UNIVERSITY OF KERALA

B.TECH DEGREE COURSE
2008 SCHEME

BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING

I to VIII SEMESTER SCHEME AND SYLLABUS

APPROVED BY BOARD OF STUDIES
AND FACULTY OF ENGINEERING

UNIVERSITY OF KERALA
BIOTECHNOLOGY AND BIOCHEMICAL ENGINEERING
SCHEME OF STUDIES AND EXAMINATION FOR B. TECH DEGREE
I and II to VIII SEMESTERS 2008 SCHEME

Semester I and II (Common to all Branches)

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.101	Engineering Mathematics	2	1	0	50	3	100	6
08.102	Engineering Physics	2	1	0	50	3	100	6
08.103	Engineering Chemistry	2	1	0	50	3	100	6
08.104	Engineering Graphics	1	0	2	50	3	100	6
08.105	Engineering Mechanics	2	1	0	50	3	100	6
08.106	Basic Civil Engineering	2	1	0	50	3	100	6
08.107	Basic Mechanical Engineering	2	1	0	50	3	100	6
08.108	Basic Electrical and Electronics Engineering	2	1	0	50	3	100	6
08.109	Basic Communication and Information Engineering	2	1	0	50	3	100	6
08.110	Engineering Workshops	0	0	2	50	3	100	4
	Total	17	8	4	500		1000	58

Semester III

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.301	Engineering Mathematics II (CMPUNETARFHB)	3	1	-	50	3	100	4
08.302	Bio-process Calculations (B)	2	2	-	50	3	100	4
08.303	Cellular and Organismal Biology (B)	2	1	-	50	3	100	3
08.304	Principles of Momentum Transfer (B)	2	2	-	50	3	100	4
08.305	Biochemistry (B)	3	1	-	50	3	100	4
08.306	Microbiology (B)	3	1	-	50	3	100	4
08.307	Bio-chemistry Laboratory (B)	-	-	3	50	4	100	3
08.308	Cellular and Microbiology laboratory (B)	-	-	3	50	4	100	3
	TOTAL	15	8	6	400	26	800	29

Semester IV

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.401	Engineering Mathematics III (CMPUERFNHB)	3	1	-	50	3	100	4
08.402	Humanities (CTARFHB)	3	-	-	50	3	100	3
08.403	Molecular Biology (B)	3	1	-	50	3	100	4
08.404	Computer Programming in C^{++} (B)							
08.405	Industrial Bioprocess Technology (B)	3	1	-	50	3	100	4
08.406	Chemical and Biochemical Reaction Engineering (B)	2	2	-	50	3	100	4
08.407	Instrumental Methods and Analysis Laboratory (B)	-	-	3	50	4	100	3
08.408	Fluid Solid Systems Laboratory (B)	-	-	3	50	4	100	3
	TOTAL	16	7	6	400	26	800	29

Semester V

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.501	Engineering Mathematics IV **(ERHBF)**	3	1	-	50	3	100	4
08.502	Genetic Engineering (B)	3	1	-	50	3	100	4
08.503	Enzyme Engineering and Technology (B)	2	1	-	50	3	100	3
08.504	Principles of Heat Transfer in Bioprocesses (B)	3	1	-	50	3	100	4
08.505	Bioprocess Engineering (B)	3	1	-	50	3	100	4
08.506	Thermodynamics of Bioprocesses (B)	3	1	-	50	3	100	4
08.507	Molecular Biology Laboratory (B)	-	-	3	50	4	100	3
08.508	Bioprocess Engineering Laboratory (B)	-	-	3	50	4	100	3
	TOTAL	17	6	6	400	26	800	29

Semester VI

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.601	Mass Transfer Operations (B)	3	1	-	50	3	100	4
08.602	Transport Phenomena in Bioprocesses (B)	3	1	-	50	3	100	4
08.603	Process Dynamics and Control (B)	3	1	-	50	3	100	4
08.604	Proteomics and Protein Engineering (B)	3	1	-	50	3	100	4
08.605	Numerical Methods for Process Engineering (B,H)	3	1	-	50	3	100	4
08.606	Elective I	2	1	-	50	3	100	3
08.607	Software Lab (B)	-	-	3	50	4	100	3
08.608	Enzyme Engineering and Technology Lab (B)	-	-	3	50	4	100	3
	TOTAL	17	6	6	400	26	800	29

Semester VII

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.701	Downstream Processing (B)	3	2	-	50	3	100	5
08.702	Bioprocess Instrumentation (B)	3	1	-	50	3	100	4
08.703	Bio-informatics (B)	3	1	-	50	3	100	4
08.704	Elective – II (B)	3	1	-	50	3	100	4
08.705	Elective – III (B)	3	1		50	3	100	4
08.706	Reaction Engineering and Process Control Lab (B)	-	-	3	50	4	100	3
08.707	Heat and Mass Transfer Operations Lab Laboratory (B)	-	-	3	50	4	100	3
08.708	Mini Project, Seminar and Industrial Training (B)	-	-	2	100	-	-	2
	TOTAL	15	6	8	450	23	700	29

Semester VIII

Course No	Name of subject	Weekly load, hours			Max sessional marks	Exam Dur Hrs	Uni. Exam max marks	Credits
		L	T	D/P				
08.801	Bio-process Plant and Equipment Design (B)	3	2	-	50	4	100	5
08.802	Biomaterials and Tissue Engineering (B)	2	1	-	50	3	100	3
08.803	Environmental Pollution, Monitoring and Control (B)	2	1	-	50	3	100	3
08.804	Managerial Economics for Process Engineers and Principles of Industrial Management (B)	3	1	-	50	3	100	3
08.805	Elective – IV (B)	2	1	-	50	3	100	3
08.806	Elective – V (B)	2	1	-	50	3	100	3
08.807	Bioinformatics Laboratory (B)	-	-	3	50	4	100	3
08.808	Downstream Processing Laboratory (B)	-	-	3	50	4	100	3
08.809	Project and Comprehensive Viva-Voce (B)	-	-	3	50	-	100	3
	TOTAL	13	7	9	450	27	900	29

LIST OF ELECTIVES

Elective –I (08-606)

EL1 A Agricultural Biotechnology (B)
EL1 B Biophysics of macro-molecules (B)
EL1 C Process Plant safety and Hazard Assessment (B)
EL1 D Process Optimization (B)
EL1 E Biocatalysts and Catalysis (B)
EL1 F Computational fluid dynamics (B)
EL1 G Communicative English and Technical Writing (B,H,E)

Elective –II (08-704)

EL2 A Biopharmaceutical Technology (B)
EL2 B Biosensors and Diagnostics (B)
EL2 C Research methodologies (B)
EL2 D Modeling and Scale up of Bioreactors (B)
EL2 E Design of Biological waste treatment systems (B)

Elective- III (08-705)

EL3 A Entrepreneurship Development (B)
EL3 B Drugs Design, Development and Manufacture (B)
EL3 C Bio-fuel Technology and Engineering (B)
EL3 D r DNA Technology (B)
EL3 E Cancer Biology (B)
EL3 F Project Engineering (B)

Elective- IV (08-805)

EL4 A Nano-Engineering of Biomaterials (B)
EL4 B Phytochemicals and Herbal Clinical Genetics and Cytogenetics (B)
EL4 C Metabolic Regulation and Engineering (B)
EL4 D Ethics and Intellectual Property Rights in Biotechnology (B)
EL4 E Immunology and Immunotechnology (B)
EL4 F Commercialization, Marketing and Management of Biotech products (B)

Elective- V (08-806)

EL5 A Molecular Modeling (B)
EL5 B Energy Engineering (B)
EL5 C Mathematical Modeling and Process Simulation of Bioprocesses (B)
EL5 D Biostatistics (B)
EL5 E Total Quality Management (B)
EL5 F Novel Analytical Methods in Biotechnology (B)

UNIVERSITY OF KERALA

B.Tech Degree Course – 2008 Scheme

REGULATIONS

1. Conditions for Admission

Candidates for admission to the B.Tech degree course shall be required to have passed the Higher Secondary Examination, Kerala or 12th Standard V.H.S.E., C.B.S.E., I.S.C. or any examination accepted by the university as equivalent thereto obtaining not less than 50% in Mathematics and 50% in Mathematics, Physics and Chemistry/ Bio-technology/ Computer Science/ Biology put together, or a diploma in Engineering awarded by the Board of Technical Education, Kerala or an examination recognized as equivalent thereto after undergoing an institutional course of at least three years securing a minimum of 50 % marks in the final diploma examination subject to the usual concessions allowed for backward classes and other communities as specified from time to time.

2. Duration of the course

i) The course for the B.Tech Degree shall extend over a period of four academic years comprising of eight semesters. The first and second semester shall be combined and each semester from third semester onwards shall cover the groups of subjects as given in the curriculum and scheme of examination
ii) Each semester shall ordinarily comprise of not less than 400 working periods each of 60 minutes duration
iii) A candidate who could not complete the programme and pass all examinations within Ten (10) years since his first admission to the B.Tech programme will not be allowed to continue and he has to quit the Programme. However he can be readmitted to the first year of the programme if he/she satisfies the eligibility norms applicable to the regular candidates prevailing at the time of readmission.

3. Eligibility for the Degree

Candidates for admission to the degree of bachelor of technology shall be required to have undergone the prescribed course of study in an institution maintained by or affiliated to the University of Kerala for a period of not less than four academic years and to have passed all the examinations specified in the scheme of study

4. Subjects of Study

The subjects of study shall be in accordance with the scheme and syllabi prescribed

5. Evaluation

Candidates in each semester will be evaluated both by continuous assessment and end semester University examination. The individual maximum marks allotted for continuous assessment and University examination for each subject is as prescribed by the scheme of study.

5.1 Continuous Assessment (C.A)

The marks awarded for the continuous assessment will be on the basis of the day-to-day work, periodic tests (minimum two in a semester) and assignments (minimum of three – one each from each module). The faculty member concerned will do the continuous assessment for each semester. The C.A. marks for the individual subjects shall be computed by giving weight age to the following parameters.

Subject	**Attendance**	**Tests**	**Assignments/ Class Work**
Theory Subjects	20%	50%	30%
Drawing	20%	40%	40%
Practical	20%	40%	40%
Project Work	Work Assessed by Guide – 50% Assessed by a three member committee out of which one member is the guide – 50%		

The C.A. marks for the attendance (20%) for each theory, practical and drawing shall be awarded in full only if the candidate has secured 90% attendance or above in the subject. Proportionate reduction shall be made in the case of subjects in which he/she gets below 90% of the attendance for a subject. The CA marks obtained by the student for all subjects in a semester is to be published at least 5 days before the commencement of the University examinations.

Anomalies if any may be scrutinized by the department committee and the final CA marks are forwarded to the university within the stipulated time.

5.2. End Semester University Examinations

i) There will be University examinations at the end of the first academic year and at the end of every semester from third semester onwards in subjects as prescribed under the respective scheme of examinations. Semester classes shall be completed at least 10 working days before the commencement of the University examination.

ii) The examination will be held twice in a year – April/May session (for even semester) and October/November session (for odd semester). The combined 1st and 2nd semester is reckoned as equivalent to an even semester for the purpose of conduct of examination and the University examination will be held during April/May. However VII and VIII Semester examination will be conducted in both the sessions. This schedule will not be changed

iii) A student will be permitted to appear for the university examination only if he/she satisfies the following requirements

a. He/she must secure not less than 75% attendance in the total number of working periods during the first year and in each semester thereafter and shall be physically present for a minimum of 60% of the total working periods. In addition, he/she also shall be physically present in at least 50% of total working periods for each subject
b. He must earn a progress certificate from the head of the institution of having satisfactorily completed the course of study in the semester as prescribed by these regulations
c. It shall be open to the Vice-Chancellor to grant condonation of shortage of attendance on the recommendation of the head of the institution in accordance with the following norms
d. The attendance shall not be less than 60% of the total working periods
e. He/she shall be physically present for a minimum of 50% of the total working periods
f. The shortage shall not be condoned more than twice during the entire course
g. The condonation shall be granted subject to the rules and procedures prescribed by the university from time to time.
h. The condonation for combined 1st and 2nd semesters will be reckoned as a single condonation for attendance purposes.

iv) A student who is not permitted to appear for the University examinations for a particular semester due to the shortage of attendance and not permitted by the authorities for condonation of shortage of attendance shall repeat the semester when it is offered again. This provision is allowed only once for a semester.

v) The university will conduct examinations for all subjects (Theory, Drawing and Practical)

vi) The scheme of valuation will be decided by the chief examiner for theory / drawing subjects

vii) For practical examinations, the examiners together will decide the marks to be awarded. The student shall produce the certified record of the work done in the laboratory during the examination. The evaluation of the candidate should be as per the guidelines given in the syllabus for the practical subject.

6. Letter Grades

For each subject in a semester, based on the total marks obtained by the student in the University examination and Continuous assessment put together a letter grade (S,A+, A, B+, B, C+, C, D, E and F) will be awarded. ***All letter grades except 'F' will be awarded if the marks for the University examination is 40 % or above and the total mark (C.A marks + University Exam mark) is 50 % or above***. No absolute mark will be indicated in the grade card. Letter grade corresponding to total marks (C.A marks+ University Exam mark) and the corresponding grade point in a ten-point scale is described below.

% of Total marks ***(C.A marks + University Exam mark)***	**Letter Grade**	**Grade Point (G.P)**	**Remarks**
90 % and above	S	10	Excellent
85 % and above but less than 90%	A+	9	
80 % and above but less than 85%	A	8.5	
75 % and above but less than 80%	B+	8	
70 % and above but less than 75%	B	7.5	
65 % and above but less than 70%	C+	7	
60 % and above but less than 65%	C	6.5	
55 % and above but less than 60%	D	6	

50 % and above but less than 55%	E	5.5	
Below 50% (C.A + U.E) or below 40 % for U.E only	F	0	Failed

7. Grade Point Average (GPA) and Cumulative Grade Point Average (CGPA)

Grade point average is the semester wise average points obtained by each student in a 10-point scale. GPA for a particular semester is calculated as per the calculation shown below.

$$GPA = \frac{\sum Credit \times \text{GP obtained for the subject}}{\sum \text{credit for subject}}$$

Cumulative Grade point Average (CGPA) is the average grade points obtained by the students till the end of any particular semester. CGPA is calculated in a 10-point scale as shown below.

$$\text{CGPA} = \frac{\sum \text{Credits for semester} \times \text{GPA obtained for the semester}}{\sum \text{credits for the semester}}$$

GPA and CGPA shall be rounded to two decimal points. The Grade card issued to the students shall contain subject number and subject name, credits for the subject, letter grades obtained, GPA for the semester and CGPA up to that particular semester. In addition to the grade cards for each semester all successful candidate shall also be issued a consolidated statement grades. On specific request from a candidate and after remitting the prescribed fees the University shall issue detailed mark to the individual candidate.

8. Minimum for a pass

a) A candidate shall be declared to have passed a semester examination in full in the first appearance if he/she secures not less than 5.5 GPA with a minimum of 'E' grade for the all individual subject in that semester.

b) A candidate shall be declared to have passed in an individual subject of a semester examination if he/she secures grade 'E' or above.

c) A candidate who does not secure a full pass in a semester examination as per clause (a) above will have to pass in all the subjects of the semester examination as per clause (b) above before he is declared to have passed in that semester examination in full.

9. Improvement of Grades

i) A candidate shall be allowed to re-appear for a maximum of two subjects of a semester examination in order to improve the marks and hence the grades already obtained subject to the following conditions

   a) The candidate shall be permitted to improve the examination only along with next available chance.
   b) The candidate shall not be allowed to appear for an improvement examination for the subjects of the VII and VIII semesters
   c) The grades obtained by the candidate for each subject in the improvement chance he has appeared for or the already existing grades – whichever is better will be reckoned as the grades secured.
   d) First and Second semester will be counted as a single chance and they can improve a maximum of three subjects

ii) A candidate shall be allowed to repeat the course work in one or more semesters in order to better the C.A. marks already obtained, subject to the following conditions

   a) He/she shall repeat the course work in a particular semester only once and that too at the earliest opportunity offered to him/her.
   b) He/she shall not combine this course work with his/her regular course work
   c) He/she shall not be allowed to repeat the course work of any semester if he has already passed that semester examination in full
   d) The C.A marks obtained by the repetition of the course work will be considered for all purposes

iii) A candidate shall be allowed to withdraw from the whole examination of a semester in accordance with the rules for cancellation of examination of the University of Kerala.

10. Classification of Successful candidates

i) A candidate who qualifies for the degree passing all the subjects of the eight semesters within five academic years (ten consecutive semesters after the commencement of his/her course of study) and secures not less than 8 CGPA up to and including eighth semester (overall CGPA) shall be declared to have passed the B.Tech degree examination in FIRST CLASS WITH DISTINCTION

ii) A candidate who qualifies for the degree passing all the subjects of the eight semesters within five academic years (ten consecutive semesters after the commencement of his/her course of study) and secures less than 8 CGPA but not less than 6.5 CGPA up to and including eighth semester shall be declared to have passed the B.Tech degree examination in FIRST CLASS.

iii) All other successful candidates shall be declared to have passed the B.Tech Degree examination in SECOND CLASS

iv) Successful candidates who complete the examination in four academic years (Eight consecutive semesters after the commencement of the course of study shall be ranked branch-wise on the basis of the CGPA in all eight semesters put together. In the case of a tie in the CGPA the total marks of the students who have got same CGPA shall be considered for finalizing the rank. Students who pass the examination in supplementary examination are also covered under this clause

11. Educational Tour

a) The students may undertake one educational tour preferably after fourth semester of the course and submit a tour report

b) The tour may be conducted during the vacation / holidays taking not more than 5 working days, combined with the vacation / holidays if required. Total number of Tour days shall not exceed 15 days.

c) The tour period shall be considered as part of the working periods of a semester

12. Revision of Regulations

The university may from time to time revise, amend or change the regulations, curriculum, scheme of examinations and syllabi. These changes unless specified otherwise, will have effect from the beginning of the academic year / semester following the notification of the University

08. 101 ENGINEERING MATHEMATICS I

Credits: 6 **L/T/P:2/1/0**

MODULE 1

Applications of differentiation: – Definition of Hyperbolic functions and their derivatives- Successive differentiation- Leibnitz' Theorem (without proof)- Curvature- Radius of curvature- centre of curvature- Evolute (Cartesian ,polar and parametric forms)

Partial differentiation and applications:- Partial derivatives- Euler's theorem on homogeneous functions- Total derivatives- Jacobians- Errors and approximations- Taylor's series (one and two variables) - Maxima and minima of functions of two variables - Lagrange's method- Leibnitz rule on differentiation under integral sign.

Vector differentiation and applications :- Scalar and vector functions- differentiation of vector functions-Velocity and acceleration- Scalar and vector fields- Operator ∇ - Gradient- Physical interpretation of gradient- Directional derivative- Divergence- Curl- Identities involving ∇ (no proof) - Irrotational and solenoidal fields – Scalar potential.

MODULE II

Laplace transforms:- Transforms of elementary functions - shifting property- Inverse transforms- Transforms of derivatives and integrals- Transform functions multiplied by t and divided by t - Convolution theorem(without proof)- Transforms of unit step function, unit impulse function and periodic functions-second shifting theorem- Solution of ordinary differential equations with constant coefficients using Laplace transforms.

Differential Equations and Applications:- Linear differential equations with constant coefficients- Method of variation of parameters - Cauchy and Legendre equations –Simultaneous linear equations with constant coefficients- Application to orthogonal trajectories (Cartesian form only).

MODULE III

Matrices:-Rank of a matrix- Elementary transformations- Equivalent matrices- Inverse of a matrix by gauss-Jordan method- Echelon form and normal form- Linear dependence and independence of vectors- Consistency- Solution of a system linear equations-Non homogeneous and homogeneous equations- Eigen values and Eigen vectors – Properties of Eigen values and Eigen vectors- Cayley Hamilton theorem(no proof)- Diagonalisation- Quadratic forms- Reduction to canonical forms-Nature of quadratic forms-Definiteness, rank, signature and index.

REFERENCES

1. **Kreyszig,** *Advanced Engineering Mathematics*, 8th edition, Wiley Eastern.
2. **Peter O' Neil** , *Advanced Engineering Mathematics,* Thomson
3. **B.S.Grewal**, *Higher Engineering Mathematics,* Khanna Publishers
4. **B.V.Ramana,** *Higher Engineering Mathematics,* Tata Mc Graw Hill, 2006
5. **Michel D Greenberg,** *Advanced Engineering Mathematics* ,Pearson International
6. **Sureshan J, Nazarudeen and Royson**, *Engineering Mathematics I*, Zenith Publications

08.102 ENGINEERING PHYSICS

Credits: 6 **L/T/P:2/1/0**

MODULE-I

Oscillations and Waves

Basic ideas of harmonic oscillations – Differential equation of a SHM and its solution. Theory of damped harmonic oscillations. Quality factor. Theory of forced harmonic oscillations and resonance. Types of waves. One dimensional waves – Differential Equation. Harmonic waves. Three dimensional waves - Differential Equation and solution. Plane waves and spherical waves. Energy in wave motion. Velocity of transverse waves along a stretched string.

Electromagnetic Theory

Del operator – grad, div, curl and their physical significance. Concept of displacement current. Deduction of Maxwell's equations. Prediction of electromagnetic waves. Transverse nature of electromagnetic waves. **E** and **H** are at right angles. Poynting's theorem (qualitative only)

Physics of Solids

Space lattice. Unit cell and lattice parameters. Crystal systems. Co-ordination number and packing factor with reference to simple cubic, body centered cubic and face centered cubic crystals. Directions and planes. Miller indices. Interplanar spacing in terms of Miller indices. Super conductivity - Meissner effect. Type-I and Type-II superconductors. BCS theory (qualitative). High temperature superconductors. Applications of superconductors. Introduction to new materials (qualitative) -Metallic glasses, Nano materials, Shape memory alloys, Bio materials.

MODULE- II

Interference of Light

Concept of temporal and spatial coherence. Interference in thin films and wedge shaped films. Newton's rings. Michelson's interferometer. Determination of wave length and thickness. Interference filters. Antireflection coating.

Diffraction of Light

Fresnel and Fraunhofer diffraction. Fraunhofer diffraction at a single slit. Fraunhofer diffraction at a circular aperture (qualitative). Rayleigh's criterion for resolution. Resolving power of telescope and microscope. Plane transmission grating. Resolving power of grating. Grating equation. X-ray diffraction. Bragg's law.

Polarization of Light

Types of polarized light. Double refraction. Nicol Prism. Retardation plates. Theory of plane, circular and elliptically polarized light. Production and analysis of circularly and elliptically polarized light. Polaroids. Induced birefringence. Photo elasticity – isoclinic and isochromatic fringes – photo elastic bench

Special Theory of Relativity

Michelson-Morley experiment. Einstein's postulates. Lorentz transformation equations (no derivation). Simultaneity. Length contraction. Time dilation. Velocity addition. Relativistic mass. Mass energy relation. Mass less particle.

MODULE – III

Quantum Mechanics

Dual nature of matter. Wave function. Uncertainty principle. Energy and momentum operators. Eigen values and functions. Expectation values. Time Dependent and Time Independent Schrodinger equations. Particle in one dimensional box. Tunnelling (qualitative).

Statistical Mechanics

Macrostates and Microstates. Phase space. Basic postulates of Maxwell-Boltzmann, Bose-Einstein and Fermi-Dirac statistics. Distribution equations in the three cases (no derivation). Bosons and Fermions. Density of states. Derivation of Planck's formula. Free electrons in a metal as a Fermi gas. Fermi energy.

Laser

Einstein's coefficients. Population inversion and stimulated emission. Optical resonant cavity. Ruby Laser, Helium-Neon Laser, Carbon dioxide Laser (qualitative). Semiconductor Laser (qualitative). Holography. Fiber Optics - Numerical Aperture and acceptance angle. Types of optical fibers. Applications.

REFERENCES

1. **Sears and Zemansky,** *University Physics, XI Edn, Pearson*
2. **Frank and Leno,** *Introduction to Optics, III Edn., Pearson*
3. **J.C. Upadhyaya,** *Mechanics., Ram Prasad and Sons*

4. **David J Griffiths,** *Introduction to Electrodynamics, III Edn , Pearson*
5. **M Ali Omar,** *Elementary Solid State Physics, Pearson*
6. **S O Pillai,** *Solid State Physics., New Age International Publishers*
7. **John R Taylor, Chris D Zafiratos & Michael A Dubson,** *Modern Physics for Scientists and Engineers. II Edn, Prentice Hall of India*
8. **Eugene Hecht,** *Optics, IV Edn, Pearson*
9. **Robert Resnick,** *Introduction to Special Relativity, John Willey and Sons*
10. **Richard L Libboff,** *Introduction to Quantum Mechanics, IV Edn, Pearson*
11. **Donald A Mcquarrie,** *Statistical Mechanics, Vivo Books*
12. **Mark Ratner and Daniel Ratner,** *Nanotechnology,* Pearson Prentice Hall Prof.
13. **T.A. Hassan et al,** *A Text Book of Engineering Physics*, *Aswathy Publishers, Trivandrum*
14. **B. Premlet,** *Advanced Engineering Physics, Phasor Books, Kollam.*

LIST OF DEMONSTRATION EXPERIMENTS

1. Newton's Rings – Determination of wave length.
2. Air Wedge – Diameter of a thin wire
3. Spectrometer – Plane transmission grating – wavelength of light.
4. Spectrometer – Refractive indices of calcite for the ordinary and extraordinary rays.
5. Laser – Diffraction at a narrow slit.
6. Laser – Diffraction at a straight wire or circular aperture.
7. Michelson's interferometer – Wavelength of light.
8. Michelson's interferometer – Thickness of thin transparent film.
9. Polarization by reflection – Brewster's law.
10. Computer stimulation – superposition of waves.
11. Computer stimulation – study of **E** & **H**. (Gauss' law & Ampere's law)

*University examination is for a maximum of **100 marks**, in **3 hour** duration. The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of* **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*

Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

08.103 ENGINEERING CHEMISTRY

Credits: 06 **L/T/P: 2/1/0**

MODULE 1

Electrochemistry - Electrodes- Electrode potential- Origin of electrode potential- Helmoltz double layer- Nernst equation and application- Reference electrodes- Standard hydrogen electrode- Saturated calomel electrode- Quinhydron electrode-Determination of P^H using these electrodes- Concentration cells- Fuel cells- Secondary cells- Lead acid cell- Nickel cadmium cell- Lithium-ion cell. - Coductometric and Potentiometric titrations (acid base, oxidation reduction and precipitation titrations). **(12hrs)**

Corrosion and its control- Theories of corrosion (chemical corrosion and electrochemical corrosion) - Galvanic series- Types of corrosion (Concentration cell corrosion, Stress corrosion, galvanic corrosion) - Factors affecting corrosion (nature of metal and nature of environment) and different methods of corrosion control (corrosion inhibitors, cathodic protection). **(5hrs)**

Protective coatings- Metallic coatings- Chemical conversion coatings- paint **(4hrs)**

Nano-materials- Introduction-Classification-preparation (laser abrasion technique and sputtering technique)- Chemical

method (reduction)-Properties and Applications of nano- materials-Nano tubes-Nano wires. **(4hrs)**

MODULE-2

Water treatment- Types of hardness- Degree of hardness- Related problems- Estimation of hardness- by EDTA method- Sludge and scales in boilers- Priming and foaming- Boiler corrosion-Water softening methods, Lime-soda process, Ion exchange methods-Internal treatments (colloidal, carbonate, phosphate and calgon conditioning)-Domestic water treatment- Methods of disinfection of water-Desalination process (Reverse osmosis, electro dialysis-Distillation). **(12hrs)**

Environmental damages and prevention- Air pollution- CFCs and ozone depletion- Alternative refrigerants-Green house effect-Water pollution- BOD and COD- Waste water treatment- Aerobic - Anaerobic and USAB processes. **(3hrs)**

Thermal methods of analysis-Basic principles involved in Thermo-gravimetry, Differential thermal analysis and applications. **(2hrs)**

Spectroscopy- Molecular energy levels-Types of molecular spectra- Electronic spectra (Classification of electronic transitions- Beer Lamberts law, Vibrational spectra (mechanism of interaction and application), Rotational spectra (Determination of bond length and application). NMR spectra (Basic principle, chemical shift, spin-spin splitting) **(6hrs)**

Chromatography- General principles- High performance liquid chromatography- Gas chromatography. **(2hrs)**

MODULE 3

Polymers- Classifications- Mechanism of polymerization (Addition, free radical, cationic, anionic and coordination polymerization)- Thermoplastics and thermosetting plastics-Compounding of plastics-Moulding techniques of plastics (Compression, Injection, Transfer and Extrusion moulding)-Preparation, properties and uses of PVC, PVA, PMMA, Nylon, PET, Bakelite, Urea formaldehyde resin- Silicon polymers- Biodegradable plastics. Elastomers- structure of natural rubber- vulcanization- synthetic rubbers (Buna-S, Butyl rubber and Neoprene) **(12hrs)**

Organo electronic compounds -Super conducting and conducting organic materials like Polyaniline, polyacetylene and [polypyrrol and its applications. **(2hrs)**

Fuels- Calorific value- HCV and LCV-Experimental determination of calorific value-Theoretical calculation of calorific value by Dulongs formula - Bio fuels -Bio hydrogen and Bio-diesel **(5hrs)**

Lubricants- Introduction-Mechanism of lubrication- solid and liquid lubricant- Properties of lubricants-Viscosity index- flash and fire point- cloud and pour point- aniline value. **(4hrs)**

Cement- Manufacture of Portland cement- Theory of setting and hardening of cement **(2hrs)**

LAB-EXPERIMENTS (DEMONSTRATION ONLY)

1. Estimation of total hardness in water using EDTA.
2. Estimation of chloride ions in domestic water.
3. Estimation of dissolved oxygen.
4. Estimation of COD in sewage water.
5. Estimation of available chlorine in bleaching powder.
6. Estimation of copper in brass.
7. Estimation of iron in a sample of hematite.
8. Determination of flash and fire point of a lubricating oil by Pensky Marten's apparatus.
9. Potentiometric titrations.
10. Preparation of buffers and standardisation of P^H meter.
11. Determination of molarity of HCl solution P^H-metrically.
12. Determinations of PH using glass electrode and quinhydron electrode.

