Systems

ORAL/DENTAL APPLICATIONS--Biological Tooth Replacement and Repair, Oral and Maxillofacial Surgery, Periodontal-Tissue Engineering, RESPIRATORY SYSTEM--Progenitor Cells in the Respiratory System, Lungs, SKIN--Cutaneous Stem Cells, Wound Repair, Bioengineered Skin Constructs CLINICAL EXPERIENCE, Current State of Clinical Application, Tissue-Engineered Skin Products, Tissue-Engineered Cartilage Products, Tissue-Engineered Bone Products, Tissue-Engineered Cardiovascular Products, Tissue-Engineered Organs , REGULATION AND ETHICS--The Tissue-Engineering Industry, The Regulatory Path From Concept to Market , Ethical Issues

Theory Examination ==Theory Examination is like other ME courses**Text / Reference**

1. Tissue Engineering by Bernhard O. Palsson and Sangeeta N. Bhatia
2. Tissue Engineering (Academic Press Series in Biomedical Engineering) by Clemens van Blitterswijk, Peter Thomsen, Jeffrey Hubbell and Ranieri Cancedda
3. Tissue Engineering: Engineering Principles for the Design of Replacement Organs and Tissues by W. Mark Saltzman
4. Stem Cell and Tissue Engineering by Song Li, Nicolas L'Heureux and Jennifer Elisseeff
5. Principles of Tissue Engineering, 3rd Edition by Robert Lanza, Robert Langer and Joseph Vacanti
6. Tissue Engineering by John P. Fisher, Antonios G. Mikos and Joseph D. Bronzino
7. Fundamentals of Tissue Engineering and Regenerative Medicine by Ulrich Meyer, Thomas Meyer, Jörg Handschel and Hans Peter Wiesmann
8. Tissue Engineering: Applications in Oral and Maxillofacial Surgery and Periodontics by Samuel E. Lynch, Robert E. Marx, Myron Nevins and Leslie A. Wisner-Lynch
9. Tissue Engineering: From Lab to Clinic by Norbert Pallua and Christoph V. Suschek
10. Nanotechnology in Tissue Engineering and Regenerative Medicine by Ketul Popat
11. The Biomedical Engineering Handbook, Third Edition - 3 Volume Set: Tissue Engineering and Artificial Organs by Joseph D. Bronzino
12. Tissue Engineering by M. Owen and John P. Fisher
13. Culture of Cells for Tissue Engineering (Culture of Specialized Cells) by Gordana Vunjak Novakovic and R. Ian Freshney
14. Integrated Biomaterials in Tissue Engineering (Biomaterials Science, Engineering and Technology) by Murugan Ramalingam, Ziyad Haidar, Seeram Ramakrishna and Hisatoshi Kobayashi

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
FACULTY OF ENGINEERING AND TECHNOLOGY
First Year Engineering
Semester-II

MEB-124 Synthetic biology design and engineering

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-124	Synthetic biology design and engineering-I	3	1	--	4	20	80	--	--	100	3hrs	4

High-Throughput Technologies and Functional Genomics, Predicting the Lymph Node Status of Breast Cancer Tumors Using Gene Expression Patterns and Genomic Signal Processing , From Recombinant Genes to Recombinant Genomes for Systems Biology

In silico Genome-scale Metabolic Models: The Constraint-based Approach and its Applications
 Mathematical Modeling of Genetic Regulatory Networks: Stress Responses in Escherichia coli ,Systems Approaches in Molecular, Diagnostics and Drug Development, Yeast as a Prototype for Systems Biology
 Construction and Applications of Genome-Scale In Silico Metabolic Models for Strain Improvement

Synthetic Biology: Putting Engineering into Bioengineering , Rational design and de novo Gene Construction, Manipulation of gene expression in prokaryotic and eukaryotic cells. Rational design and directed evolution for cell and protein engineering. Selection and screening technologies and process optimization. Synthetic Biology: engineering and application of gene circuits. Molecular biotechnology applications: Diagnosis, Therapeutics and Vaccines.

Self-replication in Chemistry and Biology, The Synthetic Approach for Regulatory and Metabolic Circuits ,

Synthetic

Genetic

Networks

The theory of biological robustness and its implication to cancer, Nucleic Acid Engineering

Potential Applications of Synthetic Biology in Marine Microbial Functional Ecology and Biotechnology ,On fundamental implications of systems and synthetic biology, Outstanding Issues in systems and synthetic biology

Theory Examination ==Theory Examination is like other ME courses

Text /References

1. Chemical Synthetic Biology by **Pier Luigi Luisi and Cristiano Chiarabelli**
2. The Emergence of Life: From Chemical Origins to Synthetic Biology by P. L. Luisi
3. An Introduction to Systems Biology: Design Principles of Biological Circuits (Chapman & Hall/CRC Mathematical & Computational Biology) by Uri Alon
4. Creating Life in the Lab: How New Discoveries in Synthetic Biology Make a Case for the Creator (Reasons to Believe) by Fazale Rana
5. Systems Biology and Synthetic Biology by **Pengcheng Fu and Sven Panke**
6. Systems Biology by **Edda Klipp, Wolfram Liebermeister, Christoph Wierling and Axel Kowald**
7. Synthetic Biology, Part B, Volume 498: Computer Aided Design and DNA Assembly (Methods in Enzymology) by **Chris Voigt**
8. Synthetic Biology: the technoscience and its societal consequences by **Markus Schmidt, Alexander Kelle, Agomoni Ganguli-Mitra and Huib de Vriend**
9. Synthetic Biology by **Markus Schmidt**
10. Synthetic Gene Networks: Methods and Protocols (Methods in Molecular Biology) by **Wilfried Weber and Martin Fussenegger**
11. Designing Human Practices: An Experiment with Synthetic Biology by Paul Rabinow and **Gaymon Bennett**
12. Synthetic Biology: A Primer by **Paul S. Freemont and Richard I. Kitney**
13. Synthetic and Integrative Biology: Parts and Systems, Design Theory and Application (Biotechnology in Agriculture, Industry and Medicine) by **James T. Gevona**
14. Biology for Engineers by Arthur T. Johnson
15. Synthetic Biology by **A.K. Sethi**