REFERENCES

1. **Willard H.A, Merrit L.L and Dean J.A,** *Instrumental methods of analysis, CBS*

2. **De A.K,** *Environmental Chemistry, New Age International*
3. **Klauhunde K.J,** *Nanoscale materials in chemistry*
4. **Gowariker B.R.,** *Polymer science, Wiley Intescience*
5. **Gonser B.W, and Hausner H. H.,** *Modern materials, Academic Press*
6. **Raghavan V,** *Material Science and engineering. A first course, Prentice Hall of India*
7. **Van Vlack L.H,** *Elements of Material science and Engineering*, Dorling Kindersley (India) Pvt Ltd
8. **Goodby J.W.** *Chemistry of liquid crystals*
9. **Glasstone S,** *A text book of physical chemistry, Mc Graw Hill*
10. **Jain P.C**, *Engineering Chemistry,* Dhanpat Raj Publishing Co., India
11. **Juhaina Ahad,** *Engineering Chemistry*, Jai Publications, Kollam, India
12. **Shashi Chawla,** *A text book of Engineering Chemistry,* Dhanpat Raj Publishing Co., India
13. **Gopalan R, Venkappayya D and S. Nagarajan S,** *Engineering Chemistry, Vikas Publishing House Pvt. Ltd,.*
14. **Kuriakose J.C and Rajaram J,** ***Chemistry*** *of Engineering and Technology volume I & II, TMH*
15. **Goyal R.N and Harmendra Goeal;** *Engineering Chemistry*, Ane Books, Thiruvananthapuram

08.104 ENGINEERING GRAPHICS

Credits: 6 **L/T/D: 1/0/2**

INTRODUCTION: Introduction to technical drawing and its language. Lines, lettering, dimensioning, scaling of figures, symbols and drawing instruments. (1 sheet practice)

MODULE 1

PLAIN CURVES: Conic sections by eccentricity method. Construction of ellipse: (i) Arc of circles method (ii)

Rectangle method (ii) Concentric circles method. Construction of parabola (i) Rectangle method (ii) Tangent method.

Construction of hyperbola (i) Arc of circles method (ii) given ordinate, abscissa and the transverse axis (iii) given the

asymptotes and a point on the curve. Construction of Tangent and Normal at any point on these curves

MISCELLANEOUS CURVES: Construction of Cycloid, Epicycloid and Hypocycloid, Involute of a circle. Archimedian spiral, Logarithmic spiral and Helix. Construction of Tangent and Normal at any point on these curves

PROJECTION OF POINTS AND LINES: Types of projections, Principles of Orthographic projection. Projections of points and lines. Determination of true length, inclination with planes of projection and traces of lines.

MODULE II

PROJECTION OF SOLIDS: Projection of simple solids such as prisms, pyramids, cone, cylinder, tetrahedron, octahedron, sphere and their auxiliary projections.

SECTIONS OF SOLIDS: Types of cutting planes, section of simple solids cut by parallel, perpendicular and inclined cutting planes. Their projections and true shape of cut sections.

DEVELOPMENT OF SURFACES:Development of surfaces of (i) simple solids like prisms, pyramids, cylinder and cone (ii) Cut regular solids.

MODULE III

ISOMETRIC PROJECTION: Isometric scale, Isometric view and projections of simple solids like prisms, pyramids, cylinder, cone sphere, frustum of solids and also their combinations.

INTERSECTION OF SURFACES: Intersection of surfaces of two solids as given below.

(i) Cylinder and cylinder
(ii)Prism and prism.
(iii) Cone and Cylinder
(Only cases where the axes are perpendicular to each other and intersecting with or without offset.)

PERSPECTIVE PROJECTION: Principles of perspective projection, definition of perspective terminology. Perspective projection of simple solids like prisms and pyramids in simple positions.

CAD: Introduction to CAD systems, Benefits of CAD, Various Soft wares for CAD, Demonstration of any one CAD software.

General Note:
(i) First angle projection to be followed

(ii) Question paper shall contain 3 questions from each module, except from CAD. Students are required to answer any two questions from each module.

(iii) Distribution of marks

Module –I: 2 x 16 = 32
Module -II 2 x 17 = 34
Module III 2 x 17 = 34

100

REFERENCES

1. Luzadder and Duff, ***Fundamentals of Engineering Drawing,*** Prentice Hall of India
2. N. D. Bhatt, *Engineering Drawing,* Charotar Books
3. K. Venugopal, *Engineering Drawing and Graphics,* New Age International
4. P.S. Gill**;** *Engineering Graphics,* ***S.K.*** Kataria and Sons Publishers
5. P.I. Varghese**,** *Engineering Graphics,* VIP Publishers, Thrissur
6. K.R. Gopalakrishnan*; Engineering Drawing* , Subash Publishers**,** Banglore
7. Thamaraselvi**;** *Engineering Drawing*
8. K.C. John**;** *Engineering Graphics, PHI*
9. K.N. Anil Kumar; *Engineering Graphics,* Adhuth Narayanan Publishers

08.105 ENGINEERING MECHANICS

Credits: 6 **L/T/P:2/1/0**

MODULE I (20 HRS)

Idealizations of Mechanics- Elements of vector algebra
Statics of rigid bodies-Classification of force systems- principle of transmissibility of a force- composition and resolution- Resultant and Equilibrant of coplanar concurrent force systems-various analytical methods- - Lami's theorem, method of resolution- Conditions of equilibrium-
Moment of a force, couple, properties of couple- Varignon's theorem- Resultant and equilibrant of coplanar non-concurrent force systems- Conditions of equilibrium. Equilibrium of rigid bodies-free body diagrams.(simple problems)
Types of supports - types of beams - types of loading- Support reactions of simply supported and overhanging beams under different types of loading.
Forces in space, equations of equilibrium, Vector approach.
Friction-Laws of friction-angle of friction- cone of friction- ladder friction- wedge friction.

MODULE II (20 HRS)

Properties of surfaces- centroid of composite areas- Theorems of Pappus-Gouldinus- Moment of inertia of areas, Parallel and perpendicular axes theorems- Radius of Gyration- moment of inertia of composite areas.
Dynamics: Kinematics-Combined motion of translation and rotation-instantaneous centre, motion of link, motion of connecting rod and piston, wheel rolling without slipping.
Relative velocity - basic concepts-analysis of different types of problems
Kinetics- Newton's laws of translatory motion- D'Alembert's principle- Motion of lift- Motion of connected bodies.

MODULE III (20 HRS)

Work, Power and Energy - Work-Energy principle-Impulse, Momentum.
Collision of elastic bodies-Law of conservation of momentum-Direct and oblique impact between elastic bodies and impact with fixed plane.
Curvilinear motion- D'Alembert's principle in curvilinear motion- Mass moment of inertia of rings, solid discs and solid spheres (no derivations required)Angular momentum-Angular impulse.
Kinetics of rigid bodies under combined translatory and rotational motion – work – energy principle for rigid bodies.
Centrifugal and centripetal forces – motion of vehicles on curved paths in horizontal and vertical planes – super elevation – stability of vehicles moving in curved paths (qualitative ideas only).
Simple harmonic motion – vibration of mechanical systems - basic elements of a vibrating system – spring mass model – undamped free vibrations – angular free vibration – simple pendulum.

REFERENCES:

1. **Beer and Johnston,** *Vector Mechanics for Engineers – Statics and Dynamics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 2005.
2. **Irving. H. Shames,** *Engineering Mechanics*, Prentice Hall Book Company, 1966.
3. **Timoshenko S. and Young D. H.,** *Engineering Mechanics*, Mc-Graw Hill –International Edition
4. **Popov,** *Mechanics of Solids* Pearson Education,2007
5. **Kumar K.L,** *Engineering Mechanics*, Tata Mc-Graw Hill Publishing Company Limited, New Delhi, 1998.
6. **Rajasekaran S.and Sankarasubramanian G**., *Engineering Mechanics*, Vikas Publishing House Private Limited, New Delhi, 2003.
7. **Tayal A K,** *Engineering Mechanics- Statics and Dynamics*, Umesh Publications, Delhi,2004
8. **Benjamin J,** *Engineering Mechanics,* Pentex Book Publishers and Distributors, Kollam, 2008

Note

Question For University Examination:- Part A – 8 compulsory questions covering entire syllabus, 5 marks each. (5 x 8 = 40) Part B – Three questions of 10 marks from each module, out of which two should be answered (10 x 2 x 3 = 60).

08.106 BASIC CIVIL ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE I

Surveying: Object and Principles of Surveying.
Linear Measurements: Direct measurements - Tape & chain only - Ranging out survey lines-Taking measurements of sloping ground - Errors - Tape correction (problems).
Levelling: Levelling instruments - Level (Dumpy Level, Tilting Level) Levelling Staff. Measurements in levelling - Temporary adjustments of a level, holding the staff, reading the staff - Principles of leveling - recording measurements in the field book - reduction of level - height of collimation method only (simple examples).
Contour maps (Brief description only). Computation of areas - Mid ordinate rule, average ordinate rule, Trapezoidal rule, Simpson's rule (examples)- Introduction to Distomat, Total Station & GPS (Brief description only)

MODULE II

Building construction*:* Selection of site for buildings - types of buildings - Components of buildings.
Foundation: Different types - Spread footing, Isolated footing, Combined footing, Mat foundation, Pile foundation (description only).
Safe Bearing Capacity of Soil: Importance of determination of the Safe Bearing Capacity of Soil (brief description only).

Super structure: *Masonry - stone masonry, brick masonry –Types- desirable qualities of stone and brick.*

Partition: Materials used for making partition - plywood, particle boards & glass.
Doors, windows & ventilators : Types - materials used for the construction of doors and windows - wood, steel & Aluminium.
Plastering: Mortar – properties - Preparation of Cement mortar
Painting: Preparation of surfaces for painting - plastered, wood and steel surfaces- Types of paint - enamel, emulsion & distemper. Flooring: Types - mosaic tiles, ceramic tiles, marble, granite and synthetic materials. Roofing: Selection of

type of roof -flat roof, sloping roof -Concrete roof, tiled roof. Selection of roof covering materials. GI Sheet , AC Sheet, PVC Sheet

MODULE III

Concrete: Ingredients- cement, aggregate, and water. Qualities of ingredients (brief description only).
Tests on Cement - consistency, initial and final setting times. Compressive strength -IS Specifications.
Aggregates – desirable qualities of fine and coarse aggregates
Plain Cement Concrete (PCC): preparation-proportioning-mixing of concrete.
Steel-common types used in construction- Mild Steel, HYSD Steel and their properties.
Reinforced Cement Concrete (RCC)-advantages of RCC over Plain Cement Concrete.
Elementary ideas on pre-cast and pre-stressed concrete constructions.
Building services – vertical transportation – stairs – types, escalators and elevators, ramps (brief description only).
Plumbing services- brief description of water supply and sewage disposal arrangements for residential buildings.

REFERENCES

1. **Adler R.,** *Vertical Transportation for Buildings*, American Elsevier Publishing Company, New York.1970
2. **B.C Punmia**, *Surveying & Leveling, Vol*. – I, Laxmi publications(P) Ltd,N.Delhi, 2004
3. **Rangwala.,** *Building Materials,*Charotar publishing house, 2001
4. **Rangwala,** *Building Construction* , Charotar Publishing House., 2004
5. **S.K. Roy,** *Fundamentals of Surveying* Prentice-Hall of India, New Delhi.2004
6. **Rangwala.,***Water Supply and Sanitary Engineering*, Charotar Publishing House. 1990
7. **Moorthy,** *Building Construction*, Modern Publishing House distributor., 1957
8. **Jha and Sinha,** *Construction and Technology*
9. **Narayanan and Lalu Mangal,** *Introduction to Civil Engineering*, Phasor Books,Kollam.
10. **Santha Minu,** *Basic Civil Engineering*, Karunya Publications,Trivandrum

Note: *The question paper will consists of two parts. Part I and part II..*

Part I is Compulsory covering the entire syllabus, for 40 marks. It contains 8 questions of 5 marks each.
Part II is to cover 3 modules. There will be two questions (20 marks each) from each module out of which one from each module is to be answered. (20 X 3 = 60)

08.107 BASIC MECHANICAL ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE I

Thermodynamics : Basic concepts and definitions of Zeroth law, First law, Second law of thermodynamics- concept of reversibility and entropy. p-v and T-s diagrams
Air cycles: Carnot, Otto and Diesel cycles-Air standard efficiency (simple problems)
IC Engines: Working and comparison of two stroke and four stroke petrol and diesel engines - general description of various systems using block diagrams – air system, fuel system, ignition system and governing system. A brief description of CRDI, MPFI, GDI and Hybrid Vehicles
Steam boilers: Classification – Cochran boiler, Babcock and Wilcox boiler, Benson boiler- fluidized bed combustion.

MODULE II

Principles and fields of application of - compressors - reciprocating and centrifugal, blower, pumps- reciprocating, centrifugal and jet pumps, steam and hydraulic turbines- impulse and reaction, gas turbine cycles- open and closed
Elementary ideas of hydro electric, thermal and nuclear power plants
Refrigeration & Air Conditioning: Refrigerants, CFC free refrigerants. Vapor compression refrigeration system, Comfort and Industrial air conditioning-typical window air conditioning unit (general description only).

MODULE III

Mechanical Power transmission systems: Belt, rope and gear drives-types, comparison and fields of application-velocity ratio-slip (simple problems) friction disc, single plate clutch, gear trains (no derivations).
Manufacturing processes: Elementary ideas of casting, forging, rolling, welding, soldering and brazing
Machining processes- turning, taper turning, thread cutting, shaping, drilling, grinding, milling (simple sketches and short notes).
Non conventional machining - Electro discharge machining (EDM) and Electro chemical machining (ECM)
Principle, application and advantages of C N C machine

REFERENCES

1. **Spalding and Cole,** *Engineering Thermodynamic,* Arnold
2. **Gill, Smith and Zuirys,** *Fundamentals of IC Engine, Oxford*
3. **Amstead, Ostwald and Begeman,** *Manufacturing processes, Wiley*
4. **Crouse**, *Automobile Engineering, Mc Graw Hill*
5. **Roy and Choudhary,** *Elements of Mechanical Engineering*
6. **Hajra Choudhary,** *Workshop Technology*
7. **R K Bensal**, *Fluid mechanics and machines*
8. **J Benjamin**, *Basic Mechanical Engineering, Zenith Publications, Kollam*

Note: Lectures are to be supplemented by demonstration in laboratories.

Note: *The question paper will consist of two parts. Part I is to be compulsory for 40 marks. This may contain 10 questions of 4 marks each. Part II is to cover 3 modules. There can be 3 questions from each module (10 marks each) out of which 2 are to be answered.*

08.108 BASIC ELECTRICAL AND ELECTRONICS ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE I

Elementary concepts - Kirchoffs laws - Magnetic Circuits - MMF, field strength, flux density, reluctance – problems in series magnetic circuits. Review of electromagnetic induction - Faradays laws, Lenz's law - statically induced and dynamically induced emf - self and mutual induction - inductance.
Alternating current fundamentals - generation of alternating currents – waveforms - frequency - period - average and rms values - form factor. Phasor representation of alternating quantities - rectangular polar and exponential forms.
Analysis of simple ac circuits – concept of impedance and admittance - phasor representation - *j* notation - power and power factor in ac circuits - active and reactive components. Solution of RL, RC and RLC series circuits.
Three phase systems - generation of three phase voltage - star and delta connection - relation between phase and line values of voltage and current - phasor representation - three wire and four wire systems.
Measurement of power in three phase circuits (two wattmeter method). Measurement of energy – working of 1-phase energy meter.

MODULE II

Transformers - Principle of operation - EMF equation - constructional details of single phase and three phase transformers
Methods of bulk generation of electric power. Block schematic of layout of generating stations - hydroelectric, thermal and nuclear power plants. Renewable energy sources - solar, wind, tidal, wave and geothermal energy.
Bulk transmission of electric power - typical electrical power transmission scheme - need for high transmission voltage - substations - substation equipments. Primary and secondary transmission and distribution systems
Different methods of wiring for LT installations. Schematic layout of LT switchboards. Earthing of installations - necessity of earthing - plate and pipe earthing. Protective fuses, MCBs, ELCBs and switches.
Working of incandescent lamps, -fluorescent lamps, energy efficient lamps

MODULE III
Diodes - PN junction diodes,. V-I characteristics, dynamic & static resistance, principle of working and V-I characteristics of Zener diode, principle of Photo diode, Solar cell, & LED. Rectifiers & power supplies - block diagram description of a dc power supply, circuit diagram & working of half-wave & full wave rectifier, final equations of Vrms, Vdc, ripple factor and peak inverse voltage in each case, principle of

working of series inductor and shunt capacitor filters. Working of simple zener voltage regulator.

Power devices – V – I characteristics and applications of SCR and Triac Working principle of UPS and SMPS

Transducers – Resistance strain guage, thermistor, LVDT

REFERENCES

1. **Mitlle V.N,** *Basic Electrical Engineering*, Tata McGraw Hill, 1990.
2. **Kothari D.P and Nagrath I.J,** *Theory and Problems of Basic Electrical Engineering*, Prentice Hall of India, 2000.
3. **Thereja B.L,** *A Text Book of Electrical Technology*, Volume I, S Chand & Co, New Delhi, 1992.
4. **Francis M Fernandez,** *A Basic Course in Electrical Engineering*, Rajath Publishers, Ernakulam.
5. **Imthias Ahmed T.P, Premlet B,** *Introduction to Electrical Engineering*, Phaser Books, Kollam
6. **Gopakumar**, I*ntroduction To Electronics and Communications*, .Phasor Books, Kollam
7. **Millman and Halkias,** *Integrated Electronics: Analog and digital circuits and systems*, McGraw-Hill Book Co
8. **Edward Hughes,** *Electrical and Electronic Technology*, Pearson Education, 2002.
9. **Soni M.L, Guptha P.U, Bhatnagar U.S and Chakrabarthy A,** *A Text Book on Power System Engineering*, Dhanpath Raj and Sons, New Delhi 1997
10. **Bhargava N.N,** *Basic Electronics and Linear Circuits*, Tata McGraw Hill
11. **Rangan C.S., Sarma G.R., and Mani V.S.V,** *Instrumentation Devices and Systems*, Tata McGraw Hill, 1992.
12. **Muhammad H. Rashid,** *Power Electronic Circuits, Devices and Applications*, Pearson education, Asia 2003.

Note : *The question paper will consist of two parts. Part – A is to be compulsory for 40 marks (10 questions of 4 marks each). Part-B is to cover 3 modules for 60 marks. (50% choice- One out of two or two out of four from each module).*

08.109 BASIC COMMUNICATION AND INFORMATION ENGINEERING

Credits: 6 **L/T/P:2/1/0**

MODULE 1(Qualitative Treatment)

(a) Bipolar junction transistors: **NPN & PNP transistors, structure, typical doping, working of NPN transistor, concepts of common base, common emitter and common collector configurations, current gain of each, input & output characteristics of common emitter configuration, comparison of three configurations with reference to voltage & current gain, input & output resistances and applications.**
(6 hrs)

(b) Field effect Transistors: basic principles of JFET, MESFET and MOSFET, comparison with BJT. (3 hrs)

(c) Amplifiers & Oscillators: circuit diagram & working of common emitter amplifier, function of each component in the circuit, need of proper biasing, frequency response, voltage gain and 3dB bandwidth, concepts of class A, B, AB and Class C power amplifiers, circuit diagram & working of push pull amplifiers, concepts of feedback, working principles of oscillators, circuit diagram & working of RC phase shift oscillator (7 hrs)

(d) Integrated circuits: advantages of ICs, analog and digital ICs, functional block diagram of operational amplifier, ideal operational amplifier,use as inverting amplifier, non inverting amplifier, summing amplifier, integrator and comparator. (4 hrs)
(e) Digital ICs: logic gates, realization of logic functions, principle of combinational and sequential logic circuits, flip flop (JK), logic families: TTL and CMOS Logic (No internal diagram) (4 hrs)

(f) IC fabrication: purification of silicon, crystal growth, wafer preparation. unit process: oxidation, diffusion, ion implantation, epitaxy, deposition, photolithography. (4 hrs)

MODULE II (Qualitative Treatment)

(a) Measurements: principle and block diagram of analog and digital multimeter, working principle of CRT, block diagram of CRO, measurements using CRO, principle of digital storage oscilloscope, principle and block diagram of function generator. (5hrs)

(b) Radio communication: principle of AM & FM, wave forms, bandwidths, block diagrams of AM & FM transmitters, principle of AM &FM demodulation, comparison of AM & FM, principle & block diagram of super heterodyne receiver.

(4 hrs)

(c) Color television: TV Standards, interlaced scanning, block diagram of PAL TV transmitter & receiver, basic principles of cable TV, CCTV system, basic principles of HDTV, basic principles of LCD & Plasma displays.

(5 hrs)

(d) Radar and navigation: principle of radar and radar equation, block schematics of pulsed radar, factors affecting range, applications of radar in measurements and navigation. (4 hrs)

(e) Satellite communication: microwave frequency bands, concept of geo-stationary satellite, frequency bands used, satellite transponder, block diagram of earth station transmitter & receiver, advantages of satellite communication, principle of Global Positioning System (GPS).

(3 hrs)

(f) Optical communication: block diagram of the optical communication system, principle of light transmission through fiber, concepts of Single Mode and Multi Mode optical fiber, working principle of source (semiconductor Laser) & detector (PIN,APD), advantages of optical communication. (5 hrs)

MODULE 3 (Qualitative Treatment)

(a) Computer Architecture: functional units: basic concept of ALU- data path and control, memory hierarchy, caches, main memory, virtual memory, operating systems, microprocessors - functional block diagram of 8085

(9 hrs)

(b) Data communication: overview, analog and digital data transmission, transmission media, digitization of wave forms,
PCM, digital modulation techniques- ASK, PSK, FSK, basic concepts of error detection , parity checking. (6hrs)

(c) Mobile communication: basic principles of cellular communications, concepts of cells, frequency reuse, principle and block diagram of GSM,principle of CDMA, WLL & GPRS technologies. (4hrs)

(d) Internet Technology: concepts of networking: client - server computing, IP addresses, domain names, network interface unit - modem, switching technologies- circuit switching and packet switching, LAN,MAN,WAN &World wide web, network topologies, communication protocols- TCP/IP, Introduction to web languages-HTML,XML, internetworking concepts, network devices- basic principles of router, bridge, switch, network security- Firewall.

(7 hrs)

REFERENCES

1. **Santiram Kal,** *Basic Electronics – Devices, Circuits and IT fundamentals*, PHI
2. **Louis.E.Frenzel,** *Principles of Electronic Communication Systems*, TMH
3. **William Stallings,** *Wireless Communications and Networks*, Pearson Education.
4. **Moris Mano M,** *Computer Architecture*, PHI
5. **Neil H E Weste and Kamran Eshraghian,** *Principles of CMOS VLSI design – A system perspective*, Pearson Education [Module 1(f)]
6. **David A. Bell**, *Electronic Instrumentation and Measurements*, PHI .[Module 2(a)]
7. **Bhargava N.N, Kulshreshtha D.C and Gupta S.C,** *Basic Electronics & Linear Circuits*, TMH
8. ITL Education Solution Ltd., *Introduction to Information Technology*, Pearson Education, 5th edition, 2008
9. **R.R. Gulati,** ***Monochrome*** *and Colour Television*, New Age International [Module 2 (c)]
10. **Gopakumar K,** *Introduction to Electronics & Communication* , 3rd edition, 2008,Phasor Publisher's,Kollam

This faculty of Dept. of Electronics and Communication in the Colleges shall handle this subject.

Question Paper

The question paper shall consist of two parts. Part I is to cover the entire syllabus, and carries 40 marks. This shall contain 10 compulsory questions of 4 marks each. Part II is to cover 3 modules, and carries 60 marks. There shall be 3 questions from each module (10 marks each) out of which 2 are to be answered.

08.110 ENGINEERING WORKSHOPS

Credits: 4 **L/T/P: 0/0/2**

A. Carpentry: Study of tools and joints. Practice in planning, chiseling, marking and sawing. Joints – Cross joint, T joint, Dove tail joint.

B. Fitting: Study of tools, Practice in filing, cutting, drilling and tapping. Male and female joints, Stepped joints.

C: Sheet Metal Work: Study of tools. Selection of different gauge GI sheets for jobs. Practice on riveted joints. Preparing tube joints, frustums, trays and containers.

D. Plumbing: Study of tools. Details of plumbing work in domestic and industrial applications. Study of pipe joints, cutting, threading and laying of pipes with different fittings using PVC pipes. Use of special tools in plumbing work.

E: Foundry: Study of tools. Preparation of sand, moulding practice and demonstration of casting.
F. Welding: Study of welding machines. Straight line practices, Making of Butt joint, T joint and Lap joint.
G: Smithy: Study of tools. Demonstration on forging of square prism, hexagonal bolt, T bolt and Eye bolt.
H: Machine Tools: Study and demonstration on working of machine tools. Lathe and Drilling machine.

NOTE: For the university examination the student shall be examined in sections A, B, C, D and E only.

III SEMESTER

08. 301 ENGINEERING MATHEMATICS II (CMPUNERFHBTA)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Multiple Integrals: Double Integrals (Cartisian only).Change of order of integration. Area enclosed by plane curves. Triple integrals. Volume of solids.
Vector integration: Line and surface and volume integrals. Greens theorem in the plane. Stokes theorem and Gauss divergence theorem (no proof).

MODULE II

Fourier series: Fourier series of periodic functions of period 2π and $2l$. Dirichlet's condition for convergence. Odd and even functions. Half range expansions.
Fourier Transforms: Fourier integral theorem(no proof)-Fourier transforms- Fourier sine and cosine transforms , inverse Fourier transforms, properties

MODULE III

Partial differential equations: Formation of PDE. Solution of Lagrange's linear equation. First order nonlinear equations-standard forms -Homogeneous PDE with constant coefficients.
Application of PDE: Derivation of one dimensional Wave and Heat equations. Solution by separation of variables. Boundary value problems in one dimensional Wave and Heat equations.

REFERENCES

1. **Kreyszig,** *Advanced Engineering Mathematics,* 8th Edn., Wiley Eastern.
2. **Peter O Neil,** *Advanced Engineering Mathematics.Thomson Learning Publishers*
3. **B.S.Grewal,** *Higher Engineering Mathematics,* Khanna Publishers.
4. **B.V.Ramana,** *Higher Engineering Mathematics,* Tata Mc Graw Hill.
5. **Michel D Greenberg,** *Advanced Engineering Mathematics,* Pearson

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.302 BIOPROCESS CALCULATIONS (B)

Credits: 04 **L/T/P: 2/2/0**

MODULE-I

Units and dimensions: Systems of units, fundamental and derived units, unit conversions, dimensional homogeneity and dimensional analysis- problems.
Conversion of units. Concept of mass and force, definition of g_c and its utility. Various equations of state including ideal gas law to evaluate. P-V.T data, their application in process calculations by solving basics numerical problems.

Chemical arithmetic: Mole concept, atomic weight, molecular weight and equivalent weight- methods of determination.
Chemical composition: Methods of expressing compositions of mixtures and solutions- mole percent, mass percent, volume percent, molarity, molality, normality etc.
Thermodynamic preliminaries: Systems and processes, steady and equilibrium state, reference states, energy forms, state properties, concept of enthalpy changes for reactive and non-reactive processes.
P-V-T behaviour of pure liquids- Gas laws, real and ideal gases, equation of state, critical properties, properties of gas mixtures- Dalton's laws, Amagat's law-Average molecular weight and density- problems.
Biochemical stoichiometry: Limiting and excess reactants- conversion, degree of completion, selectivity, yield- problems.

MODULE-II

Fundamentals of material balances- Law of conservation of mass- Types of material balances, material balance with recycle bypass and purge streams- Material balance for industrial fermentation, downstream processing and waste treatment processes- problems.

Stoichiometry of microbial growth and product formation- Growth stoichiometry and elemental balances- respiratory quotient, degree of reduction-Yield and maintenance coefficients- Oxygen consumption in aerobic microbial cultures- Theoretical Oxygen demand- problems.

MODULE-III

Fundamentals of energy balances- Law of conservation of energy- Energy balance calculations with and without reactions- Energy balance for fermentation and downstream processing- problems.

Biochemical energetics: Metabolic reaction coupling, energetics of metabolic processes (respiration and biosynthesis)- Transport across cell membranes- Thermodynamics of microbial growth- Heat generation in microbial cultures- problems.

REFERENCES

1. **Doran P.M,** *Bioprocess Engineering Principles,* Academic Press
2. **Bailey G.E** and **Ollis D.F**, *Bioprocess Engineering Fundamentals* McGraw Hill
3. **Shuler M.L** and **Kargi F**, *Bioprocess Engineering- Basic Concepts,* Pearson Education
4. **Segel I.H,** *Biochemical Calculations,* John Wiley
5. **Blanch H.W** and **Clark D.S**, *Biochemical Engineering* Marcel Dekker Inc.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.303 CELLULAR AND ORGANISMAL BIOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Cell structure and function of the organelles**:** Eukaryotic and Prokaryotic cells, Principles of membrane organisation, membrane proteins, cytoskeletal proteins, types of cell function, cell division, mitosis and meiosis, Extra cellular matrix, cell cycle and molecules that control cell cycle.

Transport across cell membranes**:** Passive and Active transport, permeases, sodium potassium pump, Ca2+ ATPase pumps, lysomal and vacuolar membrane ATP dependent proton pumps, Co Transport Symport, Antiport, transport into Prokaryotic cells endocytosis and Exocytosis. Entry of viruses and toxins into cells.

MODULE II

Receptors and models of extra cellular signalling: Cytosolic, nuclear and membrane bound receptors, Examples of receptors, Autocrine, Paracrine and Endocrine models of action, Quantitation of Characterisation of receptors.

Signal transduction: Signal amplification, Different models of signal amplifications, Cyclic AMP, Role of inositol phosphates as messengers, biosynthesis of inositol triphosphates, cyclic GMP and G proteins role in signal transduction, Calcium ion flux and its role in cell signalling, current models of signal amplification, Phosphorylation of proteins Kinases.

MODULE III

Cell culture: Techniques for the propagation of prokaryotic and Eukaryotic cells. Cell line, generation of cell lines, maintenance of stock cells, Characterisation of cells, Immuno cytochemistry, morphological analysis techniques, in cell culture, explant cultures primary cultures, contamination, Differentiation, Three Dimensional cultures, role of matrix in cell growth.

Organismal biology: Concepts of evolution and microbial diversity- fundamentals of taxonomy- Overview of animal physiology- basic elements of animal nutrition, Circulation and gas exchange, The immune system, Osmoregulation and excretion, Sensory and motor mechanisms, The nervous system, Animal reproduction and development, Hormones and the endocrine system.

Developmental Biology- Embryonic development, cellular differentiation, organogenesis, metamorphosis, genetic basis of development, stem cells.

Ecology- The ecosystem, habitats, the food chain, population dynamics, species diversity, zoogerography, biogeochemical cycles, conservation biology.

REFERENCES

1. **Ferl R.J and Wallace R.A**, *Biology- The realm of life*, Harper Collins College Publishers
2. **Mader S.S,** *Biology* Mc Graw Hill
3. **Cooper,** *The Cell- A Molecular Approach*, ASM Press, Sinouer
4. **Lodish H., Berk A, Zipursky, S.L. Matsudaria, P. Baltimore D and Darnell J,** *Molecular Cell Biology*, Media connected, W.H. Freeman and Company.
5. **Becker, Kleinsmith, Hardin,** *The World of the Cell*, Pearson Education
6. **Celis,** *Cell Biology*, Academic Press
7. **De Robertis E.D.Pi and De Robertis E.M.F,** *Cell and Molecular Biology*, B I Waverly Pvt. Ltd., New Delhi.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.304 PRINCIPLES OF MOMENTUM TRANSFER (B)

Credits: 04 **L/T/P: 2/2/0**

MODULE- I

Introduction: Fluid mechanics- Properties of fluids, fluid statics, The Basic Equation of Fluid Statics, Pressure measurement, energy balance in fluid flow through pipes and conduits, Bernoulli's equation and its application, the Bernoulli's Theorem and its relationship to the static head, kinetic head, potential head and head loss. Application of Bernoulli's Theorem in Pumps, Venturimeters, Pitot tube and orifices. Calculation of power required for pumping fluids. Examples from bioprocessing systems.

Rheology of fluids - Newton's law of viscosity. Concept of Newtonian and non - Newtonian fluids- Different types of non-Newtonian fluids with examples in bioprocessing., use of viscometers with biological reaction fluids, rheological

properties of fermentation broth, factors affecting broth viscosity (cell concentration, cell morphology, osmotic pressure, product and substrate concentration).

Measurement of viscosity using extrusion rheometer, plate and cone viscometer, impeller viscometer and coaxial cylinder rotary viscometer.

MODULE-II

Flow through pipes, average velocity, flow regimes, boundary layer concept. Laminar and turbulent flow – characterization by Reynold's number, pressure drop due to skin friction and form friction, friction factor chart, Hagen -Poiseuille equation. Various equations for friction factor and Reynold's number for laminar and turbulent flow. - Moody chart Design of pipeline diameter and flow rate.

Pipes and fittings: Standard pipe sizes, Nominal pipe size, valves, bends, elbows, prevention of leaks, mechanical seals, stuffing box (A brief study is only desired).

Fluid transportation machinery: Different types of pumps, positive displacement pumps, reciprocating pumps, diaphragm pumps, peristaltic pumps (A brief study is only desired).

Flow past immersed bodies: Definition of drag and drag coefficient, Settling : Flow around a single particle, drag force and drag coefficient, settling velocity of particles in a fluid, free and hindered settling of particles, thickening by gravity separation.

Friction in flow through beds of solids: derivation of friction factor equations and pressure drop expressions, flow though a bed of particles. Packed beds, bed porosity, fluidization and fluidized bed, conditions for fluidization minimum velocity, types of fluidization. Comparison between packed and fluidized beds.

MODULE –III

Particle Size distribution: Importance of particle size in reactions, particle size, shape and mass distributions, measurement and analysis, concept of average diameter. Screening:-Screening equipment, capacity and effectiveness of screen, effect of mesh size on capacity of screen. Particle size analysis:- mean diameter, derived diameter. Sieving - cumulative method and differential method. Sub-sieve size analysis:- microscopic counting. Pipette analysis, hydrometer analysis, Photo sedimentation - sedimentation balance, sedimentation and decantation - ICI Sedimentation

Momentum transport by agitation: Power requirements and mixing characteristics of ungassed and gassed systems- Concept of power number, use of monographs- Defining impeller Reynolds number for Newtonian and non-Newtonian fluids- Concept of aeration rate to calculate impeller power requirement of gassed systems.

Mixing:- Mixing and bioreaction interactions - Application of mixing in bioprocessing.

REFERENCES

1. **D.G.Rao**, *Introduction to Biochemical* Engineering, Tata Mc Hill
2. **Pauline M.Doran,** *Bio-process Engineering Principles,* Academic press
3. **Mc Cabe, W.L, Smith J.C. and Harriot P,** *Unit operations of Chemical Engineering*, Mc-Graw Hil,
4. **Charles, M** *Technical aspects of the rheological properties of microbial cultures,* in Advances in Biochemical Engineering and Blakebrough, N.(Eds), Spinger-Verlag, Berlin
5. **Earle, R.L,** *Unit operation in Food processing*, Pergamon Press, Oxford

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.305 BIOCHEMISTRY (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Biomolecules structure and function: Carbohydrate – simple sugars and polysaccharides, complex polymers and glycoproteins; Fatty acids structure and chemistry, complex lipids, cholesterol, steroids; amino acids – protein building blocks, structure, nomenclature, polynucleotides – DNA, RNA and their primary and secondary, tertiary structure-chemical synthesis
Role of carbohydrates, proteins, lipids and nucleic acids in cellular functions. Chemical properties and reactions of carbohydrates, proteins, lipids and nucleic acids

MODULE II

Enzymes : concepts of ligand-enzyme binding interactions, classification of reactions, activation energy and rates of reactions; Michaelis-Menten equation, inhibition and allostery; Bioenergetics –overview, basic thermodynamics , role of ATP; redox biochemistry.
Overview of metabolism. Cellular energy requirement for vital functions, energy conversions, photosynthesis and ATP, the food chain, energy content of food materials, vitamins and cofactors. Electron transport chain, chemiosmotic coupling, mitochondial metabolism. Photosynthesis. Comparison to oxidative phosphorylation, photophosphorylation, Calvin Cycle.

Carbohydrate metabolism: Glycolysis and TCA cycle- glycolysis reactions. TCA cycle and the glyoxylate cycle, mitochondrial shuttles.

MODULE III

Gluconeogenesis – urea cycle, amino acid degradative pathways, biosynthetic pathway of amino acids in microorganisms. Fatty acids metabolism – □- oxidation pathway, ketone bodies , biosynthesis of fatty acids.
Control of metabolism – biosynthetic and catabolic perspectives. Control of level of glucose in blood, hormonal integration of metabolism, regulatory mechanisms.

REFERENCES

1. **Lehninger A.L**, **Nelson D.L** and **Cox M.M**, *Principles of Biochemistry*, Palgrave Macmillan
2. **Stryer L, Berg J.M.** and **Tymoczko J.L**, *Biochemistry*, 5th Edn., W.H. Freeman and Co.
3. **Zubay G**, ***Biochemistr*y**, 4th Edition, McGraw Hill Publishers.
4. Voet. D and Voet. J.G, *Biochemistry*, John Wiley and Sons.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of 10 compulsory short answer questions each carrying 4 marks covering the entire syllabus.
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.306 MICROBIOLOGY (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Historical Perspective: Discovery of microbial world; Landmark discoveries relevant to the field of microbiology; ontroversy over spontaneous generation- Scope and relevance of microbiology. Role of microorganisms in transformation of organic matter and in the causation of diseases.

Study of microbial structure; microscopic techniques:- light microscopy, dark field microscopy, phase contrast microscopy, fluorescence microscopy, SEM, TEM, newer techniques:- confocal microscopy, scanning probe microscopy.
Staining techniques:- cell staining-simple staining, gram staining, acid fast staining; staining of specific structures.

Eukaryotic and prokaryotic cell structure and function: size, shape and arrangement, cell membranes, cell organelles, cell walls, components external to cell walls. Microbial chemotaxis, mechanisms of solute transport across cell membranes.

Microbial taxonomy:- evolution and diversity of microorganisms, taxonomic ranks, classification systems, assessment of microbial phylogeny. Bacteria, archea and their broad classification; Eukaryotic microbes: Yeasts, molds and protozoa; Viruses and their classification, viroids and prions.

Microbial nutrition and cultivation : Nutrition of microorganisms; nutritional classes of microbes, Macro and micronutrients, sources and physiological functions of nutrients. Growth factors and their functions in metabolism. Cultivation of microorganisms:- Culture media- synthetic, complex media, solidifying agents, types of media - selective, differential and enrichment media, pure culture methods - spread plate, pour plate and streak plate, special techniques for cultivation of anaerobes.

MODULE II

Microbial Growth: Definition of growth; growth curve; mathematical expression of exponential growth phase; measurement of growth and growth yields; synchronous growth; continuous culture; effect of environmental factors on growth, growth in natural environments.

Microbial Metabolism: An overview of metabolism; glycolysis; Pentose-phosphate pathway; Entner-Doudoroff pathway; Glyoxalate pathway; The citric acid cycle; Fermentation; Aerobic and anaerobic respiration; Chemolithotrophy; Photosynthesis; Calvin cycle; Biosynthetic pathway for fatty acids synthesis; Common regulatory mechanisms in synthesis of amino acids; Regulation of major metabolic pathways.

Control of microorganisms: Basic terminology- sterilization, disinfection, sanitization, antiscepsis. Patterns of microbial death, physical methods for microbial control- heat, low temperature, filtration and radiation. Use of chemical agents, evaluation of effectiveness of antimicrobial agents.

Microbial interactions and ecology: Types of microbial interactions- mutualism, protocooperation, commensalisms, predation, parasitism, amensalism, competition, symbiosis. Biogeochemical cycles:- cycles of nitrogen, carbon, sulphur and manganese.

Microorganisms in aquatic environments: microbial community in marine and fresh water environments, microbiological analysis of water purity-sanitary tests for coliforms (presumptive test, confirmed test, competed test), MPN test, defined substrate test, IMVIC test. Quality standards for drinking water.
Soil microbiology- soil as a habitat for microorganisms, physico-chemical properties of soil, microbial community in soil, role of microorganisms in organic matter decomposition.

MODULE III

Microbial Diseases and Host Pathogen Interaction: Normal microbiota; Classification of infectious diseases; Reservoirs of infection; Nosocomial infection; Emerging infectious diseases; Mechanism of microbial pathogenicity; Nonspecific defense of host; Antigens and antibodies; Humoral and cell mediated immunity; Vaccines; Immune deficiency; Human diseases caused by viruses, bacteria and pathogenic fungi.

Chemotherapy/Antibiotics: General characteristics of antimicrobial drugs; Antibiotics: Classification, mode of action and resistance; Antifungal and antiviral drugs.

Microbiology of food: Role of microorganisms in food spoilage and contamination, food preservation methods-physical and chemical methods, food borne diseases and intoxications, examples of fermented food products.

Microorganisms as biofertilizers and biopesticides, commercially important microorganisms for industrial fermentations.

REFERENCES

1. **Pelczar M.J. Chan ECE** and **Krieg NR,** *Microbiology*, Tata McGraw Hill.
2. **John. L. Ingraham** and **Catherine A lingraham**, *Introduction to Micro Biology a case History approach,* 3rd edition Thomson Publications.
3. **Brock**, *Biology of Microorganism*, Prentice Hall, International Inc.
4. **Hons. G.Schlege** , *General Microbiology*, Combridge university press.

5 **Roger Y Stanier,** *General Microbiology*., Macmillan.
6 **Prescott, Harley and Klein**, Microbiology. Mc Graw Hill

The question paper consists of Part A and Part B. Part A is for 40 marks. There will be 10 compulsory short answer questions each carrying 4 marks covering the entire syllabus.
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.307 BIOCHEMISTRY LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

Units, Volume/Weight measurements, concentrations units, pH. measurements. Preparation of buffers, Sensitivity, Specificity, precision and Accuracy.

1. Qualitative tests for Carbohydrates. Estimation of Reducing sugars by the Benedict's method.
2. Qualitative tests for Amino Acids.
3. Quantitative method for Amino Acids, Ninhydrin method.
4. Protein estimation Biuret, Folin's, Spectrophotometry and Bradford Assay.
5. Acid hydrolysis of Proteins and Estimation of Amino acids by Ninhydrin, OPA PTH.
6. Extraction of lipids.
7. Saponification of Fats.
8. Phospholipids: Ashing and estimation of phosphate.
9. Estimation of cholesterol.
10. Estimation of Nucleic Acids, Precipitation by sodium sulphate, Test for ribose and deoxyribose
11. Enzyme assays: Phosphatase from potato, Amylase from sweet potato, Trypsin digestion of proteins.
12. Precision and validity in an experiment using absorption spectroscopy.
13. Validating Lambert-Beer's law using $KMnO_4$
14. Finding the molar absorbtivity and stoichiometry of the Fe (1, 10 phenanthroline) 3 using absorption spectrometry.
15. Finding the pKa of 4-nirophenol using absorption spectroscopy.
16. UV spectra of nucleic acids.
17. Chemical actinometry using potassium ferri oxolate.
18. Estimation of SO-4 by nephelometry.
19. Estimation of AL3+ by flourimetry.
20. Limits of detection using aluminum alizarin complex.
21. Chromatography analysis using TLC.
22. Chromatography analysis using column chromatography

REFERENCES

1. **Rodney** and **Royer**, *Modern Experimental Biochemistry*, Pearson education, India.
2. **Alexander J. Ninfa** and **David P. Ballou**, *Fundamental Laboratory Approaches for Biochemistry and Biotechnology*, Fitzgerald Science Press Inc, USA.
3. **Wilson K** and **Walker J**, *Principles and Techniques of Practical Biochemistry*, Cambridge University Press.

08.308 CELLULAR AND MICROBIOLOGY TECHNOLOGY LAB (B)

Credits: 03 **L/T/P: 0/0/3**

EXPERIMENTS:

- Introduction to principles of sterile technique and cell propagation.
- Preparation of media and media components.
- Identification of plant, animal and bacterial cells and their components.
- Measurement of growth - Wet weight and dry weight measurements, extinction method of monitoring cell growth.
- Measurement of cell viability- TTC and NBT tests, staining using Fluorescein diacetate, Phenosafranin, Methylene blue, Ethidium Bromide and Evans blue.

- Selection and isolation of bacteria eg: Isolation of bacteria capable of degrading PAH from oil contaminated earth.
- Isolation and characterization of bacteria from leaf tissues, leaf rot etc.
- Testing of microbial capacity to produce biologically active substances
- Taxonomic classification of isolated microbes
- Long and short term storage of microbes (bacteria and fungi)
- Isolation of fungal and plant protoplasts
- Protoplast fusion (PEG mediated)
- Study of density gradient centrifugation (using CsCl and sucrose) for isolation of cell components.
- Cryopreservation of cells and recovery of frozen stocks into culture.
- Principles of microscopy, phase contrast and fluroscent microscopy
- Staining: Gram, Giemsa , Trypan blue
- Cytotoxicity assays-L3HJ Thymidine,
- Constituents of blood, blood smear
- Separation of plant pigments by TLC
- Osmosis and Tonicity, slide identification of different cells,
- Mitosis in onion root tip.
- Cell culture techniques- plant cell culture only.
- Microbiological examination of water.

- **Biochemical tests:**
  IMVIC test, Catalase test, Coagulase test, Gelatinase test, Oxidase test and other related tests.

REFERENCES

1. **Benson**, *Microbiological and applications, Laboratory, Manual in General Microbiology* Mc Graw Hill Publications
2. **Gunasekharan P**, *Laboratory manual in Microbiology*, New Age nternational Publishers.
3. **Cappucin J.G and N.Sherman**, A *Laboratory Manual*, 4th edition, Addison and Weslay.

FOURTH SEMESTER

08.401 ENGINEERING MATHEMATICS III (CMPUNERFHB)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Complex Differentiation: Limits, continuity and differentiation of complex functions. Analytic functions-Cauchy Reimann equations in Cartesian form (proof of necessary part only) properties of analytic functions-harmonic functions. Milne Thomson method

Conformal mapping: The Transformations $w=1/z$, $w=z^2$, $w=z+1/z$, $w=\sin z$,$w=\cos z$,Bilinear transformation

MODULE II

Complex Integration: Line integral- Cauchy's integral theorem-Cauchy's integral formula. Power series-radius of convergence-Taylors and Laurents series-zeros and singularities –Residues and residue theorem. Evaluation of real definite integrals-

$\int_0^{2\pi} f(\sin\theta, \cos\theta)\, d\theta$, $\int_{-\infty}^{\infty} f(x)\, dx$ with no poles of $f(z)$ on the real axis (proof of theorems not required)

MODULE III

Numerical Techniques: Errors in numerical computation-solution of algebraic and transcendental equations by bisection method, regula false method, Newton- Raphson method. Solution linear systems by Gauss elimination and Gauss-Seidal method. Newton's forward and backward interpolation formula. Lagranges interpolation formula. Numerical integration. Trapezoidal and Simpson's rule. Numerical solution of ODE Taylor series method,

Eulers method, Runge Kutta methods (derivation of formulae not required for the above methods.)

REFERENCES

1. **Peter V. O'Neil**, *Advanced Engineering Mathematics*, Thomson Pub.
2. **Erwin Kreyszig**, *Advanced Engineering Mathematics*, Wiley.
3. **Greenberg**, *Advanced Engineering Mathematics*, Pearson.
4. **Grewal B.S**, *Higher Engineering Mathematics*, Khanna Publishers.
5. **Ramana B.V**, *Higher Engineering Mathematics*, Tata Mc Graw hill.
6. **Veerarajan C T** and **T.Ramachandran**, *Numerical Methods with programming in C,* Second edition, TMH, 2006.
7. **Sastry S.S**, *Introductory methods of numerical analysis,* .Prentice Hall of India

*The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*
*Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*
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08. 402 HUMANITIES (CTARFHB)

Credits: 03 **L/T/P: 3/0/0**

PART I- ECONOMICS (2 periods per week)

MODULE I

Definition of Economics – Basic Concepts Goods – Choice of techniques – Production possibility curve National Income concepts - GNP – GDP – NNP – Per Capita Income – Three Sectors of the Economy – Primary – Secondary, Tertiary Sector – Significance of Money.
Meaning of Demand and Supply – Types of demand – Determinants of Demand – Demand forecasting
Production function – Law of Variable proportion – Returns to scale - Least cost combination of inputs – Cost concepts – Cost output relationship

MODULE II

Inflation – causes of inflation – measures to control inflation – Demand – Pull inflation – cost push inflation – effects of Inflation – effects of inflations comparison between inflation and deflation

India's Economic crisis in 1991 – New economic policy – Global Financial meltdown in 2008 – Applicability of Keynesian Theory to UDC'S.

Stock Market and present scenario – Industrial sector past and present – Industry Analysis – Electronics – Chemical – Automobile – FMCG Industry.

Environment and Development – Basic Issues – Sustainable Development and Environmental Accounting – Population – Resources and the Environment – Poverty and the Environment – Growth versus the Environment – The Global Environment .

PART II- ACCOUNTANCY (1 Period per week)

MODULE III

Book- Keeping and Accountancy -Elements of Double Entry -Book- Keeping-rules for journalizing -Ledger accounts – Cash book-Banking transactions – Trial Balance- Method of Balancing accounts- the journal proper (simple problems). Final accounts: Preparation of trading and profit and loss Account- Balance sheet (with simple problems) - Introduction to Accounting packages (Description only)

REFERENCES

1. **K.K Dewett**, *Modern Economic theory,* S Chand and Co.
2. **Michael – Todaro,** *Economic Developmen*t, Addison Wesley Longman Ltd.
3. **Mohinder Kumar Sharma,** *Business Environment in Indi, South Asia Books*

4. **D.M. Mithani**, *Money, Banking, International Trade and Public Finance,* Himalaya publishing House, New Delhi.
5. **Rudder Dutt and K.P.M Sundaran,** *Indian Economy*, S Chand and Co.
6. **Hal R. Varian,** *Intermediate Micro Economics- A Modern Approach*, WW Norton and Co (United States), 2006
7. **Koutsoyiannis A**, ***Modern*** *Micro Economics*, 2nd Edn, Macmillan, UK
8. **Batliboi J.R,** *Double Entry book Keeping*
9. **K.G. Chandrasekharan Nair,** *A Systematic approach to Accounting:*

UNIVERSITY QUESTION

Note: Part I and Part II to be answered in separate answer books.

Part – I Economics
Part A – 30 Marks (short answers) covering entire syllabus (3x10=30)
Part B – 40 marks (50% choice one out of two or two out of four from each module)
Part – II Accountancy
Three questions covering entire syllabus out of which two questions has to be answered (2x15=30)

08.403 MOLECULAR BIOLOGY (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Identification of the genetic material - classical experiments: Griffith's, Avery McLeod, Hershey Chase. Structure of DNA: Detailed structure of DNA, different forms of DNA, denaturation and melting curves. Structure of RNA: mRNA, rRNA and tRNA primary, secondary, tertiary structures and functions. DNA Replication: Models of DNA replication- Experimental evidence for semi conservative; Mechanism of DNA replication in E.coli (bidirectional), Stages of replication, Mitochondrial (D-loop), Viral DNA (Rolling circle), Enzymes and protein factors involved in replication. Chromosomal replication of prokaryotes and eukaryotes.

Transcription:-Transcription apparatus, RNA polymerases and proteins involved in transcription, Stages of Transcription, transcription factors, upstream activation sequences, Consensus sequences. Exon intron concept. Difference between prokaryotic and eukaryotic transcription. Post transcriptional processing of RNA's- tRNA, rRNA, mRNA splicing, inhibitors of transcription.

MODULE II

Translation: The genetic code and Wobble hypothesis and codon usage, Protein synthesis in prokaryotes and eukaryotes, protein factors involved in protein synthesis, post translational modifications, inhibitors of translation.
Chromosome organization in eukaryotes, Interaction between DNA and DNA binding proteins, DNA binding domains and motifs: Helix loop helix, Zinc finger, homeodomain Leucine zippers and basic helix-loop helix.
Mutagenesis: Types of mutations, Mutagens- types and action, DNA repair: Photoreactivation, Excision repair, Recombination repair and SOS repair
Regulation of gene expression: Constitutive and induced enzymes in bacteria, enzymes repression, catabolic repression. Regulatory genes, structural genes and repressors. The operon model - lactose, histidine operon, arabinose and tryptophan operon.

MODULE III

Transposons : Types ; retroposons – Viral and nonviral super family; LINES and SINES. Reverse transcription, retroviruses and retroviral genome.
Oncogenes: Characteristics of tumor cells, types, viruses as transforming agents (DNA and RNA virus), carcinogens, tumor suppressor genes
Genetic recombination in Bacteria: Conjugation, transduction and transformation.