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Semester-II

MEB-125 Upstream and down stream Processing

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-125	Upstream and down stream processing	3	1	--	4	20	80	--	--	100	3hrs	4

Upstream and downstream processing-introduction, solids and liquids handling, gas compression, selection criteria for fermentation air filters, media sterilization, heat management in fermentation processes, Disruption of microbial cell

Centrifugation, filtration of fermentation broths, cell processing using tangential flow filtration, cell separation with hollow fiber membrane, ultrafiltration, ultrafiltration processes in biotechnology,

Liquid- liquid extraction of antibiotics, liquid- liquid extraction of biopolymers, Ion exchange recovery of antibiotics, ion exchange recovery of proteins, affinity chromatography, hydrophobic chromatography, high performance liquid chromatography, recovery of biological products of distillation, supercritical fluid extraction, electro dialysis

case studies—penicillins, Tylosin, peptide antibiotics, anticancer agents, product from Recombinant DNA, siderophores, traditional fermented soybean foods, bacterial biomass, fermented dairy products, tryptophan, citric acid, lactic acid, ethanol, acetone / butanol, microbial insecticide, enzymes in food technology

Theory Examination ==Theory Examination is like other ME courses

Texts/References:

1. E L V Harris and S. Angal, Protein Purification Methods, Ed. IRL Press at Oxford University Press, 1989. ■
2. P.A. Belter, E.L. Cussler and Wei-Shou Hu., Bioseparations-Downstream Processing for Biotechnology, Wiley- Interscience Publication, 1988.
2. J. E. Bailey and D. F. Ollis, Biochemical Engineering Fundamentals, 2nd Edition, Mc-Graw Hill, Inc., 1986. ■
4. Separation, Recovery and Purification in Biotechnology, Aenjo J.A. and J.Hong ■
5. Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press (1984)
3. Comprehensive Biotechnology" Vol.2 Ed.: M. Moo-Young (1985)
4. Biotreatment, Downstream Processing and Modeling" (Advances in Biochemical Engineering /Biotechnology, Vol 56) by T. Schepler et al, Springer Verlag ■
5. Chromatographic and Membrane Processes in Biotechnology" by C.A. Costa and J.S. Cabral, Kluwer, Academic Publisher
6. Downstream Processing" by J.P. Hamel, J.B. Hunter and S.K. Sikdar, American Chemical Society ■
7. Protein Purification" by M.R. Ladisch, R.C. Wilson, C.C. Painton and S.E. Builder, American Chemical society ,Verlag ■
8. Protein purification: Principle and practice, third edition, Robert k. Scopes, Springer, editor: Charles R. Cantor ■
9. Physical Biochemistry: David Friefelder, 5th Ed, PHI ■
10. Guide to protein purification: Methods in enzymology, volume 182

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
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First Year Engineering
Semester-II

MEB-1210 Genetic Engineering and Bioinformatics Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-1210	Genetic Engineering and Bioinformatics Lab	--	--	4	4	--	--	--	50	50	--	2

Practicals: with reference to theory syllabus
Minimum 12 practical should conduct in laboratory

Practical Examination

Lab Experiment with viva on it in presence of One External Examiner

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Semester-II

MEB-1230 Protein, Cell and Tissue Engineering Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-1230	Protein, cell and tissue engineering Lab	--	--	2	2	---	--	---	50	50	--	1

Practicals: with reference to theory syllabus
Minimum 12 practical should conduct in laboratory

Practical Examination

Lab Experiment with viva on it in presence of One External Examiner

DR. BABASAHEB AMEBDKAR MARATHWADA UNIVERSITY, AURANGABAD
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First Year Engineering
Semester-II

MEB-1250 Upstream and downstream Processing Lab

Course Code	Subjects	Contact Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P	Total		
MEB-1250	Upstream and down stream processing Lab	--	--	2	2	--	--	---	50	50	--	1

Practicals: with reference to theory syllabus
Minimum 12 practical should conduct in laboratory

Practical Examination
 Lab Experiment with viva on it in presence of One External Examiner

2nd Year**Semester III**

Course Code	Subjects	Teaching scheme Hours per week				Examination scheme-Marks					Duration of Theory Examination	Total Credit
		L	T	P	TOTAL	CT	TH	TW	P/ Viva	Total		
MEB-231	Dissertation part-1 ****	--	--	12	12	---	---	---	50	50	---	12
Total of SEM -III		--	--	12	12	---	---	--	50	50	---	12

L: Lecture hours per week**T: Tutorials Hours per week****P: Practical Hours Per week****CT: Class Test****TH: University Theory Examination****TW: Term work****P: Practical / Oral Examination****SEM: Semester**

Dissertation—

It includes review of literature, project planning, synopsis submission, Project Diary maintenance, Pre-project presentation, every 15 days project progress report submission, timely project submission, final project report

Term work Include

Bioinformatics learning, research methodology learning

Note: Project viva with two external examiners, pre-project report should submit to department with HOD sign