REFERENCES

1. **Freifelder D,** *Molecular Biology*, Jones and Bartlett Publishers Inc
2. **Lehninger A.L, NelsonD.L** and **CoxM.M**, *Principles of Biochemistry,* Palgrave Macmillan
3. **Stryer L, Berg J.M.** and **Tymoczko J.L**, *Biochemistry*, W.H. Freeman and Co.
4. **Zubay G**, *Biochemistr*y, 4th Edition, McGraw Hill Publishers

5. **Voet. D** and **Voet. J.G**, *Biochemistry*, John Wiley and Sons

6. **Benjamin Lewin,** Genes, VI,VII., Oxford University Press.
7. **Klug, W. S.** and **Cummings, M. R**., Concepts of Genetics, Pearson Education

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
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08.404 COMPUTER PROGRAMMING IN C++ (B)

Credits: 04 **L/T/P: 2/2/0**

MODULE I

Problem solving Algorithm / pseudo code, flowchart, program development steps - C++ programming language – Character set, tokens, data types, variables, operators, expressions, Input and Output, Selection statements – if, switch statements, Looping statements - for, while, do-while statements, Jump statements – break, continue, goto exit(), Arrays - single and multi-dimensional arrays, initializing array elements, Character arrays, Unformatted console I/O functions, Unformatted Stream I/O functions, string functions.

MODULE II

Functions – Arguments, returning function results, call by value, call by reference, functions calling functions, functions and arrays - Global variables, automatic, static and register variables, pointers and arrays ,recursive functions, function overloading.
Structures - functions and structures - Arrays of structures - structures within structures, Structures containing arrays.
Files - Input and Output, sequential and random access

MODULE III

Searching – Linear and binary search methods, sorting – Bubble sort, selection sort, Insertion sort, Quick sort, merge sort.
Introduction to data structures, singly linked lists, doubly linked lists, circular list, representing stacks and queues in C using arrays and linked lists, infix to post fix conversion, postfix expression evaluation.

Basic concepts of object oriented programming, advantages of object oriented programming, Implementation of object oriented programming concepts in C++, Definition of a class, members of a class, data members and member functions, Declaration of objects, array of objects, Constructors and Destructors, Inheritance.

REFERENCES

1. **John Hubbard**, *Schaum's Outline of Programming with C++*, Tata McGraw Hill
2. **Robert Lafore**, *Object-Oriented Programming in C++*, SAMS Publishers
3. **Kamthane**, *Object Oriented programming with ANSI and TURBO C+*, Pearson Education
4. **Balaguruswamy**, *Object Oriented programming with C++*, Tata Mcgraw Hill
5. **D'Orazio, T. B**, *Programming in C++: Lessons and Applications*, McGraw-Hill

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.405 INDUSTRIAL BIOPROCESS TECHNOLOGY (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

A historical overview of industrial fermentation process – traditional and modern biotechnology. A brief survey of organisms, processes, products relating to modern biotechnology-industrially useful microorganisms. Process flow sheeting – block diagrams with industrial pictorial representation for various equipments.

Raw materials for fermentation process: Isolation, preservation and improvement of industrial micro-organisms for overproduction of primary and secondary metabolites. Medium requirements for fermentation process carbon, nitrogen, minerals, vitamins and other nutrients. Examples of simple and complex media. Basic design of the fermenter, overview of fermentation processes.

Production and purification of primary metabolites : Industrial processes for the manufacture with the important engineering problems involved in the manufacture of the following products with flow diagram, reactions and conditions:-

Organic acids-citric acid, lactic acid itaconic acid and acetic acid and other commercially important organic acids; amino acids -glutamic acid, lysine, phenyalanine, aspartic acid and other commercially important amino acids; alcohols:- ethanol, acetone and butanol.

MODULE II

Production of secondary metabolites :- Industrial production processes for various classes of secondary metabolites: antibiotics: beta-lactams-penicillin and cephalosporin; aminoglycosides- streptomycin, kanamycin; macrolides-erythromycin, quinines, aromatics; commercially important vitamins and steroids.
Production and purification of enzymes and other byproducts: Microbial production of industrial enzymes: proteases, amylases, lipases and cellulases. Production of biofertilizers- manufacture, formulation and utilization, biopesticides:- Characteristics of biopesticides. Important biopesticides- Bt-toxin, Kasugamycin, Beauverin, Devine and Collego. Biopreservatives- Nisin; biopolymers- Xanthan gum and PHB; single cell protein.

Beverages:- production of beverages, beer, wine, microbes in baking- production of baker's yeast, milk products.

Bioremediation- microbes in mining, ore leaching, oil recovery, waste water treatment, biodegradation of non cellulose and cellulosic wastes for environmental conservation

MODULE III

Production modern biotechnology products: Production of recombinant proteins having therapeutic and diagnostic applications, production of vaccines. Production of monoclonal antibodies. Products of plant and animal cell culture.

Enzymes: Isolation and purification of commercially important enzymes: Extraction of enzymes, preparation of crude enzymes, purification and characterization of enzymes from plant, animal and microbial sources. Application of enzymes in industry, analytical purposes and medical therapy.

REFERENCES

1. **Casida Jr, L.E,** *Industrial Microbioloy*, New Age International (P) Ltd.
2. **Presscott, Dunn,** *Industrial Microbiology*, Agrobios (India).
3. **Wulf Cruger and Anneliese Crueger,** *Biotechnology: A Textbook of Industrial Microbiology*, Panima Publishing Corporation.
4. **Murrey Moo and Young,** *Comprehensive Biotechnology*, Pergamon.
5. **Palmer T,** *Enzymes: Biochemistry, Biotechnology, Clinical chemistry,* Horwood publishing Colphon.
6. **Jackson, A.T,** *Process engineering in biotechnology,* Prentice Hall.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.406 CHEMICAL AND BIOCHEMICAL REACTION ENGINEERING (B)

Credits: 04 **L/T/P: 2/2/0**

MODULE I

Scope of chemical kinetics and chemical reaction engineering: Broad outline of chemical and biological reactions, their classification, industrial scale reactors, differences between chemical and biological reactors. Role of mechanism of reaction in reactor design..
Kinetics of homogeneous chemical reactions rate, order and molecularity, rate equation, rate constant, elementary and non elementary reactions, single and multiple reactions. Temperature and concentration dependence of rate: different theories.
.
Interpretation of batch reactor: Constant volume batch reactor, integral method of analysis of data, series and parallel reactions, reversible reactions- concept of equilibrium conversion. Variable volume batch reactor, development of rate equations for different homogeneous reactions. Collection and analysis of batch reactor data: differential method of rate analysis, integral method, method of half lives, method of initial rate, least square analysis.
.
A brief overview of measurement of growth kinetics of microbial cultures in ideal batch and CSTR. Brief introduction to Chemostat models- Monod, Tessier, Moser and Contois models. Introduction to kinetics of enzymatic reactions- Michaelis – Menten equation. (A brief account of the above models is required at this stage as this will be discussed in detail in Bioprocess Engineering course).

MODULE II

Ideal reactors: Isothermal batch, mixed flow reactor, plug flow reactor, semi-batch reactors; concept of holding and space time. Performance equations for single reactors; multiple reactor systems, comparison of productivity in plug flow and CSTR. Numerical problems.
Design of multiple reactors: Kinetics of series and parallel reaction, yield and selectivity of multiple reactions, Contacting patterns for series and parallel reactions, quantitative treatment of product distribution and reactor size, best operating conditions for parallel and series reactions. Series-parallel reactions. Numerical problems.

Application of tubular reactor concept in the design of packed bed bioreactors, bubble-column bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors, photo bioreactors.

MODULE III

Non isothermal reactor design - Heat of reaction from thermodynamic, heat of reaction and temperature, equilibrium constants from thermodynamics, equilibrium conversion, adiabatic temperature and equilibrium, graphical design procedure, optimum temperature progression. Heat effects: adiabatic operations and no adiabatic operations, Non-isothermal continuous flow, reactors at steady state, application to the CSTR, adiabatic tubular and batch reactor, steady state tubular reactor with heat exchange.

Analysis of non- ideal behavior in bioreactors- reasons for non ideality-importance of RTD studies- stimulus-response experiment-circulation time distribution, exit age distribution, F-curve and C-curve- mean and variance of residence time-diagnosis of ills of flow reactors- models for non-ideal reactors- zero, one and two parameter models (with emphasis on the tanks in series model and dispersion model) - estimation of conversion using these models.

REFERENCES

1. **Levenspiel O**. *Chemical Reaction Engineering*, Edition. John Wiley.
2. **Fogler H.S**. *Elements Of Chemical Reaction Engineering*, Prentice Hall India
3. **Missen R.W, Mims C.A** and **Saville B.A,** *Introduction to Chemical Reaction Engineering and Kinetics*, John Wiley.
4. **D.G.Rao, *Introduction to Biochemical Engineering***, Tata Mcgraw Hill.
5. **Syed Tanveer Ahmed Inamdar**, *Biochemical Engineering*, Prentice Hall of India

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.407 INSTRUMENTAL METHODS AND ANALYSIS LAB (B)

Credits: 03 **L/T/P: 0/0/3**

1. Verification of Lambert – Beers Law by UV – VIS spectrophotometer .
2. Estimation of different macromolecules by visible spectrophotometer
3. Estimation of turbidity using UV-VIS spectrophotometer
4. Estimation of proteins and nucleic acids by U.V. method.
5. Emission spectra of Anthracene using Spectrofluorimeter.
6. Separation of different macromolecules by Paper, Thin layer and HPLC chromatography
4. Separation of amino acids/ sugars by paper chromatography.
5. Extraction of lipids from tissues and their separation using TLC.
6. Partial purification of an enzyme by ammonium sulphate fractionation, Ion exchange and gel filtration chromatography of proteins.
7. Determination of molecular weight of an enzyme by gel filtration.
8. Separation of proteins by SDS-PAGE.
9. Cell fractionation
10. Image analysis and densitometry
11. Determination of optical activity of simple sugars by polarimetry
12. Determination of refractive index of sugar solutions by refractometry
13. Conductometric acid-base solutions titrations:

REFERENCES

1. **Campbell I.D**.and.**Dwek R.T**, *Biological Spectroscopy*, Benjameer Cunmeib and Co.
2. **Settle F**. *Handbook of Instrumental Techniques for Analytical Chemistry* Prentice Hall
3. **Botton W**, *Instrumentation and Process Measurements*, University Press.
4. **Wilson K** and **Walker J.**, *Principles and techniques of Practical Biochemistry*, Cambridge University Press,
5. **David T. Plummer,** *An introduction to Practical Biochemistry,* McGraw- Hill.

08.408 FLUID SOLID SYSTEMS LABORATORY (B)

Credits: 03 **L/T/P: 3/1/0**

Experiments:

1) Determination of size distribution of pellets in a cell suspension (photosedimentation/ beaker decantation/ use of Andreason's pipette/ ICI sedimentation columns/manometric methods. micromerograph)
2) Size analysis by microscopy, sieve analysis and Hydrometer method. (the sample used may be cassava powder/ powdered yeast)
3) Determination of porosity of particles (porosimeters)
4) Determination of surface area of particles (gas absorption measurements)
5) Batch settling test using yeast suspension to determine area of a continuous thickener.
6) Use of viscometers for measurement of viscosity of fermentation broths /process fluids.
7) Studies on factors influencing viscosity of process fluids.
8) Scale up of centrifuges- use of Gyrotesters.
9) Studies on flocculation- analysis of orthokinetic and perikinetic aggregation.
10) Scale up studies on mixing vessels.
11) Estimation of various parameters for agitation of liquids.
12) Calibration of flow meters for liquid flows
13) Reynold's experiment.
14) Determination of velocity profile using Pitot tube.
15) Flow through packed beds: Estimations of pressure drop.
16) Flow through fluidised beds: Estimations of pressure drop.
17) Fall of solid bodies and liquid drops through liquids: determination of drag coefficient and verification of Stoke's Law.

N.B Questions from the following demonstration experiments should not be included in the University examination.

Demonstration Experiments:

1. Characteristics of pumps.
2. Measurement of flow using notches and weirs

3. Measurement of pressure.
4. Friction losses in pipes and fittings
5. Measurement of flow using orifices and mouth pieces.

FIFTH SEMESTER
08.501 ENGINEERING MATHEMATICS IV (ERHBF)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Discrete and continuous random variables and their probability distributions- Probability distribution (density) functions-Distribution functions- Mean and Variance - Simple problems -Binomial, Poisson, uniform and exponential distributions - Mean and Variance of the above distributions - Normal distribution - Properties of normal distribution-Computing probabilities using Binomial, Poisson, uniform, exponential and normal distributions

MODULE II

Curve fitting- Principle of least squares-Fitting a straight line-Fitting a parabola-Linear correlation and regression-Karl Pearson's coefficient of correlation-Sampling distributions-Standard error-Estimation- Interval estimation of population mean and proportions (small and large samples)-Testing of Hypothesis- Hypothesis concerning a mean, Equality of means-Hypothesis concerning one proportion, difference of two proportions.

MODULE III

Joint probability density function-Properties-Marginal and conditional distribution- Independence-Random processes - Classification of random processes- Examples-Average values such as mean, autocorrelation, auto covariance, correlation coefficient of random processes- stationarity- strict sense stationary process-wide sense stationary process-Autocorrelation function and its properties-Power spectral density and its properties (no proof)-Related problems-Markov chains. Transition probability matrices-Chapman-Kolmogorov equation (no proof)-Poisson process-Mean and autocorrelation of Poisson process-Related problems

REFERENCES

1. **Papoulis and S.U. Pillai,** *Probability, random variable and stochastic processes,* 4/e, TMH
2. **Veerarajan,** *Probability and Random Processes*, 2/e, TMH
3. **Stark and Woods**, *Probability and Random processes with application to signal processing,* 3/e, Pearson Education
4. **Gubner,** *Probability and Random Processes for Electrical and Computer Engineers,* Cambridge University Press, 2006

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.502 GENETIC ENGINEERING (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Introduction and basic concepts: 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; DNAaseI footprinting; Methyl interference assay**.**

Cloning Vectors: Plasmids; Bacteriophages; M13 mp vectors; PUC19 and Bluescript vectors, Phagemids; Lambda

vectors; Insertion and Replacement vectors; EMBL; Cosmids; Artificial chromosome vectors (YACs; BACs); Animal Virus derived vectors-SV-40; vaccinia/bacculo and retroviral vectors; Expression vectors; pMal; GST; pET-based 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 vector system, Plant based vectors, Ti and Ri as vectors, Yeast vectors, Shuttle vectors

MODULE II

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 Farwestern 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)

MODULE III

Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; RNA sequencing; Chemical Synthesis of oligonucleotides; 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 knock out 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.

REFERENCES

1. **Primrose S.B, Twyman R.M and .Old R.W,** *Principles of Gene Manipulation*, 6th Edition, S.B.University Press, 2001.
2. **Sambrook J and Russel D.W,** *Molecular Cloning: A Laboratory Manual, Vol 1 Cold Spring Harbour Laboratory(CSHL),* 2001.
3. **Brown TA,** *Genomes*, 3rd ed. Garland Science 2006
4. **Desmond S.Tand Nicholl,** *Introduction to Genetic Engineering*, Cambridge University Press, 2004
7. **Preeti Joshi,** *Genetic Engineering and its applications,* Agrobios, India, 2004
8. **Gurbachan S.Minglani,** *Advanced Genetics,* Narosa Publishing House, 2003
9. **Scott R. Hawley and Michelle Y.Walker,** *Advanced Genetic Analysis-Finding meaning in a Genome,* Blackwell Publishing Company, 2004.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.503 ENZYME ENGINEERING AND TECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction: Enzymes as biocatalysts- Chemical nature of enzymes- role of coenzymes – comparison of enzymes with chemical catalysts- nomenclature and classification- Oxidoreductases, Transferases, Hydrolases, Lyases, Isomerases, Ligases- specificity of enzyme action- types of substrate specificity- theories of Enzyme substrate complex formation- Fischer's template theory, Koshland's theory, Substrate strain theory -action of enzymes- proximity effect and orbital steering- mechanism of enzyme catalysis- theories of reaction rates- collision theory, transition state theory. Extremozymes- non traditional enzymes- Abzymes, Ribozymes.

Kinetics of enzymatic reactions: Mechanistic models for simple enzyme kinetics-rapid equilibrium and quasi steady state assumptions- determination of rate parameters for Michaelis- Menten type Kinetics- double reciprocal plot, Eadie-Hofstee plot, Hanes-Woolf plot, batch kinetics – specific activity of enzymes- Models for complex enzyme kinetics-allostery (cooperative binding), Inhibited enzyme kinetics-reversible and irreversible inhibition- kinetics of reversible enzyme inhibition- competitive, non-competitive, uncompetitive inhibition- substrate inhibition kinetics- effects of pH, temperature, pressure and ionic strength on enzyme activity- enzyme half life – enzyme deactivation models and kinetics- bisubstrate reactions- ternary complex model, Ping- Pong mechanism.

MODULE II

Enzyme preparation and use: Sources of enzymes- screening for novel enzymes-media for enzyme production-preparation of enzymes- cell lysis, liquid/solid separation, nucleic acid removal, purification, concentration, finishing-safety and regulatory aspects of enzyme use- industrial applications of enzymes in solution-applications of hydrolytic enzymes (esterases, carbohydrases etc.) and non hydrolytic enzymes (fumarase, glucose isomerase, glucose oxidase etc.) - Medical applications.
Preparation and kinetics of immobilized enzymes: Mechanical forces acting on enzymes-strategies for enzyme stabilization- economic argument of immobilization-methods of immobilization- industrial processes employing immobilized enzymes-medical and analytical applications of immobilized enzymes-Kinetics of immobilized enzymes-effects of solute partition and solute diffusion- analysis of diffusional effects in porous supports- effects of external mass transfer resistance-effectiveness factor- analysis of intraparticle diffusion and reaction-Thiele modulus-Simultaneous film and intraparticle mass transfer resistances- Biot number-effects of inhibitors, temperature and pH on Immobilized enzyme catalytic activity and deactivation.

MODULE III

Design and analysis of enzyme reactors: Ideal reactor operation-batch and continuous operation of a mixed reactor for enzyme reaction- chemostat with immobilized cells- continuous operation a PFR for enzyme reaction- novel reactors- stirred tank batch reactor, membrane reactor, packed bed reactor, continuous flow stirred tank reactors, fluidized bed reactor- design equations- factors influencing productivity and conversion effectiveness.
Enzyme Biosensors: Use of enzymes in analysis- beneficial features and components of Biosensors- Biosensor types-Calorimetric biosensors, Potentiometric biosensors, Amperometric biosensors, Optical biosensors, Piezo-electric biosensors, Immunosensors.
Recent advances: Enzymatic reactions in biphasic liquid systems- stabilization, equilibria, kinetics and applications-Practical applications of enzymes in reverse- use of proteases in peptide synthesis-use of glycosidases in synthetic reactions- interesterification of lipids- artificial enzymes (Synzymes) - applications of genetic engineering techniques to enzyme technology (Enzyme engineering)- poly functional enzymes- solvent engineering.

REFERENCES

1. **Michael. L.Shuler, Fikret Kargi,** *Bioprocess engineering- basic concepts,* Prentice Hall of India.2002
2. **James. E. Bailey, David. F. Ollis**, ***Biochemical engineering fundamentals,*** McGraw Hill.1986
3. **Mukesh Doble and Sathyanarayana N. Gummad**i, B**ochemical Egineering,**Prentice Hall of India.2007
4. **Syed Tanveer Ahmed Inamdar,** *Biochemical Engineering- Principles and Concepst,* Prentice Hall of India.2007
5. **Pauline. M.Doran**, Bioprocess engineering principles, Academic press. 1995
6. **Brahma Deo Singh**, *Biotechnology*, Kalyani Publishers. 1998
7. **M.F. Chaplin, C. Bucke**, *Enzyme technology,* Oxford University press.
8. **Trevor Palmer,** *Enzymes: Biochemistry, Biotechnology and clinical chemistry,* Affiliated East West Press.
9. **Nicholas. C. Price, Lewis Stevens**, *Fundamentals of Enzymology***:** *The cell and molecular biology of catalytic proteins*, Oxford University press.1999.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.504 PRINCIPLES OF HEAT TRANSFER IN BIOPROCESSES (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

INTRODUCTION: Importance of heat transfer in bioprocessing industries, various applications and principle and mechanism of the different modes of heat transfer *Viz.* Conduction, Convection and Radiation.

CONDUCTION: General heat conduction equation in rectangular geometry, Laplace equation, Poisson equation, heat diffusion equation, different boundary conditions applied in heat transfer problems, formulation of heat transfer problems using different boundary conditions with and without generation of heat at steady state and unsteady state for rectangular, cylindrical and spherical geometries at steady and unsteady states. Fourier's law, thermal conductivity of materials, Steady state unidirectional heat flow through single and multiple layer slabs, cylinders and spheres with constant and variable thermal conductivities. Numerical problems.

Solution of steady state one dimensional heat conduction with heat generation in slabs, cylinders, spheres. Numerical problems.

Unsteady state conduction: Elementary treatment of unsteady state heat conduction- Lumped capacity analysis. Biot Modulus, Fourier number and their significance. Numerical problems. Chilling and freezing of food and biological materials. Unsteady state thermal processing and sterilization of biological materials. General principles of thermal/heat sterilization, sterilization of medium using High Temperature Short Time (HTST) methods. Design of Continuous sterilizers.

INSULATION: Properties of insulation materials, Types of insulation, Critical radius and Optimum thickness of insulation.

EXTENDED SURFACES: Fins – Types of fins, general conduction analysis of fins for different boundary conditions. Solution of general conduction equation for temperature profile and rate of heat transfer at different boundary conditions (Constant temperature, infinitely long fin, insulated tip boundary conditions), fin efficiency and fin effectiveness. Numerical problems.

MODULE II

CONVECTION: Boundary layer concept, thermal and velocity boundary layer and the relationship between the two. Film concept of heat transfer, Individual and overall heat transfer coefficient, LMTD, LMTD correction factor. Dimensional numbers - Dimensional analysis, Buckingham's pi theorem, Empirical correlation for forced and natural convection for internal and external flows (flows over flat plates, cylinders and spheres)- Numerical problems. A brief introduction of the analogy between momentum and heat transfer – Reynolds, Colburn and Prandtl analogies, their merits and demerits (Deriving the analogy expressions from the basic concepts is not desired. Only analogy expressions and their significance are required).

RADIATION: Properties and definitions, Absorptivity, Reflectivity, Emissive power and intensity of radiation, Black body radiation, Gray body radiation, Stefan – Boltzman law, Wien's displacement law, Kirchoffs law, View factors, Radiation between surfaces:- two black bodies, two infinite parallel grey planes, one small grey body enclosed in another black body. A brief overview of radiation involving gases and vapours.

MODULE III

HEAT TRANSFER WITH PHASE CHANGE: Boiling heat transfer: Types of boiling, factors affecting boiling heat transfer coefficient, dimensionless variables, Pool boiling curve, Correlations for determining boiling heat transfer coefficient- Rohsenow correlation, Critical heat flux- Zuber correlation and minimum heat flux- numerical problems. Elementary treatment of flow boiling with its different regimes. Numerical problems.
Condensation – Types of condensation, Nusselt's equation (Derivation is required), correlations for determination of condensing coefficients for film condensation on single cylinders (horizontal and vertical orientations), spheres and banks of tubes- Numerical problems

HEAT TRANSFER EQUIPMENT: Detailed classification of heat exchangers based on different modes, Types of shell and tube heat exchangers, their constructional details indicating the function of various components. Condenser – types of condensers, Use of Wilson's plot, Elementary design as to the determination of area, length and number of tubes for shell and tube heat exchanger and condensers.-Numerical problems. A brief overview of Effectiveness-NTU method of analysis of heat exchangers (Derivation of expressions for effectiveness is not required). Use of effectiveness-NTU plots- Numerical problems
Use of plate-heat exchangers for biological fluids. Construction and basic design of plate heat exchangers with the correlations used for the design.
EVAPORATORS: Types of evaporators, performance of tubular evaporator – Evaporator capacity, Evaporator economy, Material and energy balance in single effect evaporators. Multiple effect evaporators – Methods of feeding, Effect of liquid head and boiling point elevation. Factors to be considered in the selection of evaporators, Calculations

on single effect evaporators alone are desired. - Numerical problems. Vapor recompression evaporation evaporators- Numerical problems.

REFERENCES

1. **M.Necati. Ozizik**, *Heat transfer - A basic Approach,* McGraw-Hill College, 1985.
2. **Binay K. Dutta,** *Heat Transfer- Principles and Applications*, Prentice Hall of India.
3. **Geankopolis C J,** *Transport Processes and Separation Process Principles*, Prentice Hall of India, 4th Edition, Eastern Economy Edition, 2004.
4. **Holman J P,** *Heat Transfer*, McGraw Hill Book Co., 1992.
5. **Incropera F P and DeWitt D P,** *Introduction to Heat Transfer,* 2nd Ed John Wiley New York, 1996.
6. **Kern D Q,** *Process Heat Transfer*, McGraw Hill Book Co., 1997.
7. **Coulson J M and Richardson J F,** *Chemical Engineering* Volume 1, Pergamon Press, 1999..
8. **Johnson A.T,** Biological *Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer and Mass Transfer Applied to Biological Systems*, Wiley-1998.
9. **K. Shah and Dušan P. Sekulic,** *Fundamentals of Heat Exchanger Design,* John Wiley and Sons, Inc. 2003
10. **Kothandaraman C.P,** *Heat and Mass Transfer Data Book,* New Age International, India

FOR UNIVERSITY EXAMINATION

1. *Reference **No. 10** indicated in the group of references given above is allowed in the examination hall, which may be mentioned along with the directions to be provided on thefacing sheet of the question paper. Steam tables are also permitted in the examination hall. No other charts, tables and codes are permitted in the Examination hall. Necessary relevant data shall be given along with the question paper by the question paper setter.*

2. *The question paper consists of Part A and Part B. Part A is for **40** marks and comprises of 10 compulsory short answer questions each carrying 4 marks, covering the entire syllabus.*
3. *Part B is for **60** marks. Part B comprises of two questions from each module. The candidate has to answer one full question of 20 marks from each module.*

08.505 BIOPROCESS ENGINEERING (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

***Overview of bioprocess engineering*:** Engineering perspective of fermentation processes – role of bioprocess engineers- integrated bioprocessing-- comparison of bioprocess engineering with biochemical engineering.

Kinetics of microbial growth and product formation: Microbial growth as an autocatalytic reaction- specific growth rate- Malthus' law-quantification of cell concentration-determination of cell number density and biomass concentration- direct and indirect methods- Key determinants of cell population kinetics- growth patterns and kinetics in batch cultures- batch growth curve- kinetics of exponential growth- implications of endogeneous and maintenance metabolism- death phase kinetics- yield and maintenance coefficients- classification of microbial products - growth associated, non-growth associated and mixed growth associated product formation- Leudeking Piret equation- influence of various environmental conditions such as temperature, pH, DO concentration, redox potential, DCO_2 concentration, ionic strength and substrate concentration on growth kinetics-heat evolution by microbial growth- classification of fermentation processes- Gaden's scheme and Deindoerfer's scheme- Batch, fed-batch and continuous fermentations- ideal reactors for kinetics measurements- Ideal batch reactor, Ideal chemostat, fed-batch reactors, ideal plug-flow tubular reactors- design equations based on biochemical reactions.

Thermal death kinetics of cells and spores: Survival curve- decimal reduction factor, Extinction probability- sterilization of culture medium- batch and continuous sterilization- design aspects- air sterilization- design of fibrous type filters.

Kinetic modelling of cell growth: Model structure and complexity- different perspectives for kinetic representations using models- prediction of specific growth rate using unstructured un-segregated models-Monod equation- Monod chemostat model- Models with growth inhibitors (substrate inhibition, product inhibition and inhibition by toxic compounds)- logistic equation- growth models for filamentous organisms-structured kinetic models- compartment models, metabolic models, cybernetic models.

***Bioreactor Engineering*:** Comparison of bioreactors with chemical reactors- Analysis of non- ideal behavior in bioreactors- reasons for non ideality-importance of RTD studies- stimulus-response experiment-circulation time distribution, exit age distribution, F-curve and C-curve- mean and variance of residence time-diagnosis of ills of flow reactors- models for non-ideal reactors- zero, one and two parameter models (with emphasis on the tanks in series

model and dispersion model)- estimation of biochemical conversion using these models- application of dispersion model to design of continuous sterilizers – design of novel bioreactors- packed bed bioreactors, Bubble-column bioreactors, fluidized bed bioreactors, trickle bed bioreactors, airlift loop bioreactors, photobioreactors,- Key issues in bioreactor design and operation -alternate bioreactor configurations- bioreactor dynamics- stability analysis in bioreactors- nontrivial and wash out steady states.

MODULE II

Mass transfer in bioprocessing systems: Gas liquid mass transfer- volumetric oxygen transfer coefficient-correlations (Cooper correlation, Oldshue correlation, Yamamoto correlation, Yoshida correlation, Richards correlation) – oxygen transfer mechanism- assessment of K_La- chemical method, dynamic differential gassing out method, dynamic integral gassing out method, oxygen balance method, enzymatic method- merits and demerits of each method.

Scale up and scale down of bioprocess systems: Need for scale up and scale down- operating boundaries for aerated and agitated fermenters- scale up criteria for microbial cell processes- constant power input per unit volume, constant K_La, constant mixing quality, constant momentum factor, constant impeller tip speed, constant mixing rate number-scale up example with flow chart- scale down procedure.

Monitoring and Control of Bioprocesses:

Fermentation monitoring: Various physical, chemical and biological parameters measured or controlled in bioreactors-Physical and chemical sensors for fermentation medium and gases- online sensors for cell properties-offline analytical methods- measurement of medium properties and cell population composition- flow cytometry.

Analysis by Microfluidics: Basic principles of flow based analytical techniques, flow injection, sequential injection, Bead injection and Sequential injection chromatography- methods and applications.

Measurement analysis: Use of digital computers for data acquisition, interpretation and analysis- software systems-data smoothing and interpolation –Fault analysis- state and parameter estimation methods- use of observers or estimators.

Process control: Open loop and closed loop control-direct regulatory control, cascade control of metabolism-programmed control- application of artificial intelligence in bioprocess control-knowledge based expert systems, neural networks (A brief overview of the above is only required).

Bioprocess modeling and simulation: Structure of bioprocess models- concept of balance domain- model validation using MATLAB- objectives and benefits of bioprocess simulation-simulation tools such as SIMULINK, Biopro Designer, Biotechnology Design Simulator and Bioprocess Simulator.

MODULE III

Medium engineering for cell cultivation and bioreaction: Technological concerns of medium design engineering in bioprocessing-design procedure for growth and production medium- stoichiometric design approach- bioorganic reaction medium engineering- Novel media.

Immobilized cell systems: Potential advantages of cell immobilization, methods of active and passive immobilization-diffusional limitations in immobilized enzyme systems-bioreactor considerations.

Bioprocess considerations in using plant and animal cell cultures: Methods for cultivation of animal cells-requirements for culturing of animal cells-bioreactor design considerations- perfusion systems-products of animal cell cultures- importance of plant cell cultures-comparison of plant cell and microbes in culture-bioreactor considerations for suspension cultures, immobilized systems and organ cultures- products of plant cell cultures

Bioprocess systems for genetically engineered organisms: Basic elements of genetic engineering, genomics and bioinformatics- guidelines for choosing host-vector systems-comparison of strategies-genetic instability in recombinant cell cultures- segregational loss, plasmid structural instability, host cell mutations, growth rate dominated instability-considerations in plasmid design to avoid process problems- simple mathematical model for prediction of genetic instability- regulatory constraints on genetic processes- outline of metabolic engineering and protein engineering with simple case studies.

Medical applications of bioprocess engineering: overview of tissue engineering-commercial tissue culture processes-gene therapy using viral vectors-use of bioreactors as artificial hybrid organs and for mass production of cells for transplantation.

REFERENCES

1. **Pauline. M. Doran,** *Bioprocess engineering principles,* Academic press.1995.
2. **James. E.Bailey, David.F. Ollis,** *Biochemical engineering fundamentals*, Second edition, McGraw Hill.1986.
3. **Michael. L.Shuler, Fikret Kargi,** Bioprocess *Engineering- Basic concepts* ,second edition, Prentice Hall of India.2002.
4. **Colin Ratledge and Bjorn Kristiansen,** *Basic Biotechnology*, Second edition, Cambridge university press.2001.
5. **Mukhopadhyay S.N,** Process *Biotechnology fundamentals*, 2nd edn. Viva Books

6. **Mukesh Doble, Sathyanarayana and Gummadi N**, *Biochemical Engineering*, Prentice Hall of India. 2007.
7. **D.G.Rao**, Introduction *to Biochemical Engineering*, Tata Mcgraw Hill. 2005.
8. **Nielsen J and Villadsen J and Liden G,** *Bioreaction Engineering Principles*, 2nd Edition, Elsevier, 2003.
9. **Irving J. Dunn, Elmar Heinzle, John Ingham and Jiri E. Prenosil,** *Biological Reaction Engineering: Dynamic Modelling Fundamentals with Simulation Examples*, 2nd Edition, Wiley- VCH. 2003.
10. **Jackson AT,** *Bioprocess Engineering in Biotechnology,* Prentice Hall, Engelwood Cliffs, 1991.
11. **Aiba S, Humphrey AE and Millis NF,** *Biochemical Engineering*, 2nd Edition, University of Tokyo press, Tokyo, 1973.
12. **Mansi EMT, Mansi, E.L, Bryle CFA.** *Fermentation Microbiology and Biotechnology*, 2nd Edition, Taylor and Francis Ltd, UK, 2007.
13. **Mukhopadhyay S.N,** Advanced *Process Biotechnology,* Vivo Books

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.506 THERMODYNAMICS OF BIOPROCESSES (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Basic Concepts and Laws of Thermodynamics:
Brief review of System, Surroundings and Processes, Open and Closed systems, State properties, Intensive and Extensive Properties, State and Path functions, equilibrium state and Phase Rule, Zeroth Law of Thermodynamics, Reversible and Irreversible processes, General Statement of First and Second and Third laws of thermodynamics. (A brief review of the above is desired with simple numerical problems).

THERMODYNAMIC PROPERTIES OF PURE FLUIDS

Thermodynamic Properties of pure Fluids: Reference properties, energy properties, derived properties, Work function, Gibbs free energy, relationships among thermodynamic properties: Exact differential equations, fundamental property relations, Maxwell's equations, Clapeyron equations, Entropy and heat capacity relations, Modified equations for internal energy (U) and enthalpy (H), Effect of temperature on U, H and entropy (S), relationships between C_p and C_v, Gibbs-Helmholtz equation, Fugacity, fugacity coefficient, effect of temperature and pressure on fugacity, Determination of fugacity of pure gases, Fugacities of solids and liquids, Activity: Effect of temperature and pressure on activity, Departure functions and generalized charts, thermodynamics diagrams,

MODULE II

SOLUTION THERMODYNAMICS

Properties of Solutions: Partial molar properties: Physical meaning of partial molar properties, partial molar properties and properties of solution, determination of partial molar properties. Chemical potential: Effect of temperature and pressure on chemical potential. Fugacity in solutions: Fugacity in gaseous solutions, Lewis Randal rule, fugacities in liquid solutions, ideal solutions and Raoult's law. Henry's law and dilute solutions: Ideal behaviour and real solutions, Henry's law and gas solubility. Activity in solutions: Activity coefficients, Effect of pressure and temperature on activity coefficients Gibbs-Duhem equation, property changes of mixing: activity and property changes of mixing, property changes of mixing for ideal solutions, excess properties: excess Gibbs free energy. Numerical problems.

BIOCHEMICAL THERMODYNAMICS

Energetics of Metabolic Pathways; Energy Coupling (ATP and NADH); Stoichiometry and energetic analysis of Cell

Growth and Product Formation- elemental Balances, Degree of reduction concepts; available electron balances; yield coefficients; Oxygen consumption and heat evolution in aerobic cultures; thermodynamic efficiency of growth
:

MODULE III

PHASE EQUILIBRIA

Criteria of phase equilibria, criterion of stability: phase equilibria in single and multi-component systems, phase rule for non-reacting systems, Duhem's theorem, Vapour-Liquid Equilibria, VLE in ideal and Non-ideal solutions, Non-Ideal solutions: azeotropes, VLE at low pressures, VLE at high pressures, Consistency test for VLE data, calculation of activity coefficients using Gibbs-Duhem equation, Liquid-Liquid equilibrium diagrams, Liquid phase reactions, heterogeneous reaction equilibrium, solid-solid equilibria. Numerical examples.

CHEMICAL REACTION EQUILIBRIA

Equilibrium criteria for homogeneous chemical reactions; evaluation of equilibrium constant; effect of temperature and pressure on equilibrium constant; other factors affecting equilibrium constant. Calculation of equilibrium conversion and yields for single and multiple reactions. Evaluation of equilibrium for liquid phase reactions. Heterogeneous reaction equillibria involving biological reactions, phase rule for reacting systems. Numerical examples.

REFERENCES

1. **Smith J.M, VanNess H.C, Abbot M.M,** *Chemical Engineering Thermodynamics*. 6th Edition. McGraw-Hill, 2001.
2. **Narayanan K.V,** *A Text Book of Chemical Engineering Thermodynamics,* Prentice Hall India, 2001.
3. **Sandler S.I**, *Chemical and Engineering Thermodynamics*, John Wiley, 1989
4. **Doaran, P.M,** *Bioprocess Engineering Principles,* Academic Press, 1995.
5. **Koretsky M.D,** *Engineering and Chemical Thermodynamics,* John Wiley and Sons, 2004
6. **Jones J. B. Hawkins,** *Engineering Thermodynamics*, John Wiley.
7. **Roels J.A,** Kinetics *and Energetics in Biotechnology*, Elsevier, 1983.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
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08.507 MOLECULAR BIOLOGY LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

Compulsory experiments:

1. Isolation of plant genomic DNA (CTAB method)
2. Agarose gel electrophoresis of DNA and detection/visualization using Ethidium Bromide.
3. Analysis of protein by gel electrophoresis under denaturing conditions. (SDS -PAGE)
4. Isolation of plasmid DNA from *E.Coli* by alkaline lysis method.
5. Purification of plasmid DNA by column chromatography and CsCl/ EtBr Density gradient centrifugation.
6. Digestion of bacteriophage lambda DNA using a restriction enzyme.
7. Preparation and transformation of competent cells of *E.coli.*

- Transformation of plasmids and recombinant DNA into *E.coli* by Calcium chloride method and characterization of the transformants obtained.

- Preparation and storage of competent *E.Coli* cells.

8. Ligation of DNA fragments

- Ligation of plasmid DNA with λ DNA restriction fragments

- Electrophoresis of ligation samples

Demonstration experiments *(Based on availability of required facilities):*

1. Preparative Isolation of low copy number plasmid DNA from *E.coli* by potassium acetate method

2. Isolation of High copy number plasmid using 'Mini screen' method.

3. Restriction mapping- determination of positions of restriction sites in the plasmid DNA used in restriction digestion.

4. Isolation of chromosomal DNA from E.coli

5. Isolation of total RNA from *E.Coli* and determination of concentration and purity of RNA.

6. Southern transfer of DNA from Agarose gels onto nitrocellulose or Nylon membrane.

7. Detection of nucleic acids by non- radioactive methods (hybridization with non- radioactive labeled probes).

8. Demonstration of in Vitro synthesis of specific DNA fragments with Polymerase chain reaction (PCR)

- In vitro amplification of Double stranded DNA

- Gel purification of PCR product

9. DNA sequencing by dideoxy method and determination of DNA sequence by reading from autoradiogram.

10. Oligonucleotide directed mutagenesis (Kunkel method)

REFERENCES

1. **Sambrook and Russell,** *Molecular Cloning – A Laboratory Manual,* Cold spring Harbor Laboratory.
2. **Hans- Peter Schmauder** *Methods in Biotechnology,* Taylor and Francis.

08.508 BIOPROCESS ENGINEERING LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

1. Demonstration of various bioreactor configurations, parts and integrated process control systems.
2. Screening of process variables single dimensional search: Plackett-Burman design practice
3. Determination of Thermal Death Point (TDP) and Thermal Death Time (TDT) of microorganisms for design of a sterilizer.
4. Demonstration of inoculation and sampling in a CSTR
5. Demonstration of reactor studies: Batch, fed-batch and continuous flow reactor analysis and residence time distribution.
6. Determination of mixing time and Power number
7. Microbial cell growth kinetics: Growth of microorganisms, estimation of Monod parameters and temperature effect on growth-estimation of energy of activation and Arrhenius Constant for microorganisms.
8. Estimation of cell maintenance coefficient and true growth yield by studying the mass and energy balance during cell growth.
9. Determination of volumetric mass-transfer coefficient (KLa) by dynamic method and sulphite oxidation method.
10. Preparation and characterization of immobilized cell systems
11. Determination of kinetic constants in free and immobilized cell systems- Evaluation of Effectiveness factor and Thiele modulus
12. Studies on biotransformations in continuous flow reactors (Packed-bed and Plug- flow).

13. Production of wine from grapes:

(i) Determination of *pH*, TSS (degree Brix), titrable acidity of wine.

(ii) Determination of alcohol (ethanol) percentage of wine by Ebulliometry.
(iii) Estimation of Total/free SO_2 in wine / juice / must by Ripper titrimetric method.
(iv) Protein stability test / Heat stability test of wine
(v) Lab scale and pilot scale production of wine from different fruits.
(vi) Tartarate and bitartrate stability test / Cold stability test of wine.
(vii) Determination of Acetaldehyde content, phenol content of wine by titrimetric method.
(viii) Sensory analysis of hydrogen sulphide and Mercaptans in wine.
(ix) Methanol estimation/ alcohol estimation by specific gravity method.
(x) Estimation of reducing and total sugar by copper reduction technique.
(xi) Determination of total tannin content by visible spectrometry.

SIXTH SEMESTER

08.601 MASS TRANSFER OPERATIONS (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Introduction to Mass Transfer and Diffusion: Introduction to Mass Transfer Operations; Fick's Law of Diffusion, Gas diffusion and liquid diffusion (one component transferring to non-transferring component and equimolar counter diffusion.) Diffusivity estimation (Stefan's experiment); permeability, distribution of gas and liquid components through solid, diffusion of biological solutes in liquids, diffusion in biological gels.

Mass Transfer Co-efficients: Definition of Mass Transfer Co-efficient , F-type, K-type coefficients, Dimensionless numbers, Sherwood number, Stanton number, Schmidt number; estimation of Mass Transfer Co-efficients for the case where mass is diffusing from solid wall to bulk liquid. (Flat plates, cylindrical tubes) and flow past single solids.

Interface mass transfer, gas phase controlling and liquid phase controlling operations.

MODULE II

Gas-Liquid Operation: Absorption: Definition, Solubilities of gases in liquids, single stage (one component transferring) operation- Numerical problems. Distillation: VLE, single stage equilibrium distillation, simple distillation and steam distillation operation; continuous distillation (McCabe Thiele method only)- Numerical problems. Basic concepts of various methods of distillation: batch, continuous, flash, steam, azeotropic, extractive and vacuum distillations.

Gas- Solid Operation: Drying: Importance of drying in processes, principles of drying, equilibrium and free moisture, bound and unbound water, constant drying conditions, constant-rate period, critical moisture content and falling-rate period, porous solids and flow by capillarity, calculation of drying time under constant drying conditions.- Classification of dryers, solids handling in dryers, equipments for batch and continuous drying processes: working principle of tray driers, tower driers, rotary driers, spray driers. Concept of freeze drying

Liquid – Liquid and Solid –Liquid operations:

Liquid-Liquid extraction: Liquid-liquid extraction: types of equilibrium system, Singe stage extraction, Multi stage cross and counter current operations-Numerical problems

General principles of extraction, working principle of extraction equipments: mixer settlers, spray and packed extraction towers, agitated tower extractors (Design is not required). Percentage extraction calculation for single stage and multistage crosscurrent operations when liquids are insoluble. Minimum solvent rate and number of theoretical stages for continuous countercurrent, multistage extraction operation when liquids are insoluble. Numerical problems

Solid liquid operation: Leaching, General principles of leaching, Description of leaching operations and technologies, applications of leaching in bioprocessing operations, solid- liquid equillibria in leaching, Single stage leaching, working principle of moving-bed leaching equipments: Bollman extractor, Hildebrandt extractor.

MODULE III

Adsorption: Introduction to adsorption, adsorbents and adsorption processes, Physical adsorption, Chemisorption, Adsorption hysterisis, adsorption isotherms for single component and mixtures, Single stage operation. A brief account of fixed bed adsorption equipment, gas- drying equipment. Pressure-swing adsorption, adsorption from liquids.

Crystallization: Introduction to crystallization, Mier's supersaturation theory, crystallization equipment: continuous vacuum crystallizer, Draft tube-baffle crystallizer (with and without internal system for fines separation and removal), Swenson-walker crystallizer. Material and energy balance calculations in batch crystallizers. Numerical problems

MISCELLANEOUS PROCESSES

Membrane Separation Processes: Dialysis; Hemodialysis; Gas permeation process, introduction to types of flow in gas permeation; hollow – fiber separation assembly, reverse osmosis, application of reverse osmosis, introduction of ultra filtration processes and micro filtration processes. Elementary concept of thermal diffusion, sweep diffusion, foam separation process.-Ion-exchange-principles and industrial application of Ion exchange, types of ion exchange resins.

REFERENCES

1. **Robert E. Treybal,** *Mass Transfer Operations* III Edition, Mc. Graw Hill International.
2. **Christi J. Geankoplis**, *Transport process and Unit operations, Ill ed.,* Prentice Hall India Pvt. Ltd.
3. **Judson Kind**: *Separation Processes*, II Edition, Mc Graw Hill Chemical Engineering series.
4. **Philip A. Schweitzer**, *Handbook of separation Techniques for chemical Engineering,* III Edition, Mc.Graw Hill.
5. **Philip C. Wankat**, *Rate, Controlled separations*, Chapman and Hall, 1985.
6. **Ashim K. Datta**, *Biological and Bioenvironmental Heat and Mass Transfer,* Marcel Dekker.
7. **Warren L. Mccabe, Julian C. Smith and peter Harriott**, *Unit Operations of Chemical Engineering*, 6th Edn., McGraw Hill International Edition, New York 2001.
8. **Coulson J.M., J.F. Richardson, J.R. Backhurst and J.M. Harker**, ***Coulson and Richardson's Chemical Engineering***, Vol. I, 6th Edn., Butter worth Heinemann, Oxford, 1999.
9. **Geankoplis C.J,** *Transport Processes and Unit Operations.* Ed 4. Prentice Hall of India. 2004.
10. **Foust et. al,** *Principles of Unit Operations*. Ed 2. John Wiley. Reprint 2007.

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08. 602 TRANSPORT PHENOMENA IN BIOPROCESSES (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Momentum Transport: Mechanism of momentum transport: Newton's Law of Viscosity, Non- Newtonian fluids- different models for Non-Newtonian flow, theory of viscosity of gases and liquids, time dependant viscosity, viscosity measurement (cone-and-plate viscometer, coaxial cylinder rotary viscometer, impeller viscometer), Experimental viscometry:- Use of viscometers with biological reaction fluids, rheological properties of fermentation broth, factors affecting broth viscosity (cell concentration, cell morphology, osmotic pressure, product and substrate concentration), Bubbles and drops - bubble formation, break-up and coalescence; bubble rise velocities; interfacial area and hold-up in agitated and non-agitated systems; behaviour of bubbles in beverages; drop dispersion. Numerical problems.

Velocity distribution in laminar flow: Shell momentum balances: boundary conditions, flow of a falling film, flow through a circular tube, flow through an annulus, adjacent flow of two immiscible fluids.

General transport equation for momentum, derivation of continuity equation, Analysis of equation of motion in rectangular coordinates (derivation not desired), Navier Stoke's equation and Euler equation with significance of each terms, transport equation in curvilinear coordinates (derivation not desired), application of transport equations to solve steady flow problems:- flow through a tube, tangential annular flow, rotating liquid, cone and plate viscometer.

MODULE II

Energy Transport: Thermal conductivity and the mechanisms of energy transport- prediction of thermal conductivity of gases and liquids, effect of temperature and pressure on thermal conductivity of gases and liquids, relationship between thermal conductivity and viscosity of gases. Thermal conductivity of solids, relationship between thermal and

electrical conductivity of solids, Numerical problems.

Shell energy balance:- Boundary conditions, application of shell balances to heat conduction problems with electric, nuclear and viscous heat sources, cooling fins with insulated tip condition, free and forced convection.

Equations of energy in rectangular coordinates, energy equations in curvilinear coordinates (derivation not desired), application to steady state heat transfer problems:- tangential flow in annulus with viscous heat generation, free convection from vertical plate, flow of non-isothermal film and transpiration cooling.

MODULE III

Diffusivity and the Mechanism of Mass Transport: Definition of concentrations, velocities and mass fluxes, Fick's law of diffusion, kinetic theory of diffusion in gases at low density, theory of ordinary diffusion in liquids. Prediction of diffusivity of gases and liquids. Role of diffusion in bioprocessing. Numerical problems.

Shell mass balances: Boundary conditions, diffusion through a stagnant gas film, diffusion with heterogeneous chemical reaction, diffusion with homogeneous chemical reaction, diffusion into a falling liquid film, diffusion and chemical reaction inside a porous catalyst: the effectiveness factor. Analogies between heat, mass and momentum transfer.

General study equation of continuity for binary mixtures in rectangular coordinates (derivation not desired), equation of continuity in curvilinear coordinates (derivation not desired).

REFERENCES

1. **Bird R B, Stewart W E and Lightfoot R N**, *Transport Phenomena*, John Wiley and Sons.
2. **John C Slattery,** *Momentum, Energy and Mass transfer in continua*, McGraw Hill, Co.
3. **Bennet C U and Myers J E,** *Momentum, Heat and Mass Transfer,* Tata McGraw Hill Publishing Co.
4. **Robert S. Brodkey and Harry C Hersing,** *Transport Phenomena a Unified Approach,* McGraw Hill.
5. **Atkinson B and Mavituna F,** *Biochemical Engineering and Biotechnology*, Handbook, Macmillan
6. **Doran P,** *Bioprocess Engineering Principles,* Academic Press
7. **Blanch H.W and Clark D.S,** *Biochemical Engineering,* Marcel Dekker
8. **Scragg A.H,** *Bioreactors in Biotechnology - A Practical Approach,* Ellis Horwood.
9. **Bailey J. and Ollis D**, *Biochemical Engineering Fundamentals,* McGraw Hill.

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Note: The students may be permitted to use attested copies of **tables of general equations of continuity, motion and energy in rectangular and curvilinear coordinates,** inside the examination hall for the University examination.

08.603 PROCESS DYNAMICS AND CONTROL (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Design aspects of a process control system: Classification of the variables in a chemical process. Design elements of a control system. Control aspects of a complete chemical plant.
Hardware for a process control system: Hardware elements of control system. Use of digital computers in process control.

Development of a Mathematical Model: State variables and state equations for chemical process. Additional elements of mathematical models. Additional examples of mathematical modeling. Modeling difficulties.

Modeling considerations for control purposes: The input-output model, degrees of freedom, degrees of freedom and process controllers. Formulating the scope of modeling for process control.

Linearization of nonlinear systems: Computer simulation of process dynamics, linearization of systems with one variable, deviation variables, linearization of systems with many variables

Laplace Transforms: Definition of the Laplace transform. Laplace transforms of some basic functions, Laplace transform of derivatives and integrals, initial value theorem and final value theorem.

Solution of linear differential equations using Laplace transforms: A characteristic example and the solution procedure. Inversion of Laplace transforms. Heavy side expansion. Examples on the solution of linear differential equations using Laplace transforms. Transfer functions and input-output models.

Transfer functions of a process with a single output, Transfer function matrix of a process with multiple outputs. Poles and zeros of a transfer function. Qualitative analysis of the response of a system.

Dynamic behaviour of first order systems: Basic concepts and definition, Processes modelled as first order systems. Dynamic response of a pure capacitive process. Dynamic response of a first order lag system. First order systems with variable time constant and gain.

Dynamic behaviour of higher order systems: Capacities in series. Dynamic systems with dead-time. Dynamic systems with inverse response.

MODULE II

Introduction to feedback control: Concept of feedback control. Types of feedback controllers. Measuring devices (sensors), transmission lines and final control elements. Dynamic behaviour of feedback controlled processes.

Block diagrams and closed loop response: Effect of proportional control on the response of a feedback controlled process. Effect of integral and composite control actions on the response. Stability analysis of feedback systems Notion of stability, the characteristic equation, Routh Hurwitz criterion for stability, Root locus analysis.

Bode diagrams, Nyquist plots. Design of feedback control systems using frequency response techniques. Bode stability criterion, gain and phase margins, Ziegler Nichols tuning, Nyquist stability criterion, Cohen and Coon tuning method.

MODULE III

Design of feedback controllers: Outline of the design problems, simple performance criteria, time-integral performance criteria, selection of the type of feedback controller, controller tuning, frequency response analysis of linear processes. Response of a first order system to a sinusoidal input, frequency response characteristics of a general linear system,

A general introduction to advanced control systems, familiarity of terms like dead-time compensation, inverse response, cascade control, selective control systems, split-range control, feed forward control, ratio control, adaptive control, inferential control, state space models and MIMO systems

A brief introduction to advanced control systems the terms like *dead-time compensation, cascade control, selective control, split –range control, feed-forward control, ratio control, adaptive control, inferential control, distributed control, direct digital control and supervisory control (*Only familiarity of the terms is desired). Concept of discretization and Z-transforms.

REFERENCES

1. **Stephanopoulose G.** *Chemical Process Control, An introduction to theory and practice*, Prentice Hall of India, New Delhi, 1993.
2. **Coughanow,** *Process Systems Analysis and Control,* McGraw Hill
3. **Luyben W. L,** *Process Modeling Simulation and Control For Chemical Engineers*, 2nd Edn.. McGraw Hill, Singapore, 1990.
4. **Seborg E and Edgar J.F and Mellichamp,** *Process Dynamics and Control, John Wiley*.

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08.604 PROTEOMICS AND PROTEIN ENGINEERING (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Introduction: The proteome and the Genome, protein structure, functional protein families, need for proteomics, scope of proteomics, challenges of proteomics.
Protein folding: Hierarchical protein folding, Molecular chaperones, The HSP 70 chaperone system, Defective protein folding; Proteasomes, Prions, Polyketides and non-ribosomal peptides- Combinational manipulation of polyketides and non ribosomal peptides.

MODULE II

Strategies for protein separation: Two-dimensional polyacrylamide gel electrophoresis for proteome analysis, Brief history of 2-Dimensional Electrophoresis, 2-DE with pH gradients- sample preparation, solubilization, reduction- The first dimension: IEF with IPG, Equilibration between dimensions- The second dimension: SDS-PAGE- resolution and reproducibility of 2-Dimensional Electrophoresis, liquid chromatography in proteomics.
Detection of proteins in polyacrylamide gels and on electroblot membranes: Use of Organic dyes and silver stains, Reverse stains, Colloidal dispersion stains, organic fluorophore stains, metal chelate stains.
Image analysis of two-dimensional gels: Data acquisition, digital image procesing, Protein spot detection and quantitation, Gel matching, Data analysis, data presentation, protein data bases.

MODULE III

Protein modification in proteomics: Introduction, phosphoproteins; glycoproteins, Ubiquitin etc.
Enhancing high-throughput proteome analysis: Impact of stable isotope labeling: Sample preparation, two-dimensional gel separation and analysis, Mass spectrometry: protein identification using MS data, Mass spectrometry: protein identification using MS/MS data.
Protein chips and functional proteomics: Introduction, different types of protein chips, detection and quantification of proteins bound to protein chips, emerging protein chip technologies.
Applications of Proteome analysis: Mining proteomes, protein expression profile, identification of protein-protein interactions and protein complexes, mapping proteins complexes.
Recent advances in Proteomics.
Directed mutagenesis and Protein engineering: Directed mutagenesis procedures- Oligonucleotide directed and random mutagenesis, DNA shuffling; Protein engineering- basic principles, strategies and case studies: Addition of disulfide bonds- T4 Lysozyme, Xylanase, Human pancreatic Ribonuclease; changing asparagine to other amino acids, reducing the number of free sulphydryl residues, increasing enzyme activity, modifying metal cofactor requirements, decreasing protease sensitivity, modifying protein specificity- FokI endonuclease, Antibodies; increasing enzyme stability and specificity- altering multiple properties (Subtilisin, Peroxidase).

REFERENCES

1 **Pennington. S.R. and Dunn M.J,** Proteomics*: From Protein Sequence to Function,* Viva Books, 2001.
2. **Daniel C. Liebler** *Introduction to Proteomics,* Humana Press.
3. **Twyman R. M,** Principles *of Proteomic*s, BIOS Scientific Publishers, 2004
4. **Sahai S,** *Genomics and Proteomics- functional and computational aspects,* Plenum publications, 1999.
5. **Moody PCE and Wilkinson AJ,** Protein *Engineering*, IRL press, Oxford, 1990.

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08.605 NUMERICAL METHODS FOR PROCESS ENGINEERS (B, H)

Credits: 04 **L/T/P: 3/1/0**

MODULE 1

High speed computations using digital computers. Computer arithmetic, Error analysis. Approximation of functions- Chebyshev polynomials Economized power series, Rational functions, Fourier series. Methods of fitting models to data. Empirical relations.

Numerical solution of nonlinear, transcendental and polynomial equations. Linear interpolation methods: Bisection method, Secant method, False position method, Birge- Vieta method, Newton Raphson method, Mullers method, Fixed point iteration method, Bairstow's method, QD algorithm, Chebyshev's method, Graeffe's root squaring method, Newton Raphson method for system of nonlinear equations.

Linear Algebraic Equations: Physical problems modeled with set of linear algebraic equations, Solution of sets of linear algebraic equations. Gauss elimination, Gauss- Jordan method, LU decomposition, Crout reduction, Triangular decomposition, Iterative methods, Jacobi method, Gauss- Seidel iteration, Relaxation method, Eigen value problems- Power method, Jacob's method, Given's method.

MODULE II

Finite differences: Forward, backward and central differences. Properties and relations between finite difference operators, Property of difference of a polynomial, factorial polynomial and reciprocal factorial function. Difference equations.

Interpolation with Equal Intervals: Gregory- Newton forward interpolation formulae, Central difference interpolation formulae, Gauss's forward and backward interpolation formulae, Stirling's interpolation, Bessel's interpolation, Laplace- Everet interpolation. Interpolation with Unequal Intervals: Lagrangian polynomials, Divided differences, Hermite interpolation, Piece-wise linear interpolation, Cubic splines, Bezier curves and B- splines.

Numerical Integration and Differentiation: Derivatives using Newton's forward and backward interpolation formulae. Use of Stirling's formula, Undetermined coefficients and Finite difference. Newton- Cotes Quadrature formula, Trapezoidal rule, Composite Trapezoidal rule, Simpson's rule, Boole's rule, Romberg integration. Gaussian Quadrature, Gauss- Legendre integration. Lobatto integration, Adaptive integration, Double integrals.

MODULE III

Ordinary Differential Equations (ODE): Physical examples- The spring- mass problem, Initial value problem, Taylor-Series method, Euler's method, Modified Euler's method, Runge- Kutta method, Multi- step methods- Predictor-Corrector methods, Adams- Moulton method, Adams- Bashforth method, Boundary Value Problems:

Partial Differential Equations (PDE): Types of PDE, Physical examples: Temperature distribution in a rod, Temperature distribution in a slab, Solution methods: Shooting method, Alternating direction implicit method. Types of partial differential equations: Solution techniques for the Heat equation and the Wave equation in one and two dimensions- Numerical solution of Laplace equation.

REFERENCES

1. **Curtis F. Gerald and Patrick O. Wheatley,** *Applied Numerical Analysis,* Pearson Education Asia, Sixth Edition, 2002.
2. **Veerarajan T and Ramachandran T**, *Numerical Methods with Programs in C,* Second edition, TMH, 2006.
3. **Jain, M.K, Iyengar S.R.K and Jain R.K,** *Numerical Methods for Scientific and Engineering Computation,* New Age International Publishers, 2007.

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08.606 ELECTIVE-I (EL1 A)
AGRICULTURAL BIOTECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Conventional Plant Breeding: Introduction to cell and tissue culture, tissue culture as a technique to produce novel plants and hybrids-Tissue culture media (composition and preparation) Initiation and maintenance of callus and suspension culture : single cell clones.

Organogenesis : somatic embryogenesis; transfer and establishment of whole plants in soil. shoot-up culture ; rapid clonal propagation and production of virus-fee plants- Embryo culture and embryo rescue. Protoplast isolation, culture and fusion : selection of hybrid cells and regeneration of hybrid plant. Symmetric and asymmetric hybrids. Cybrids. Anther, pollen and ovary culture for production of haploid plants and homozygous lines. Cryopreservation, slow growth and DNA banking for germ plasm conservation.

MODULE II

Plant Transformation Technology : basis of tumour formation, hairy root , features of Ti and Ri plasmids- mechanisms of DNA transfer , role of virulence genes, use of Ti and Ri as vectors, binary vectors . Use of 355 and other promoters, genetic markers, reporter genes, use of scaffold.

Methods of nuclear transformation , viral vectors and their applications-Multiple gene transfers. Vectors less or direct DNA transfer, particle bombardment, electroporation, microinjection, transformation of monocots. Transgene stability and gene silencing.

Application of Plant Transformation for productivity and performance herbicide resistance.-Phosphoinothricin, glyphosate, sulfonyl urea, atrazine. insect resistance- Bt genes, Non-Bt like protease inhibitors, alpha amylase inhibitor, virus resistance, coat protein mediated nucleocapsid gene, disease resistance, chitinase, 1-3 beta glucanase, RIP antifungal proteins , thionins, PR proteins, nematode resistance, abiotic stress, post-harvest losses, long shelf life of fruits and flowers.use of ACC synthase, poly galacturonase, ACC oxidase, male sterile lines, bar and barnase systems carbohydrate composition and storage- ADP glucose pyrophosphatase. Nitrogen Fixation: Basic concepts, nif genes and their regulation, potential scope in crop improvement

MODULE III

Transformation of organelles**:** Methods and success, advantages of organellar transformation. Chloroplast Transformation : advantages vectors, success with tobacco and potato Metabolic Engineering and Industrial Products; Plant secondary metabolites, control mechanisms and manipulation of phenylpropanoid pathway, shikimate pathway .

Molecular Marker-aided Breeding: RFLP maps, linkage analysis, RAPD markers, STS, Microsatellites, SCAR (sequence characterised amplified regions). SSCP (single strand conformational polymorphism), AFLP, QTL, map based cloning, molecular marker assisted selection. Arid and semi-arid plant biotechnology
Green House and Green-Home technology.

Molecular pharming**:** Use of plants and animals for production of neutraceuticals, edible vaccines and other desired products.

REFERENCES

1. **Hammond J, McGarvey P and Yusibov V** (Eds), *Plant Biotechnology,* Springer Verlag,
2. **Fu. G. Singh T.J and Curtis W.R. (Eds),** *Plant Cell and Tissue Culture for the production of Food Ingredients,* Kluwer, Academics/Plenum Press, 1999.
3. **Chawla H.S,** *Biotechnology in crop Improvement*, International Book Distributing Company, 1998
4. **Henry R.J**, *Practical Application of Plant Molecular Biology*, Chapman and Hall, 1997.
5. **Gupta P.K**, *Elements of Biotechnology,* Rastogi and C. Meerut, 1996
6. **Bhojwani S.S**, *Plant Tissue Culture: Applications and Limitations* Elsevier, Amsterdam.
7. **Debergh P.**C and Zimmerman R.H, *Micropropagation,* Kluwer Academic Publ. Dordrecht.
8. **Arie Altman,** Agricultural Biotechnology, *Marcel Dekker, Inc*, 2001.
9. **Chrispeels, M.J and Sadava D.E,** Plants, Genes and Crop Biotechnology, American Society of Plant Biologists, *Jones and Bartlett Publishers*, USA.
10. **Buchanan B.B, Gruissem W and Jones RL**, *Biochemistry and Molecular Biology of Plants,* American *Society of Plant Biologists, USA.*

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.606 ELECTIVE-I (EL1 B)

BIOPHYSICS OF MACROMOLECULES (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction to biophysics: Basic strategies in biophysics, Central questions in biophysics. Levels of structures in biological macromolecules, Strong and weak interactions in biomolecules, dielectric properties of biomolecules, electronic properties of biomolecules – conductivity, photoconductivity and piezoelectric effect, conformation and configuration of biomolecules.

MODULE II

Conformational analysis of macromolecules: Forces that determine protein and nucleic acid structure, basic problems, polypetide chain geometries, potential energy calculations, observed values for rotation angles, hydrogen bonding, hydrophobic interactions and water structures, ionic interactions, disulphide bonds. Conformation of proteins and enzymes, effect of amino acids on the structure of proteins, energy status of a protein molecule, helix coil conformation of proteins, structure-function relations of enzymes, cooperative properties of enzymes, dynamics of protein folding. Conformation of nucleic acids, thermodynamics of DNA denaturation, Changes in nucleic acid structures during biochemical processes.

MODULE III

Structural analysis of macromolecules: Prediction of protein and nucleic acid structure- general characteristics of nucleic acid structure, geometrics, glycosidic bond rotational isomers and ribose puckering backbone rotational isomers - forces stabilizing ordered forms, base pairing, base stacking -tertiary structure of nucleic acids.

Methods for study of biomolecule structure and function -- Size and shape of macromolecules-methods of direct visualisation - macromolecules as hydrodynamic particles-macromolecular diffusion-ultracentrifugation- viscometry-x-ray crystallography, optical, UV and IR spectroscopy, luminescence, fluorescence, magnetic resonance. Determination of molecular structures, X-ray fibre diffraction, electron microscopy, neutron scattering-light scattering.

REFERENCES

1. **Cantor R, Samuel P.R,** *Biophysical Chemistry,* W.H., Freeman and Co., 1985.
2. **Van Holde, Johnson and Ho,** *Principles of Physical Biochemistry*, Second Edition, Pearson Prentice Hall 2006.
3. **Bengt Nölting**, ***Methods in Modern Biophysics, Springer***
4. **Igor N. Serdyuk, Nathan R. Zaccai, Joseph Zac,** *Methods in molecular biophysics: structure, dynamics,* function, Cambridge University Press

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.606 ELECTIVE I (ELI C)
PROCESS PLANT SAFETY AND HAZARD ASSESSMENT (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Safety and Hazard Analysis: Hazards: Chemical hazards classification, Radiation hazards and control of exposure to radiation. Types of fire, Fire prevention methods:- Chemistry of fire; Production of fire; fire development; severity and duration; effect of enclosure and heat transfer.

Industrial hygiene; Routes of entry of foreign substance; Long term medical disorders and epidemiology; Stress and the workplace; Industrial noise; Hazardous waste. Mechanical hazards. Electrical hazards.

Pyschology and Hygiene: Industrial psychology and Industrial hygiene: Safety in plant site selection and plant layout. Industrial lighting and ventilation. Industrial noise. Occupational diseases and control: Occupational diseases and prevention methods. Safe housekeeping instrumentation for safe operation. Personal protective equipments. Safety in chemical operations and processes.

MODULE II

Hazard: Identification; Occupational hazard; Preliminary hazard analysis; Hazard and operability review (HAZOP). Hazard control: Engineering and management controls; Fault tree analysis; Risk analysis and management.

Case studies of safety and hazard assessment in different industries; Disaster management planning; Insurance tariffs in hazardous industries; Design for safety, maintenance and fault diagnosis.

RISK ANALYSIS and HAZOPS: A brief introduction to Consequence Analysis - Dispersion and Toxic models: Risk analysis: Introduction, Rapid risk analysis, Comprehensive risk analysis - Failure types and release rate calculation - Emission and dispersion - Dispersion models for dense gas – Plume dispersion - Jet dispersion - Toxic dispersion model - Evaluation of risk contours.

MODULE III

Biosafety: Introduction; historical backround; Biosafety in the laboratory/institution: Laboratory associated infections and other hazards, assessment of biological hazards and levels of biosafety, prudent biosafety practices in the laboratory/ institution. Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and infected Animals;

Biosafety guidelines: Government of India guide lines; Definition of Genetically modified Organisms (GMOs) and Living Modified Organisms (LMOs); Roles of Institutional Biosafety Committee, RCGM, Genetic Engineering Approval Committee (GEAC) etc. for GMO applications in food and agriculture; biosafety assessment procedures for biotech foods and related products, including transgenic food crops, case studies of relevance.

Environmental release of GMOs; Risk Analysis; Risk Assessment; Risk management and communication; Overview of National regulations and relevant International Agreements including Cartegana Protocol on biosafety, bioterrorism and convention on biological weapons.

REFERENCES

1. **Wills, G.L,** *Safety in Process Plant Design*, John Wiley and Sons
2. **Frank P. Less,** *Loss Prevention in Process Industries, Volume I and II,* Butterworth Heinemann, 1980.
3. **Crowl, D.A and Louvar, J.F,** *Chemical Process Safety: Fundamentals with Applications,* Prentice Hall, Inc.
4. **Pandey, C.G,** *Hazards in Chemical Units: a Study*, Oxford IBH Publishing Co., New Delhi.
5. **Fawcett H.H and Wood W.S,** *Safety and Accident Prevention in Chemical Operation,* 2 Ed, Wiley *Interscience, 1982.*
6. Industrial Safety and Laws*, 1993, by Indian School of Labour Education, Madras.*
7. **Raghavan K. V and Khan A A,** *Methodologies in Hazard Identification and Risk Assessment, Manual by CLRI, 1990.*
8. **Marshal V. C,** *Major Chemical Hazards, Ellis Horwood Ltd., Chichester, United Kingdom, 1987.*
9. **et. al,** *A Guide to Hazard Operability Studies, Chemical Industry Safety and Health Council of the Chemical Industries Association (London , 1977.*

WEB REFERENCES

http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section 3.html

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*

Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.606 ELECTIVE I (ELI D)
PROCESS OPTIMIZATION (B)

Credits: 03 **L/T/P:2/1/0**

MODULE I

Nature and organization of optimization problems: what optimization is all about, Why optimize, scope and hierarchy of optimization, examples of applications of optimization, the essential features of optimization problems, general procedure for solving optimization problems, obstacles to optimization. Classification of models, how to build a model, fitting functions to empirical data, the method of least squares, factorial experimental designs, fitting a model to data subject to constraints.

Basic concepts of optimization: Continuity of functions, unimodel versus Multimodel functions. Convex and Concave functions, Convex region, Necessary and sufficient conditions for an extremum of an unconstrained function, interpretation of the objective function in terms of its quadratic approximation.

MODEL II

Optimization of unconstrained functions: one-dimensional search: Numerical methods for optimizing a function of one variable, scanning and bracketing procedures, Newton's, Quasi-Newton's and Secant methods of uni-dimensional search, region elimination methods, polynomial approximation methods, how the one- dimensional search is applied in a multi-dimensional problem, evaluation of uni-dimensional search methods.

Unconstrained multivariable optimization: Direct methods, random search, grid search, uni-variate search, simplex method, conjugate search directions, Powell's method, indirect methods- first order, gradient method, conjugate method, indirect method- second order: Newton's method forcing the Hessain matrix to be positive definite, movement in the search direction, termination, summary of Newton's method, relation between conjugate gradient methods and Quasi-Newton method.

MODULE III

Linear programming and applications: Basic concepts in linear programming, Degenerate LP's – graphical solution, natural occurrence of linear constraints, the simplex method of solving linear programming problems, standard LP form, obtaining a first feasible solution, the revised simplex method, sensitivity analysis, duality in linear programming, the Karmarkar algorithm, LP applications.

Genetic Algorithms (GA): (Qualitative treatment) Working principles, differences between GAs and traditional methods, similarities between GAs and traditional methods, GAs for constrained optimization, other GA operators, real coded GAs, Advanced Gas.

REFERENCES

1. **Edgar T.F and Himmelblau D.M,** *Optimization of chemical processes*, Mc- Graw. Hill.2001.
2. **Deb Kalyanmoy,** O*ptimization for Engineering Design–Algorithms and Examples*, Prentice-Hall of India, New Delhi,
3. **Hadley G,** *Non-linear and Dynamic Programming*, Addison Wesley, New York, 1964.
4. **Rao S S,** *Optimization Theory and Applications,* Wiley Eastern, New Delhi, 1991.
5. **Reklaitis G V, Ravindran A and Ragsdell K M,** *Engineering Optimizations– Methods and Applications*, Wiley, New York, 1983.

6. **Beveridge G.S and Schechter R.S,** *Optimization Theory and Practice,* Mc Graw Hill, Newyork, 1970.
7. **Rekllitis, G.V, Ravindran, A and Ragdell, K.M,** *Engineering Optimization- Methods and Applications,* John Wiley, New York, 1983.
8. **Mital K.V and Mohan C**, *Optimization Methods in Operations Research and systems Analysis*, New Age International (P) Limited, Publishers, 3rd edition, 1996.
9. **Taha H.A,** *Operations Research: An Introduction,* Prentice Hall of India Pvt. Ltd., 6th edition.
10. **Kasene H.S. and Kumar, K.D,** *Introductory Operations Research,* Springer (India), Pvt .Ltd

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08-606 ELECTIVE-I (EL1 E)
BIOCATALYSTS AND CATALYSIS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Biocatalysis: Definition of biocatalysis; chirality and biological activity- advantages and disadvantages of biocatalysis over chemical catalysis. Different types of biocatalysis- microbial, enyzmatic and immobilized system of biocatalysis; industrial biocatalysis with different enzymes.

Introduction to enzymes: Introduction, Classification, action and specificity, Enzyme stability, monomeric and oligomeric enzymes. Structure of enzymes- X ray crystallography of enzymes, Extraction and Purification of enzymes, control of Enzyme activity.
Multifunctional catalysis and simple models – alpha chymotrypsin - Hydrolytic Enzymes, Stereo electronic control - Immobilised enzymes - Enzymes in synthetic organic chemistry - Design of molecular clefts.

Enzyme kinetics and modeling of enzymatic systems: Kinetics of single substrate, multisubstrate enzyme catalyzed reaction, relation of kinetic parameters, microenvironmetal effects on enzyme kinetics.

Enzyme models: Host guest complexation Chemistry, Developments in Crown ether chemistry, membrane chemistry and micelles - Cyclodextrin - Enzyme design using steroid templates - Remote functionalisation reaction - Biomimetic polyene cyclisations.

Regeneration of co-factors for enzyme biocatalysis: NADP (H) regeneration, ATP/NTP regeneration, sugar nucleotide regeneration, acetyl CoA enzyme regulator etc.

MODULE II

Enzyme catalyzed organic synthesis: Introduction, solvent systems, enzyme inactivation in organic solvents, effects on enzyme activity, enzyme formulation in organic media, lymphoid enzyme, absorbed, entrapped etc. and applications-Kinetic resolution, asymmetric synthesis.

Biotransformation with enzymes: Biocatalyst selection, biocatalyst treatment and mode of operation (Immobilization) and application- steroids, terpenes etc. Production of molecules with flavoring properties.

Enzyme as tools for stereo specific c- c bond formation in Monosaccharide and analogues: Enzymes like DHAP aldolase, pyruvate aldolase, tyrosine kinase and their uses,Uses of mutagenesis to increase substrate specificity, Producing catalytic antibodies etc.

Stereoselective biocatalysis for synthesis of chiral pharmaceutical intermediates such as synthesis of ACE inhibitors; definition, mode of action of inhibitors; recent developments, synthesis of anticholesterol drugs by biocatalytic routes, calcium channel blocking drugs, potassium channel openers, antiviral etc.

MODULE III

Industrial enzymes: Modes of action and applications of a few industrial enzymes like glucose isomerase, cellulases, pectinases, proteolytic enzymes, carbohydrases, lignocellulose degrading enzymes, lipases, Penicillin acylases, amino acylase, cyclodextrin glycosyl transferase.

Protein Engineering of Industrial enzymes: Targets by Chemo enzymatic Synthesis, rational design methods, site directed mutagenesis, Chemical modification and unnatural amino acids, Random methods like molecular evolution, DNA shuffling, sequence space, method for mutagenesis, methods for recombination, sequence homology independent recombination, screening and selection.

REFERENCES

1. **Palmer.T**, *Enzymes*, Horwood Publishing Series.2001
2. **Price N.C and. Stevens L,** Fundamentals *of Enzymology,* Oxford University Press. 2002
4. **Branden and Tooze**, *Introduction to Proteins Structure Garland*, Publishing Group. 1998
5. **Zubay G,** Biochemistry, Maxwell Macmillan International Editions, Second Edition, 1987.
6. **Dugas H,** *Bio-Organic Chemistry - A Chemical approach to enzyme action, Springer* Verlag, 1989
7. **Andreas S. Bommarius and Bettina R. Riebel,** *Biocatalysis: Fundamentals and Applications,* Wiley VCH, 2004.
8. **Lawrence P. Wackett and C. Douglas Hershberger**, *Biocatalysis and Biodegradation: Microbial Transformation of Oraganic Compounds,* ASM Press, Washington DC, 2001.
9. **Stanley M. Roberts, Nicholas J. Turner, Andrew J. Willets and Michael K. Turner.** *Introduction to Biocatalysis: Using Enzymes and Microgansims,* Cambridge University Press, 1995.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
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08.606 ELECTIVE- I (ELI F)
COMPUTATIONAL FLUID DYNAMICS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Conservation Laws of Fluid Motion and Boundary Conditions: Governing equations of fluid flow and heat transfer, Equations of state, Navier-Stokes equations for a Newtonian fluid, Classification of physical behaviour, Classification of fluid flow equations, Auxiliary conditions for viscous fluid flow equations.

Turbulence and its Modeling: Transition from laminar to turbulent flow, Effect of turbulence on time-averaged Navier-Stokes equations, Characteristics of simple turbulent flows, Free turbulent flows, Flat plate boundary layer and pipe flow, Turbulence models, Mixing length model, The k-ε model, Reynolds stress equation models, Algebraic stress equation models.

MODULE II

The Finite Volume Method for Diffusion Problems: Introduction, one-dimensional steady state diffusion, two-dimensional diffusion problems, three-dimensional diffusion problems, discretised equations for diffusion problems.

The Finite Volume Method for Convection-Diffusion Problems: Steady one-dimensional convection and diffusion, The central differencing scheme, Properties of discretisation schemes-Conservativeness, Boundedness, Transportiveness, Assessment of the central differencing scheme for convection-diffusion problems, The upwind differencing scheme, The hybrid differencing scheme, The power-law scheme, Higher order differencing schemes for convection-diffusion, Quadratic upwind differencing scheme. Construction of geometry and discreation using Gambit-Fluent's manuals; Commercial CFD solvers.

MODULE III

The Finite Volume Method for Unsteady Flows and Implementation of Boundary Conditions: One-dimensional unsteady heat conduction, Discretisation of transient convection-diffusion equation, Solution procedures for unsteady flow calculations, Implementation of Inlet, outlet and wall boundary conditions, constant pressure boundary condition.

Customizing commercial CFD solver.

Concept of using CFD in bioreactors for the culture of tissue engineered construct (TEC)). A brief outline of the analogous nature of fluid mechanics and nutrient transport. A brief overview of CFD being as a tool for tissue engineers to analyze and visualize the impact of fluidic forces and stresses on cells and TECs. Concept of CFD to study oxygen transfer in Bioreactors.

REFERENCES

1. **Anderson, J.D,** *Computational Fluid Dynamics: The Basics with Application* McGraw Hill Co. Inc.
2. **Anderson, D.A, Tannehill, J.C. and Pletcher, R.H**., *Computational Fluid Mechanics and Heat Transfer,* Hemisphere Publishing Corporation.
3. **Patankar, S.V,** *Numerical Heat Transfer and Fluid Flow*, Hemisphere Publishing Corporation.
4. **Ferziger, J.H and Peric, M**., *Computational Methods for Fluid Dynamics,* Springer.
5. **Versteeg, H.K and Malalasekera, W**, *An Introduction to Computational Fluid Dynamics: The Finite Volume Method,* Prentice-Hall Inc.
6. **Versteeg H. K and MalalasekeraW,** *An introduction to computational fluid dynamics: the finite volume method,* Longman scientific and technical publishers, 2007.
7. **Vivek V. Ranade,** *Computational Flow Modeling for Chemical Reactor* Engineering, Academic Press, San Diego, 2002.
8. **H. Singh and D. W. Hutmacher,** *Bioreactor Systems for Tissue Engineering,* Springer Berlin/ Heidelberg, 2009

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
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08.606 ELECTIVE- I (ELI G)
TECHNICAL ENGLISH COMMUNICATION SKILLS (B, H, E)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Vocabulary and Functional English: This area attempts at making learners withstand the competition at the transnational technical environment so as to enable them to undertake various professional operations.
1) Vocabulary – a basic word list of one thousand words.
2) Functional grammar, with special focus on Common Errors in English.
3) Idioms and Phrasal verbs.
(A brief review of the above topic is only desired)

Listening, Speaking and Reading: This area exposes the learners to the standard expressions including stress, rhythm and various aspects of isolated elements and connected speech.

The use of diphthongs, elements of spoken expression, Varieties of English, accent neutralization

Listening Skills: Listening for general content, Intensive listening, listening for specific information. Sounds, stress, intonation, question tag, listening to lectures, audio/video Cassettes, asking and answering questions, note-taking, dialogue-writing.
Speaking Skills: Oral practice: Describing objects/situations/people-Role play-(Individual and group activities) Just A Minute (JAM)/Group Discussion.

Reading Comprehension: This area exposes the learners to the techniques deciphering and analyzing longer texts pertaining to various disciplines of study.

Types of Reading, Sub skills of Reading, Eye span – fixation, Reading Aloud and Silent Reading, Vertical and Horizontal Reading, Vocalization and sub-vocalization.

Reading Skills: Skimming the text- exposure to a variety of technical articles, essays, graphic representation, and

journalistic articles.

MODULE II

Written Communication Skills

This area exposes the learners to the basic tenets of writing; the style and format of different tools of written communication

Description (through paragraph writing), Reflection (through essay writing), Persuasion (through indented letter writing), skills to express ideas in sentences, use of appropriate vocabulary -sentence construction-paragraphs development-note making, informal letters, essentials of telephonic conversation, invitations, minutes of a meeting, editing a passage and essay writing.

Technical communication skills

Technical report writing (informational, analytical and special reports), technical vocabulary, technical communication-features, distinction between general and technical communication, and language as a tool of communication: levels of communication, interpersonal, organizational, mass communication, the flow of communication: upward, downward and lateral, importance of technical communication, barriers to communication.

Technical English for specific purposes (ESP): Business letters-sales and credit letters, letter of enquiry, letter of quotation, placing order. Job application and resume. Official letters, government letters, letter to authorities. Reports-types, significance, structure and style, writing reports, condensing .Technical proposals-writing a proposal –the steps involved. Technical papers, projects, dissertation, thesis writing. Preparing audio-visual aids.

MODULE III

A non-detailed study of the autobiography: "Wings of Fire-An Autobiography by APJ Abdul Kalam".
Students should read the book on their own and selected topics may be discussed in the class.

REFERENCES

1. **Andrea J Rutherford**, *Basic Communication Skills for Technology, Pearson* Education.
2. **Mohan K and Sharma R C**, *Business Correspondence and Report Writing*, Tata Mc Graw Hill
3. **Barun K Mitra,** *Effective Technical Communication,* Oxford University Press, New Delhi.
4. **Robert J Dixson,** *Everyday Dialogues in English*, Prentice Hall of India.
5. **Lakshmi Narayanan K.R,** *English for Technical Communication,* Vol. I and II, Sci Tech Publications.
6. **Abdul Kalam A.P.J,** *Wings of Fire-an autobiography, Universities* Press, 2004.
7. **Randolph Quirk,** *Use of English Ist Edn,* Pearson, 1962
8. **Thomson A.J and Martinet A.V,** *Oxford Practical English Grammar 3rd Edn,* University
9. **Thomas Eliot Berry,** *Most Common Mistakes in English Usage*, McGraw Hill
10. **Sarma B.S,** *Structural Patterns and Usage in English*, Poosha Series
11. **John Langan, College Writing Skills**, Tata McGraw Hill, 2001.
12. **Louis Trimble,** *Technical Communication Skills in English,* Cambridge University Press.
13. **John Gartside,** *Business Communication,* ELBS, 1991.
14. **Sethi J and Dhamija P.V,** *A Course in phonetics and spoken English*, Prentice Hall, 2004.

University Examination. Maximum Marks: 100

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***Six** short questions to be answered out of 8 questions from Module I. Each question in Module I carries 5 marks (So the maximum Marks for Module I is 30). Two questions out of four have to be answered from Module II. Each question in module II carries 15 marks. (So the maximum mark for Module II is 30). Module III consist of four essay questions out of which two questions has to be answered. Each question in Module III carries 20 marks. (So the maximum mark for Module III is 40).*

08.607 SOFTWARE LAB (B)

Credits: 03 **L/T/P: 0/0/3**

C^{++} Programming exercises

Develop programs to implement the following numerical methods

Solution of:

1. Nonlinear and transcendental equations
2. Linear Algebraic Equations, Set of equations
3. Methods for interpolation and extrapolation
4. Numerical Differentiation and Integration
5. Solution of Ordinary Linear Differential Equations
6. Boundary Value Problems Ordinary and Partial Differential Equations
7. Fitting Models to data

Learning and Use of MATLAB

Exercises in MATLAB application to Solution of Engineering problems, Systems Simulation, Optimization and Control.

Software Packages

Steady State Simulation and Optimization of Flash Drums, Reactor/Bioreactor Models, Distillation Column models. Chemical/Bioprocess Plant Simulation and Design Using State –of –the art software packages like ASPEN PLUS, HYSIS, CHEMCAD, DESIGN II, Biopro Designer, Biotechnology Design Simulator and Bioprocess Simulator and other related packages applicable in process industries.

Simulation studies of dynamics and control of reactors including bio reactors, Distillation Columns, Pressure driven Processes and Reactive Distillation Columns.

REFERENCES

Veerarajan T and Ramachandran T, *Numerical Methods with Programs in C,* Second edition, TMH, 2006.

08.608 ENZYME ENGINEERING AND TECHNOLOGY LAB (B)

Credits: 03 **L/T/P: 0/0/3**

LIST OF EXPERIMENTS

1. Isolation of high yielding microbial strains for the production of commercially important enzymes.
2. Production of commercially important enzymes from microbial sources.
3. Standardization of medium composition for the optimum production of enzymes.
4. Determination of enzyme activity and specific activity.
5. Partial purification of isolated enzymes.
6. Characterization of enzymes-Effect of pH, temperature and inhibitors on enzyme activity etc.
7. Molecular weight determination of enzyme by Gel filtration method.
8. Method of checking the purity of the enzyme -SDS-PAGE
9. Immobilization of enzymes –Different Techniques such as adsorption, entrapment, encapsulation and cross-linking.
10. Strain improvement techniques- physical, chemical and genetic manipulation methods.
11. Development of enzyme assay methods.
12. Formulation of enzyme stability.

REFERENCES

1. **Eisenthal R and Dansen M.. J,** Enzyme Assays –A Practical Approach, IRL Press, Oxford University Press, 1993

2. **Chaplin M.F and Bucke C,** *Enzyme Technology*, Cambridge University Press, Cambridge,1990.

SEVENTH SEMESTER

08.701 DOWNSTREAM PROCESSING (B)

Credits: 05 **L/T/P: 3/2/0**

MODULE I

Overview of bioseparations: Broad classification of bioproducts, characteristics of fermentation broths, spectrum of bioseparations, need for downstream processing, criteria for choice of recovery processes, synthesis of bioseparation processes.
Cell disruption: Analysis of various physical, chemical, enzymatic and mechanical methods for release of intracellular products- kinetics of bead milling and high pressure homogenization- maintenance of activity of intracellular proteins during cell lysis.
Flocculation: Importance in downstream processing, electrical double layer concept, DLVO theory, mechanisms of charge dependent flocculation.
Foam and bubble fractionation: Principle and operation-applications
Gravity sedimentation: Mechanisms of sedimentation, Design of industrial equipments for gravity settling- thickeners, classifiers etc. – applications in downstream processing
Centrifugal bioseparations: Theory of centrifugal settling- basic equations, Sedimentation coefficient, production centrifuges, centrifuge selection-RCF, scale up of centrifuges- sigma analysis, equivalent time- Isopycnic sedimentation, ultra centrifugation.
Filtration: Equipments for conventional filtration- filter media, pretreatment methods, general filtration theory- Darcy's law, compressible and incompressible filter cakes, filtration cycle, scale up and design of filtration systems- laboratory filtration tests- batch pretreatment test, funnel filtration tests, filter leaf tests.

MODULE II

Extractive bioseparations: General principles, analysis of batch and staged extraction - analytical and graphical methods, differential and fractional extraction-scale up and design of extractors- reciprocating plate extraction columns, centrifugal extractors- aqueous two phase extraction, reversed micellar extraction and supercritical fluid extraction- theoretical principles, process, equipment and applications.
***Adsorption*:** Adsorption equilibrium, adsorbent types, equipment operation- adsorption column dynamics- fixed bed and agitated bed adsorption, scale up of adsorption processes- LUB method, computer simulation method.
Precipitation: Factors influencing protein solubility, methods of precipitation, precipitate formation phenomena- orthokinetic and perikinetic aggregation- Smoluchowski's equation-precipitate ageing- Camp number- design of precipitation systems.
Membrane separation processes: Crossflow filtration – filter media- ultra filtration and microfiltration membranes, filter modules, modes of operation, concentration polarization and fouling- reverse osmosis, dialysis, electrodialysis, pervaporation, perstraction.

MODULE III

***Chromatographic separations*:** Classification of techniques, elution chromatography- retention theory, band broadening effects, separation efficiency, resolution, yield and purity, discrete stage analysis, kinetic analysis- Gas and liquid chromatography- Bonded phase chromatography, Ion exchange chromatography, gel permeation chromatography, affinity chromatography- supercritical fluid chromatography - Chiral chromatography- expanded bed chromatography- simulated countercurrent chromatography- process scale up.
Electrokinetic separations: Electrophoresis – Principles and techniques- immunoelectrophoresis, capillary zone electrophoresis - isoelectric focusing, isotachophoresis
Product crystallization: Basic principles- nucleation and crystal growth- Mier's supersaturation theory- kinetics of crystallization-analysis of dilution batch crystallization-commercial crystallizers- process crystallization of proteins- scale up and design of crystallizers- Recrystallization.
Product drying: Heat and mass transfer in drying- types of commercial dryers- vacuum dryers, freeze dryers, spray dryers- scale up and design of drying systems.
Ancillary operations in bioseparations: Water quality assessment, solvent recovery, waste disposal, biosafety.

Economics of downstream processing: Cost estimation, profitability analysis, analysis and evaluation of bioproduct manufacture by fermentation (with emphasis on product recovery steps) - case studies.
Modern strategies: Bioprocess integration, intensification, *in situ* bioproduct recovery, combined operations- whole broth processing, mass recycle.

REFERENCES

1. **Juan A. Asenjo** (Ed), *Separation processes in biotechnology,* CRC
2. **Satinder Ahuja** (Ed), *Handbook of Separations,* Academic Press
3. **Roger. H. Harrison et.al.** *Bioseparations Science and Engineering,* Oxford University press, 2004.
4. **Paul. A. Belter, E.L.Cussler,** Wei-Shou Hu ***Bioseparations-Downstream processing for Biotechnology,*** John Wiley and sons, 1988
5. **James.E.Bailey, David.F. Ollis** ***Biochemical engineering fundamentals,*** McGraw Hill.1986
6. **Syed Tanveer Ahmed Inamdar** ***Biochemical engineering- Principles and concepts***, Prentice Hall of India.2007
7. **Richardson J.F, Harker J.H, Backhurst J.R,** ***Coulson and Richardson's Chemical Engineering- Vol.2: Particle technology and separation processes,*** Butterworth Heinemann. 2002

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
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08.702 BIOPROCESS INSTRUMENTATION (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE 1

Principles of measurement. Error Analysis, Classification, methods of measurements - Direct and indirect measurements, various elements in a measuring instrument - Sensing element, transducing element manipulating element and functioning element etc. Principles of working with a suitable example, static and dynamic characteristics of measuring instrument, accuracy, reproducibility, sensitivity, static error, dead zone, dynamic error, fidelity lag, speed of response etc.

Sensing elements - various types of sensing elements, sensors for temperature, pressure and fluid flow, transducers, different types of transducers, their principles and working: Classification, resistive strain gages, RTD, LVDT, Peizoelectric transducers, electromagnetic transducers, optical transducers, transducers for biomedical applications. Process Instrumentation: Recording, indicating and signaling instruments, Transmission of instrument readings, Instrumentation diagram. Principles of analog and digital meters; CRO, energy meters, time and frequency meters.

MODULE I1

Industrial instruments for measurement:

Temperature measurement: Filled system Thermometer, Thermocouples- ranges of different types of temperature measuring instruments, resistance thermometers, radiation and optical pyrometers.

Pressure measurement: Principles of working of manometers, various types of manometers - McLeod gauge, Knudsen gauge, Bourdon gauge, bellows, diaphragm, electrical pressure transducers piezoelectric manometers, thermal conductivity gauges- ionisation gauge high pressure measuring instrument,

Flow measurement: Head flow meters, area flow meters, positive displacement flow meters, mass and magnetic flow meters and strain gauges. A brief overview of P and I diagrams.
Level measurement: Direct and inferential type.
Miscellaneous measurement: Measurement of density and specific gravity, humidity, viscosity and composition.

MODULE 1I1

Introduction to Instrumentation and Process Control in Bioprocesses: Measurement of physical and chemical parameters in bioreactors- Physical and chemical sensors; Biosensors; On-line sensors for cell properties; off-line -

Monitoring and control of dissolved oxygen, dissolved carbon dioxide, pH, impeller speed and temperature in a stirred tank fermenter. Agitation and capacity coefficient in fermenters; Rheological measurement and control application of microcomputers in the study of microbial process.

Computer Interfaces and peripheral devices; Data acquisitions systems, Fermentation software systems, Data smoothing and interpolation; State and parameter estimation; Direct regulatory control; cascade control of metabolism. Programmed batch bio-reaction; Design and operation strategies for batch plants;

REFERENCES

1. **Eckman D P**, *Industrial Instrumentation*, Wiley Eastern Ltd, 1975.
2. **Patranabis,** *Principles of industrial Instrumentation*, Tata Mc Graw Hill
3. **Shuler M. L. and Kargi F**, *Bio-process Engineering*, 2nd Edition, Prentice Hall of India, New Delhi, 2002.
4 **Bailey J.E and Ollis D.F,** *Biochemical Engineering Fundamentals*, 2nd Ed., McGraw-Hill Publishing Co.
5. **Stanbury P, Whitakar A and Hall S.J,** *Principles of Fermentation Technology*2nd Ed., Elsevier-Pergamon Press, 1999.
6. **Ghose T.K.** *(Ed), Process Computations in Biotechnology,* Tata McGraw Hill, *1994.*
7. **A.Fischer** *(Ed), Advances in Biochemical Engineering, Vol. 13, Springer Verlag, Germany, 1973.*
8. **Aiba, Humphry and Millis,** *Biochemical Engineerin , 2nd Ed., Academic press, 1973,*
9. **McNeil and Harvey,** *Fermentation - A Practical Approach IRL Press, U.K, 1990.*
10. **Scragg,** *Bioreactors in Biotechnology - A Practical Approach, Ellis Horwood Ltd., U.K, 1991.*
11. **Kerk F W, Rimboi W and Tarapore R,** *Instrumentation*, Wiley and Sons, 1983.
12. **Considine D N**, *Process Instruments and Controls Handbook,* McGraw Hill, 2001.
13. **Andrew W G,** *Applied instrumentation in the Process Industries Vols I,II,III* Gulf Publishing Company, 1987.
14. **Ashok Mulchandani and Kim R. Rogers,** *Enzyme and Microbial Biosensors: Techniques and Protocols-* (Eds); Humana Press, Totowa, NJ, 1998.
15. **Ashok Mulchandani and Kim R. Rogers,** (Eds).;*Affinity Biosensors: Techniques and Protocols, Humana Press,* Totowa, NJ, 1998.
16. **Yang, V.C and Ngo T.T**, ***Biosensors and Their Applications,*** Kluwer Academic/Plenum Publishers, 2000.

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08.703 BIOINFORMATICS (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Introduction to Genomic data and Data Organization: Sequence Data Banks – Introduction to sequence data banks – protein sequence data bank. NBFR-PIR, SWISSPROT, Signal peptide data bank, Nucleic acid sequence data bank – GenBank, EMBL nucleotide sequence data bank, AIDS virus sequence data bank. rRNA data bank, structural data banks – protein Data Bank (PDB), The Cambridge Structural Database (CSD) - Genome data bank – Metabolic pathway data -Microbial and Cellular Data Banks.

MODULE II

Introduction to MSDN (Microbial Strain Data Network): Numerical Coding Systems of Microbes, Hybridoma Data Bank Structure, Virus Information System, Cell line information system- other important Data banks in the area of Biotechnology/life sciences/biodiversity.
Sequence analysis: Analysis Tools for Sequence Data Banks; Pair wise alignment - Needleman and Wunsch algorithm, Smith Waterman algorithm, BLAST, FASTA algorithms to analyze sequence data- Sequence patterns motifs and profiles.

MODULE III

Secondary and ertiary Structure predictions; prediction algorithms; Chao-Fasman algorithm, Hidden Markov model, Neural Networking.

Applications in Biotechnology: Protein classifications, Fold libraries, Protein structure prediction: Fold recognition (threading), Protein structure predictions: Comparative modeling (Homology), Advanced topics: Protein folding, Protein-ligand interactions, Molecular Modeling and Dynamics, Drug Designing.

REFERENCES

1. **Lesk, *Introduction to Bioinformatics***, Oxford University Press
2. **Cynthia Gibas and Per Jambeck**, *Developing Bioinformatics Computer Skills,* 2001 SPD
3. **Atwood,** *Introduction to Bioinformatics,* Pearson Education
4. **Tisdall,** *Beginning Perl for Bio-informatics,* SPD
5. **Smith D.W**, *Biocomputing: Informatics and Genome Project,* Academic Press, NY.1994
6. **Baxevanis A.D, Quellette B.F.F,** *Bioinformatics: A practical Guide to the Analysis of Genes and Proteins,* John Wiley and Sons.

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08-704 ELECTIVE-II (EL2 A)
BIOPHARMACEUTICAL TECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Pharmaceuticals, biologicals and biopharmaceuticals**:** An overview Pharmaceutical and Biopharmaceutical biotechnology, current status and future prospects. Pharmaceuticals of animal origin, plant origin and of microbial origin.
The drug development process: Drug discovery, rational drug design. Delivery of biopharmaceuticals, Pre-clinical trials and clinical trials. The role of regulatory authorities.
Biopharmaceuticals: Description, pharmacology, formulation, pharmaceutical concern, clinical use recombinant vaccines, edible vaccines.
Drug manufacturing process: International pharmacopeia. Guide to good manufacturing practice. Manufacturing facility. Sources of pharmaceuticals, production of final product and analysis of final product.
Strategies in the search for new lead drugs/compounds: Improvement of existing drugs. Pros and cons of therapeutic copies. Systematic screening, including high throughput screening. Exploitation of biological information and planned research and rational approach.

MODULE II

Natural products as pharmaceuticals and source of new lead structures: Design of effective natural products based approach to drug discovery. Examples of natural products or analogs as pharmaceuticals.
Combinatorial chemistry: Principles of combinatorial chemistry, synthetic methodology including solid phase synthesis. Compound purification and analytical tools in solid-phase synthesis.
Production and formulation of Biotech Compounds: Cultivation, production and purification, downstream processing, excipients, microbiological considerations, shelf life, doses, therapeutic response, routes of drug administration, delivery systems.
Proteins based drugs: Source, structure, folding, stability, analytical technique, purification, characterization, therapeutic protein, pharmacokinetic and pharmacodynamics of peptides and proteins. Absorption, distribution, metabolism, elimination, protein binding. Protein engineering peptidomimetics.
Post productuction handling and delivery: Preparation, storage, handling, administration, Rationale and basic principles, physiologic and mechanistic approaches, approaches using devices, molecular approaches.

MODULE III

Drug targets classification:DNA, RNA, post-translational processing enzymes, metabolic enzymes involved in nucleic acid synthesis, G-protein coupled receptors (monomeric transmembrane proteins), small molecule receptors,

neuropeptide receptors, ion channels (monomeric multi-transmembrane)proteins, ligand-gated ion channels (Oligomeric transmembrane proteins), transporters (multi-transmembrane proteins);

Drug Delivery and Drug targeting: Concepts of Bio availability, Process of drug absorption, Pharmacokinetic processes, Timing for optimal therapy, Drug delivery considerations for the new biotherapeutics, Parenteral delivery-intravenous, intramuscular, interperitoneal. Oral delivery and systemic delivery through oral route-Structure and physiology of Gastro Intestinal tract, Impediments against oral availability, Advantages and disadvantages of oral drug delivery Drug targeting to CNS –Blood-Brain barrier, physiological and physiochemical factors for delivering to CNS ,current and new technologies in CNS delivery, Pulmonary drug delivery, Cell specific drug delivery, topical and intraocular drug delivery.
Oligonucleotides- Gene therapy in cancer treatment and in HIV infection, Antisense therapy, Ribozymes. Oligosaccharides- Oligosaccharide synthesis, Heparin, Glycoproteins, Polysaccharide bacterial vaccines, Approaches to carbohydrate-based cancer vaccines. Cardiovascular Drugs- Myocardial infarction agents, Endogenous vasoactive peptides, Hematopoietic agents. Anticoagulants, anthrombotics and hemostatics.

Chemotherapeutic Agents**:** Synthetic antibacterial agents, Anthelminitic agents, Antiamebic agents, Antiviral agents. Endocrine Drugs -Female sex hormones and analogs, Agents affecting the immune response.
Enzymes: Applications of enzyme in therapeutics, clinical analysis and pharma industry. Antibiotics: Antibacterial, antifungal antibiotics, screening of antibiotics procedures, inoculums and medium for commercial production of penicillin and cephalosporin, fermentation process, extraction and purification. Cancer immunotherapy.

REFERENCES

1. **Gray Walsh and B. Murphy,** *Biopharmaceuticals–An industrial prospective, KluwerPublishers,*1999.
2. **Camille G. Wermuth,** *The practice of Medicinal chemistry*. Academic Press, 2003.
3. **Dann, J.A, Crommelin and Robert D, Sindelar,** *Pharmaceutical Biotechnology*, *Taylor and Francis.* 2002.
4. **Christine M.Bladon,** *Pharmaceutical Chemistry*, John Wiley and Sons, Ltd.2002.
5. **Manfred E, Wolff. A** *Burger's Medicinal Chemistry and Drug Discovery* John Wiley and Sons, 2000.
6. **Grietje Molema and Dirk K.F.Meijer**. *Drug Targeting Organ-Specific Strategies,* Wiley VCH, 2002.
8. **Hillery A.M, Lloyd A.W and J.Swarbrick**, *Drug Delivery and Targeting,,* Harwood Academic Publishers.
10. **Templeton and Lasic,** *Gene therapy* Marcel and Dekker.2000

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08-704 ELECTIVE-II (EL2 B)
BIOSENSORS AND DIAGNOSTICS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction –Immobilization key to biosensor construction, Biosensors diversification. Biosensor instrumentation-Transduction principles used in a biosensor, Biocomponent of the sensor. Biological sensing elements and transducer systems- their sensitivity specificity and linearity.

MODULE II

Biosensor types: Design, construction and operation of major types of biosensors-Redoxmediated systems, FETs (Field Effect Transistors), Thermistors, Conductimeters, Piezoelectric crystals,Optoelectric biosensors. Flow injection analysis based biosensors, potentiometeric biosensors, fiber optics biosensors, Bioluminescence biosensors, Microbial biosensors, Affinity biosensors, amperometric biosensors, immunosensors.
DNA Probes, organic acid probes, antigen-antibodies reaction, biochemical detection of organelles, receptors, sensors for pollution gases stability and reusability of sensors.

MODULE III

Applications of Biosensors: Biosensors for personal diabetes management, Noninvasive Biosensors in Clinical analysis and health care- Microfabricated Sensors and the Commercial Development of the I- stat Point-of-Care system- Surface

Plasmon Resonance - Biosensors based on Evanescent Waves.
Applications in Veterinary, Agriculture and Food production, Environmental control and pollution monitoring.
Biochips and their applications in modern sciences.

REFERENCES

1. **Turner A.P.F, Karube I and Wilson G.S,** *Biosensors- Fundamentals and applications,* Oxford Univ. Press.
2. **Thomas D and Laval J.M,** *Enzyme Technology in concepts in Biotechnology*, Balasubramaniam et al, Univ.Press, 1996.
3. **Yang V.C. and T.T.Ngo,** *Biosensors and their Applications*, Academic/Plenum Publishers. 2000
4. **Ashok Mulchandani and Kim R Rogers,** *Enzyme and Microbial bio sensors: Techniques and Protocols,* Humana Press Totowa, NJ,1998.
5. **Turner A.P.F and Wilsons G.S,** *Biosensors: Fundamentals and Applications,* Oxford Science Publications, Oxford.

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08.704 ELECTIVE II (EL2 C)
RESEARCH METHODOLOGIES (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction to research: The hallmarks of scientific research, the building blocks of science in research, relevance to preliminary information, the research process for applied and basic research. Hypothesis development, Laboratory safety, bio safety, recombinant material safety.

Experimental designs: The laboratory and the field experiment, internal and external validity, factors affecting internal validity. Measurement of variables, scales and measurements of variables.

Developing scales: rating scale and attitudinal scales. Validity testing of scales developed. Reliability concept in the scales being developed. Stability measures. In vitro, in vivo and
clinical trial designs, rules and regulation for animal and human experiments.

MODULE II

Data collection methods: Interviewing questionnaires etc. secondary sources of data collection. Guidelines for questionnaire design – electronic questionnaire design and surveys. Special date sources: focus groups, static and dynamic panels. Review of the advantages and disadvantages of various data collection methods and when to use each. Sampling techniques. Probabilistic and non – probabilistic samples. Issues of precision and confidence in determining sample size. Hypothesis testing. Determination of optimal sample size. Data relevance to intellectual property rights (IPR), bookkeeping.

MODULE III

Biostatistics: Definition and scope, Types of biological data – Collection and presentation of data (Table, Graphs, Diagrams). Measures of central tendency, Dispersion : Skewness and Kurtosis; Probability analysis, Testing of significance, Goodness of fit (chi^2 test) , Student's test. Simple and multiple regression – Correlation: Canonical Correlation – Correlation coefficient, ANOVA (one way and two way analysis). Factor analysis, Cluster analysis , Discrimnant analysis. Application of SPSS package.

The Research Report: The purpose of the written report – concept of audience – Basics of written reports. The integral parts of a report, the little of a report, the table of contents, the synopsis, the introductory section, method section, results section , discussion section, recommendations and implementation section and reference section.

REFERENCES

1. **Donald R. Cooper and Remela S. Schindler,** *Business Research Methods*, Tata McGraw Hill publishing company limited, New Delhi, 2000.
2. **Uma Sekaran,** *Research Methods for Business*, John Wiley and Sons Inc., New York, 2000.
3. **C.R. Kothari**, *Research Methodology,* Wishva Prakashan, New Delhi, 2001.
4. **Donald H. McBurney**, *Research Methods,* Thomson Asia Pvt. Ltd. Singapore, 2002
5. **Ticehurst G.W. and Veal A.J,** *Business Research Methods*, Longman, 1999.
6. **Ranjit Kumar,** *Research methodology,* Sage Publications, London, New Delhi, 1999.
7. **Raymond, Alain Thie' tart, et al.,** *Doing Management research*, Sage publications, London, 1999.

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08.704 ELECTIVE II (EL 2 D)
MODELING AND SCALE UP OF BIOREACTORS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

A brief outline of types and structure elements of bioreactors: Reactors with mechanical and compressed air energy input, membrane reactors for bubble free aeration; modes of operation of a bioreactor- Batch, fed-batch, continuous cultivation, cultivation with cell retention, repeated (cyclic batch) cultivation; aerobic , anaerobic and micro aerobic processes.

Modeling basics: Definition of a model; types of models (physical, mathematical and verbal); the need for modeling and control in biotechnical processes; steps in model building. Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models. Stochastic model for thermal sterilization of the medium

MODULE II

Bioreactor Models: *Stirred tank reactors*- Description of physical processes in the stirred tank reactor, Modeling of gas/liquid flow in stirred tank reactors, single phase flow- transport equations; gas /liquid flow- multiphase conservation equations, interfacial forces, drag force, virtual mass force- turbulence and impeller models; Bubble column bioreactors. Recirculation and compartment models; *Bubble column and Airlift tower loop reactors*- description of physical processes, Flow models, Reactor models. Basic equations of motion- fundamental laws (mass conservation, momentum conservation, Navier Stoke's equation system); Two fluid model, Euler- Lagrange approach- Dynamics of dispersed gas phase, effective viscosity, Mass transfer with chemical reaction, mixing due to bubble rise, Problems of bubble coalescence and redispersion; modeling particular aspects of bubble column reactors- velocity patterns, fate of individual cells, influence of tilted columns, oxygen distribution-design procedure for bubble columns.

Sub models of bioreactor processes: Engineering components- Temperature control system, Pressure behavior, Aeration behavior; pH model, reaction model (A brief introduction is only desired).

MODULE III

Principles of similarity, pilot plants and models: Introduction to scale-up methods, pilot plants and models and principles of similarity. Dimensional Analysis and Scale-Up Criterion: Dimensional analysis, regime concept, similarity criterion and scale up methods used in chemical engineering.

Scale up and scale down issues: Regime analysis of bioreactor processes. Correlations for oxygen transfer Effect of scale on oxygenation, mixing, sterilization, pH, temperature, inoculum development, nutrient availability and supply; Bioreactor scale-up based on constant power consumption per volume, mixing time, impeller tip speed (shear), mass transfer coefficients. Scale-up of stirred tank bioreactors.

Scale up of downstream processes: Adsorption (LUB method); Chromatography (constant resolution etc.); Filtration (constant resistance etc.); Centrifugation (equivalent times etc.); Extractors (geometry based rules). Scale-down related aspects.

REFERENCES

1. **Schugerl K., Bellgardt K.H,** *Bioreaction Engineering- Modeling and contro*l, Springer.
2. **Harvey.W. Blanch, Douglas. C. Clark,** *Biochemical engineering,* Marcel Dekker.
3. **K.Schugerl, M***easuring, Modeling and Control* in Biotechnology- a multivolume comprehensive treatise (Rehm and Reed eds.) VCH, Weinheim.
4. **Johnstone and Thring**, *Pilot Plants Models and Scale-up methods in Chemical Engg*., McGraw Hill, New York, 1962.
5. **Marko Zlokarnik,** *Dimensional Analysis and Scale-up in Chemical Engg.,* Springer Verlag, Berlin, Germany, 1986.
6. **Donald G. Jordan,** *Chemical Process Development (Part 1 and 2)*, Interscience Publishers, 1988.
7. **Nauman Bruce,** *Handbook of Chemical Reactor Design, Optimization and Scale up* McGraw Hill, 2002
8. **Nauman, E. B**, *Chemical Reactor Design, Optimization and Scale up, 2nd ed.*, John Wiley and Sons. 2008
9. **Pauline. M. Doran,** *Bioprocess engineering principles,* Academic press, 1995.
10. **Najafpour, G. D,** *Biochemical Engineering and Biotechnology,* Elsevier, 2007.

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08.704 ELECTIVE II (EL 2 E)
DESIGN OF BIOLOGICAL WASTE TREATMENT SYSTEMS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Wastewater characteristics: composition and microbiology of wastewater, Mathematical modeling of BOD, kinetics.
Wastewater treatment: Basic design consideration, principles of reactor design and process flow sheets.

Objectives and fundamentals of biological treatment, types of biological treatment processes. Conventional activated sludge process, process kinetics and design considerations, process control measures, operational problems. Design of aerobic suspended growth systems including activated sludge process (Activated sludge process and its modifications, Integrated design procedure, design and control parameters, applications)and aerated lagoon. Biological Nitrogen Removal, Biological Phosphorous Removal.

Trickling filter: Classification- standard and high rate, Principles of design, process design considerations, construction and design of oxidation ponds, aerobic sludge digestion, theory and design of waste stabilization ponds and oxidation ditches, factors affecting the design, design of digestion tank, septic tanks: working principles and design, soak pits.

Biosorption contact stabilization. Biological film flow processes - Sanitation land fill - Municipal and compost treatment - Predigestion of waste

Theory and design of aerobic attached growth systems including rotating biological contactor.

MODULE II

Fundamentals of anaerobic treatment, types, Anaerobic lagoons - Anaerobic digestion - contact and filter digestion - Energy production by digester and Non homogeneous reactions - reactors – physical and chemical removal of dissolved materials - Gas transfer - mass models - Bubble aeration - film flow oxygen transfer - stripping - solids removal. Discrete particle - sedimentation and thickening.
General design considerations, of anaerobic reactors. Anaerobic sludge blanket processes, Design considerations for Up flow Anaerobic Sludge Blanket process and hybrid reactors.

Theory and design of Sludge treatment, sludge thickening, sludge drying, incineration, aerobic and anaerobic digestion

of sludge. Sewage treatment plant layout, concept of sustainable wastewater treatment.

MODULE III

BIOGAS TECHNOLOGY

Worldwide perspective of anaerobic digestion, Review of anaerobic digestors, Realistic potential of biogas plant installation, Problems encountered in the installed plants, Analysis of biogas systems, Optimising the prospects of different designs of biogas plants, Engineering design of fixed dome type - continuous type plants - semi continuous plants, Microbiology of biogas production, Methods to enhance the biogas production, Design parameters affecting the success and failure of biogas plants, Structural behaviour and stress conditions in fixed dome biogas plant, Structural behaviour and stress conditions in KVIC plant, Performance of different types of gas holders, Alternate constructions material for biogas plant construction, Various techniques for increasing gas production in cold region.

Effect of heating , insulation and stirring on gas production, Design optimization for biogas production, Multi criteria optimization, Immobilisation biogas plant system – principle, Application of immobilization, Modular biogas systems for tropical areas – principle, Prospects of modular biogas systems, Alternate feedstock for biogas production

Effect of pesticides on anaerobic digestion, Effect of herbicide on anaerobic digestion, Kinetic models for predicting biogas production, Monod kinetics and related studies, Determination of kinetic parameters, Design equations of biogas plants.

REFERENCES

1. **Marcos Von Sperling,** *Waste Water Characteristics, Treatment and Disposal, Biological Waste Water Treatment, Serie I,* Iwa Publishing (Intl water Association), 2007
2. Manual on Sewerage and Sewage Treatment, C.P. H.E. E. O, Ministry of Urban Development, Government of India, New Delhi
3. **Tchbanoglous and F.L. Burton,** *Metcalf and Eddy's Wastewater Treatment-isposal And Reuse (Third Ed.),* TMH publishing Co Ltd, N. Delhi. (1996)
4. **Howard S. Peavy, Donald R. Rowe and George Techobanoglous:** *Environmental Engineering,* McGraw-Hill

. **Reynolds T.D** and **Richards P.A,** *Unit Operations and Processes in Environmental Engineering*, PWS, 1996.

5. **Viessman W. and Hammer M. J,** *Water Supply and Pollution Control,* 7th Edition, Harper Collins, 2004.
6. **Rittmann and McCarty,** *Environmental Biotechnology* 1st Edition, McGraw-Hill, 2001
7. **Grady Jr. C. P. L., Daigger G. T. and Lim H. C,** *Biological Wastewater Treatment*. 2nd Ed., Revised and Expanded, Marcel Dekker, Inc., New York, 1999.
8. **Santhosh Kumar Garg,** *Sewage Disposal and Air Pollution Engineering,* Khanna Publishers.
9. **Syed R. Qasim and Sayeed R. Qasim,** *Wastewater Treatments: Planning, Design and Operation*, CRC Press, 1998
10. **Parker,** *Wastewater Systems Engineering,* CBS Publishers
11. **Mark J. Hammer and Mark J. Hammer Jr.,** *Water and Wastewater Technology,* Prentice Hall of India
12. **Sincero and Sincero,** *Environmental Engineering: A Design Approach,* Prentice Hall of India
13. **Rao C.S,** *Environmental Pollution Control Engineeri*, Wiley 2nd Edition, New Age International Publishers, 2006.
14. **Mahajan S.P,** *Pollution Control in Process Industries*, Tata McGraw Hill, New Delhi, 1985
15. **Vogt,P,** *Energy conservation and use of Renewable Energies in the Bio-industries.*
16. **Nejat Veziroglu, T,** *Alternate Energy sources Vol IV*. Ann Arbor Science, London, 1982. .
17. **Halwagi,** *Biogas Technology - Transfer and Diffusion.* MNES Publication.
18. **Chawla, O.P,** *Advances in Biogas technology.*
19. **Leslie Grady, C.P and Henry C. Lim,** *Biological waste water treatment,* Marcel Dekker, Inc. New York, 1980.

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08.705 ELECTIVE-III (EL 3 A)

ENTREPRENEURSHIP DEVELOPMENT (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Entrepreneur: Meaning of Entrepreneur; Evolution of the Concept; Functions of an Entrepreneur, Types of entrepreneur, Intrapreneur – an emerging class, Concept of Entrepreneurship-Evolution of Entrepreneurship; Development of Entrepreneurship; The entrepreneurial Culture; Stages in entrepreneurial process. Concepts of Entrepreneur,Manager,Intrapreneur/Corporate.Entrepreneur–comparative study-Roles, Responsibilities, Career opportunities. Entrepreneurship as a career, Entrepreneurship as a style of management.The changing role of the entrepreneur: mid career dilemmas–Closing the window:

Creativity and Innovation: Creativity, Exercises on Creativity, Source of New Idea, Ideas into Opportunities. Creative problem solving: Heuristics, Brainstorming, Synectics, Value Analysis Innovation and Entrepreneurship: Profits and Innovation, Globalization, Modules of Innovation, Sources and Transfer of Innovation, Why Innovate, What Innovation, How to Innovate, Who Innovates.

Business Planning Process: Meaning of business plan, Business plan process, Advantages of business planning, Marketing plan, Production/operations plan, Organizational plan, financial plan, Final project report with Feasibility study, preparing a model project report for starting a new venture.

MODULE II

Institutions supporting entrepreneurs Small industry Financing developing countries, A brief overview of financial institutions in India, Central level and state level institutions, SIDBI, NABARD, IDBI, SIDO, Indian Institute of Entrepreneurship, DIC, Single window, Latest Industrial policy of Government of India

Family Business: Importance of family business, Types, History, Responsibilities and rights of shareholders of a family business, Succession in family business, Pitfalls of the family business, strategies for improving the capability of family business, Improving family business performance.

MODULE III

International Entrepreneurship Opportunities: The nature of international entrepreneurship, Importance of international business to the firm, International versus domestic entrepreneurship, Stages of economic development, Entrepreneurship entry into international business, exporting, Direct foreign investment, barriers to international trade.

Informal risk capital and venture capital: Informal risk capital market, venture capital, nature and overview, venture capital process, locating venture capitalists, approaching venture capitalists.

Managing growth: Using external parties to help grow a business, franchising, advantages and limitations, investing in a franchise, joint ventures- types, Acquisitions and mergers

REFERENCES

1. **David H. Holt,** *Entrepreneurship-new venture creation,* Prentice Hall of India
2. **Poornima Charantimath,** *Entrepreneurship Development-Small Business Enterprise*, Pearson Education, 2007
3. **Robert D Hisrich**, **Michael P Peters and Dean A Shepherd,** *Entrepreneurship,* 6th Edition, McGraw-Hill, 2007.
4. **Mathew J. Manimala,** *Entrepreneurship theory at crossroads,* Biztantra, 2007
5. **Vasant Desai,** *Entrepreneurial Development and Management*, Himalaya Publishing House, 2007
6. **Maddhurima Lall and Shikha Sahai,** *Entrepreneurship*, Excel Books, 2006
7. **Kurakto,** *Entrepreneurship-Principles and practices*, 7th Edition, 2007, Thomson publication
8. **Satish Taneja and S.L.Gupta,** *Entrepreneurship Development New Venture Creation*
9. **Marc J. Dollinger,** *Entrepreneurship: Strategies and Resources*
10. **Brigitte Berger ,** *The Culture of Entrepreneurship*, ICS Press, Sanfrancisco
11. **Peter F. Drucker, *Innovation*** *and Entrepreneurship*
12. **Dale Meyer G and Kurt A. Heppard,** *Entrepreneurship as Strategy*
13. **Sahay A. and.Chhikara M.S,** *New Vistas of Entrepreneurship: Challenges and Opportunities*

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*

Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.

No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.705 ELECTIVE –III (EL3 B)
DRUG DESIGN, DEVELOPMENT AND MANUFACTURE (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction: History of pharmacy; The pharmaceutical industry and development of drugs; Economics and regulatory aspects; Quality management; GMP

Analog Based Drug Design: Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modeling in drug discovery.

Structure Based Drug Design: 3D pharmacophores, molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies.

Further applications on the design of new molecules: 3D data base searching and virtual screening, Sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility.

MODULE II

Drug kinetics and biopharmaceutics: Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

Drug development and trial planning - pre-study requirements for clinical trials; Regulatory approvals for clinical trials; Consort statement; Trial responsibilities and protocols - roles and responsibilities of investigators, sponsors and others; Requirements of clinical trials protocols; Legislative requirements for investigational medicinal products.

Principles of drug manufacture: Compressed tablets, wet granulation-dry granulation or slugging-direct compression-tablet presses, coating of tablets, capsules, sustained action dosage forms Liquid dosage forms – solutions, suspensions and emulsions; Topical applications – ointments, creams, suppositories; Solid dosage forms – powders, granules, capsules, Aerosols; Preservation; Packing techniques. analytical methods and test for various drug and pharmaceuticals, quality management, GMP.

Important Unit Processes and their Applications: Bulk drug manufacturers, Type of reactions in bulk drug manufacture and processes. Special requirement for bulk drug manufacture.

MODULE III

Pharmaceutical Product and their Control: Therapeutic categories such as vitamins, laxatives, analgesics, non-steroidal contraceptives, Antibiotics, biologicals, hormones.

Advances in drug delivery: Advanced drug delivery systems – controlled release; Transdermals, Liposomes and drug targeting.

Biopharmaceuticals
Understanding principles of pharmacology, pharmacodynamics; Study of a few classes of therapeutics like Recombinant therapeutics, Monoclonal Antibodies, Vaccines, Gene therapy, Antibiotics and Hormones.

REFERENCES

1. **Lachman, L. et al.,** *The Theory and Practice of Industrial Pharmacy,* 3rd Edition, Varghese Publishing House, 1987.
2. **Aulton, M.E.** *Pharmaceutics: The Science of Dosage form Design,* 2nd Edition, Churchill Livingstons, 2002.
3. **Ansel, H.C. etal.,** *Pharmaceutical Dosage Forms and Drug Delivery Systems*, 7th Edition, Lippincott Williams, Wilkins, 2002.

4. **Nogardy Thomas,** *Medicinal Chemistry: A Molecular and Biochemical Approach,* 3rd Edition, OUP, 2005.
5. **Rawlins, E.A,** *Bentley's Textbook of Pharmaceutics,* 8th Edition, Baillire, Tindall, 2005.
6. **Remington,** *The Science and Practice of Pharmacy,* Vol. I and II, 20th Edition, 2007.
7. **Banker, G.S. and C.T. Rhodes,** *Modern Pharmaceutics,* 4th Edition, Marcel Dekker, 2002.
8. **Tripathi, K.D,** *Essentials of Medical Pharmacology,* 6th Edition, Jaypee Bros. Med. Publishers, 2008.
9. **Andrew Leach,** *Molecular Modeling: Principles and Applications, 2nd Edn, Pearson Education, Singapore*
10. **Hans Pieter, Heltje and Gerd Folkens,** *Molecular Modelling,* VCH.
11. **Jonathan M. Goodman,** *Chemical Applications of Molecular Modelling,* Springer Verlag.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08 705 ELECTIVE-III (EL3 C)
BIO-FUEL TECHNOLOGY AND ENGINEERING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Biomass Sources, Characteristics and Preparation: Biomass Sources and classification. - Chemical composition and properties of different biomass materials and bio-fuels – Sugar cane molasses and other sources for fermentation ethanol-Sources and processing of oils and fats for liquid fuels- Energy plantations -Preparation of woody biomass: Size reduction, Briquetting of loose biomass, Drying, Storage and Handling of Biomass.

Pyrolysis and Gasification of Biomass: Thermo-chemical conversion of ligno- cellulose biomass - Biomass processing for liquid fuel production - Pyrolysis of biomass – Pyrolysis regime, effect of particle size, temperature and products obtained. Thermo-chemical gasification principles: Effect of pressure, temperature and of introducing steam and oxygen.

Clean Coal Technology: Biotechnology and Microbiology of Coal Degradation – Aerobic and Anaerobic pathway of coal degradation- Characterisation/identification of bioconversion substrates and products – Biosolubilization and bioliquefaction of coal- Biodesulfurisation of coal and oil- Mechanisms of coal biosolubilization- Enzymes that depolymerise coal – Recent Advances in Bioprocessing of coal.

MODULE II

Biogas, Technology: Feedstock for biogas production, Aqueous wastes containing biodegradable organic matter, animal residues. Microbial and biochemical aspects- Operating parameters for biogas production. Kinetics and mechanism - Dry and wet fermentation. Digesters for rural application - High rate digesters for industrial waste water treatment. KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes – development in energy routes.

Bio-Ethanol and Bio-Diesel Technology: Production of Fuel Ethanol by Fermentation of Sugars. Gasohol as a Substitute for Leaded Petrol. - Trans-Esterification of Oils to Produce Bio-Diesel.

MODULE III

Green Technology – Microbial Fuel Cell: Types of Biological fuel cells – Working Principle - Applications of biological Fuel cells. A brief study of the principle, construction of different types of fuel cells.

Hydrogen production by photosynthetic bacteria, biophotolysis of water and by fermentation; Microbial recovery of petroleum by biopolymers (Xanthum gum), biosurfactants.

Design and operation of Fixed and Fluidized Bed Gasifiers. Combustion of Biomass and Cogeneration Systems: Combustion of Woody Biomass: Theory, Calculations and Design of Equipments. Cogeneration in Biomass Processing Industries. Case Studies: Combustion of Rice Husk, Use of Bagasse for Cogeneration.

REFERENCES

1. **Chakravarthy A,** Biotechnology *and Alternative Technologies for Utilization of Biomass or AgriculturalWastes*, Oxford and IBH publishing Co, 1989.
2. **Yogi Goswami D, Frank Kreith and Jan. F .Kreider,** Principles of Solar Engineering, 2nd Edition, Taylor and Francis, 2000, Indian reprint, 2003.
3. **Mital K.M,** *Biogas Systems: Principles and Applications,* New Age International publishers (P) Ltd., 1964.
4. **Nijaguna, B.T,** *Biogas Technology*, New Age International publishers (P) Ltd., 2002.
5. **Venkata Ramana P and Srinivas S.N**, *Biomass Energy Systems*, Tata Energy Research Institute, 1996.
6. **Rezaiyan. J and N. P. Cheremisinoff**, *Gasification Technologies, A Primer for Engineers and Scientists,* Taylor and Francis, 2005.
7. **Khandelwal. K. C. and Mahdi S. S,** *Bio-Gas Technology*, Tata McGraw-Hill Pub. Co., 1986.
8. **Smith J.E,** *Biotechnology*, 3rd ed. Cambridge Univ Press.
9. **Sarkar S,** *Fuels and combustion*, 2nd ed., University Press.
10. **Pandya S.B,** *Conventional Energy Technology - Fuels and chemical Energy,* Tata McGraw Hill, 1987

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.705 ELECTIVE-III (EL 3D)
r DNA TECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction and basic concepts: General overview of enzymes and vectors used in rDNA technology; creation and screening of gene libraries; Cloning of DNA sequences that encode eukaryotic proteins; methods for genetic transformation of prokaryotes; chemical synthesis, sequencing and amplification of DNA.
Manipulation of gene expression in Prokaryotes: Gene expression from strong and regulatable promoters; fusion proteins- cleavage, uses, surface display; unidirectional tandem gene arrays, translation expression vectors; enhancing protein stability; protein folding; overcoming oxygen limitation- use of protease deficient host strains, bacterial Haemoglobin; DNA integration into host chromosome; enhancing secretion; generation of metabolic load due to overexpression.
Heterologous protein production in eukaryotic cells: *S.cerevisiae* expression systems and vectors, Intracellular protein production and secretion in *S.cerevisiae*; *Pichia pastoris* and other yeast expression systems; Baculovirus-insect cell expression system- general features; Construction of E.coli- insect cell Baculovirus shuttle vector, mammalian glycosylation and processing of Precursor proteins in insect cells; Mammalian cell expression systems-general features, selectable markers for mammalian expression systems.

MODULE II

Directed mutagenesis and protein engineering: Directed mutagenesis procedures-oligonucleotide directed mutagenesis with plasmid DNA, M13 phage DNA, random mutagenesis; DNA shuffling; Protein engineering- basic strategies and case studies.
Molecular Diagnostics: DNA diagnostic systems- development and use of hybridization probes, Non radioactive hybridization procedures, molecular Beacons, DNA fingerprinting, RAPD analysis; molecular diagnosis of genetic diseases- Screening for *Cystic Fibrosis*, Sickle cell anaemia- use of PCR/OLA procedure, Padlock probes, genotyping with fluorescence labeled PCR primers.
Therapeutic agents and vaccines: Production of antibodies in E.coli- phage combinatorial libraries, shuffling CDR sequences, single chain antibodies; Nucleic acids as therapeutic agents- antisense RNA, antisense oligonucleotides, Ribozymes, chimeric RNA-DNA molecules, interfering RNAs, Antibody genes; Treatment of genetic disorders-Human gene therapy; Vector vaccines- Implications of rDNA technology in development of vaccines directed against viruses and bacteria.
Synthesis of commercial products by recombinant microorganisms: Implications of rDNA technology in synthesis of small biological molecules like L- ascorbic acid, Indigo and L-cysteine; Production of Antibiotics- cloning of antibiotic biosynthesis genes, synthesis of novel antibiotics, improving antibiotic production; Biopolymers-Engineering *Xanthomonas campestris* for Xanthan gum production, synthesis of animal adhesive biopolymer in

microbial cells, microbial synthesis of rubber, Polyhydroxyalkanoates.

MODULE III

Bioremediation and biomass utilization: Microbial degradation of Xenobiotics, Genetic engineering of biodegradative pathways- manipulation by transfer of plasmids, manipulation by gene alteration; utilization of starch and sugars- improving alcohol production, cellulose utilization- isolation and manipulation of prokaryotic and eukaryotic cellulase genes.
Human molecular genetics: Genetic mapping of human chromosomes- Genetic polymorphism, RFLP, short tandem repeat polymorphism; whole genome BAC map- Radiation hybrid mapping; Human genome project- implications of rDNA technology; Detection of mutants in human genes- single strand conformation analysis, denaturing gradient gel electrophoresis, heteroduplex analysis, chemical mismatch cleavage, direct DNA sequencing; determination of gene function.
Regulations on rDNA technology: Regulation of food and food ingredients, deliberate release of GMOs-issues and controversies, Human gene therapy- concerns.

REFERENCES

1. **Bernard.R.Glick, Jack.J. Pasternak,** *Molecular Biotechnology,* ASM press.
2. **Sandy.B.Primrose, Richard.M.Twyman, Robert.W.Old**, *Principles of gene manipulation,* Blackwell Scientific.
3. **Sambrook.J, Fitch.E.F, Maniatis.T**, *Molecular cloning: a laboratory manual,* Cold Spring Harbor press, USA
4. **Winnacker,** *From Genes to Clones*, Panima Books
5. **Brown T.A,** *Gene Cloning and DNA Analysis: An Introduction (4th edition),* Blackwell Publishing
6. **Glover D.M.,** *Genetic Engineering, Cloning DNA,* Chapman and Hall, New York, 1980
7. **Mahesh. S and Vedamurthy A.B,** *Biotechnology-4* (rDNA Technology, Environmental Biotechnology, Animal cell culture), New Age International Publisher.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
*Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.*No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08-705 ELECTIVE-III (EL3 E)
CANCER BIOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Fundamentals of Cancer Biology: Regulation of Cell cycle, mutations that cause changes in signal molecules, effects on receptor, signal switches,

Tumor Suppression: Tumour suppressor genes, modulation of cell cycle in cancer. Different forms of cancers, Diet and cancer.

Principles of Carcinogenesis I: Chemical Carcinogenesis, Metabolism of Carcinogenesis, Natural History of Carcinogenesis, Targets of Chemical Carcinogenesis. Principles of Physical Carcinogenesis, X - Ray radiation - mechanism of radiation Carcinogenesis.

MODULE II

Molecular Cell Biology Of Cancer: Oncogenes, Identification of Oncogenes, Retroviruses and Oncogenes, detection of Oncogenes, Growth Factor and Growth Factor receptors that are Oncogenes, Oncogenes / Proto Oncogene activity. Growth factors related to transformations.
Principles of Cancer Metastasis: Clinical significances of invasion, heterogeneity of metastatic phenotype, Metastatic cascade, Basement Membrane disruption, Three-step theory of Invasion, Proteinases and tumour cell invasion.

MODULE III

Detection of Cancer: Detection of Cancers, Prediction of aggressiveness of Cancer, Advances in Cancer detection.
New Molecules for Cancer Therapy: Different forms of therapy, Chemotherapy, radiation Therapy and Immuno

therapy: advantages and limitation.

REFERENCES

1. **Maly B.W.J.** *Virology a practical approach,* IRL Press, Oxford, 1987.
2. **Dunmock N.J and Primrose.S.B,** *Introduction to modern Virology,* Blackwel Scientific Publications, Oxford, 1988.
3. An Introduction to Cellular and Molecular Biology of Cancer, Oxford Medical publications, 1991.
4. **King R.J.B,** *Cancer Biology*, Addision Wesley Longmann Ltd, U.K, 1996.
5. **Ruddon R.W,** *Cancer Biology*, Oxford University Press, Oxford, 1995.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08 .705 ELECTIVE-III (EL 3 F)

PROJECT ENGINEERING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE 1

Scope of project engineering: the role of project engineer-Rand D-TEFR-plant location and selection-preliminary data for construction projects-process engineering-flow diagrams-plot plans-engineering design and drafting. Company formation process license, statutory sanctions contracts, financing with special reference to financial institutions in India, personnel recruitment and training.

MODULE II
Planning and scheduling of projects-bar chart and network techniques-procurement operations-effective procedures-contracts and contractors- project financing- statutory sanctions.

MODULE II1

Details of engineering design and equipment selection I- (design calculations excluded)- vessels- heat exchangers-process pumps- compressors and vacuum pumps- motors and turbines- other process equipment.

Details of engineering design and equipment selection II- (design calculations excluded)- piping design – thermal insulation and buildings – safety in plant design – plant construction, start-up and commissioning.

REFERENCES

1. **Rase and Barrow,** *Project Engineering of Process Plants,* John Wiley
2. **Peters and Timmerhaus,** *Plant Design and Economics for Chemical Engineers* McGraw Hill, New York, 4th Edition, 2003
3. **Valle Riestra,** *Project Evaluation in Chemical Process Industries,* McGraw Hill
4. **Anilkumar,** *Chemical process synthesis and engineering design* Tata McGraw Hill, 1981.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.706 REACTION ENGINEERING AND PROCESS CONTROL LAB (B)

Credits: 03 **L/T/P: 0/0/3**

List of Experiments *

GROUP A

1. Kinetic studies and determination of activation energy in an isothermal batch reactor
2. Kinetics studies and determination of activation energy in a isothermal plug flow reactor
3. Kinetics studies and determination of activation energy in an isothermal CSTR
4. Kinetics studies and determination of activation energy in an isothermal semi-batch reactor.
3. Kinetics in an isothermal PFR followed by an isothermal CSTR
4. RTD studies in a PFR
5. RTD studies in a CSTR
6. RTD studies in a packed bed reactor
7. RTD studies in a fluidized bed reactor
8. RTD in CSTR's in series
9. Measurement of surface area and porosity of solid catalysts.

GROUP B

10. Study of dynamic response of first order systems and determination of time constant in measuring instruments
11. Study of dynamic response of second order systems and determination of time constant in measuring instruments.
12. Study of dynamic response in single tank level control system
13. Study of dynamic response in two tanks non-interacting level control system
14. Study of dynamic response in two tanks interacting level control system

GROUP C

15. Study of valve characteristics
16. Optimum controller settings for laboratory scale temperature control system
17. Optimum controller settings for laboratory scale pressure control system
18. Optimum controller settings for laboratory scale level control system
19. Tuning of controllers for distillation control system.
20. Selected laboratory experiments based on calibration of pressure gauges, pneumatic differential pressure transmitters, dynamics of filled thermometer, pressure tank and proportional controller, feed back control of liquid level and temperature systems, computer control of temperature and pressure.

*Minimum 12 experiments shall be offered. The minimum number of experiments to be done from groups A, B and C are respectively 6, 4 and 2.

08.707 HEAT AND MASS TRANSFER OPERATIONS LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

Heat Transfer Operations (GROUP A)

1. Determination of thermal conductivity of solid
2. Determination of thermal conductivity of liquids
3. Determination of emmissivity for surface heat transfer
4. Determination of heat transfer coefficient by natural convection
5. Determination of heat transfer coefficient by forced convection
6. Determination of heat transfer coefficient of fins by natural convection
7. Determination of heat transfer coefficient for fins by forced convection
8. Determination of heat transfer coefficient by film-type condensation
9. Determination of boiling heat transfer coefficient by conducting pool boiling experiment
10. Determination of overall heat transfer for parallel flow and counter flow in double pipe heat exchanger
11. To conduct test on heat pipe and compare the temperature distribution
12. Determination of heat transfer coefficient and effectiveness in shell and tube heat exchanger
13. Determination of overall heat transfer coefficient in an open pan evaporator
14. Heat Transfer in Composite walls- Determination of effective thermal conductivity and overall resistance.

15. Determination of radiation constant, emissivity, convective and radiation heat transfer coefficient.
16. Evaporation: Study of evaporation equipment - determination of steam economy in multiple effect evaporators.
17. Heat transfer in packed beds.
18. Heat transfer in fluidised beds

Mass Transfer Laboratory (GROUP B)

19. To plot the ternary phase diagram for any ternary liquid sstem (ex. acetic-acid – water Toluene). To draw the tie line and to determine plait point for ternary system
20. To determine the diffusivity of liquid in gas (ex. acetone in air)
21. To study the drying characteristics of the given wet material by conducting a batch drying experiment and draw the drying curve.
22. To determine the Mass Transfer Coefficient for vaporization of naphthalene in air
23. To verify Rayleigh's Equation for Batch distillation
24. To find HETP and HTU for packed distillation column
25. Steam distillation (ex. To purify turpentine oil having high boiling point using steam distillation)- Determination of steam requirement and vaporisation efficiency, efficiency in steam distillation,
26. VLE studies (To determine VLE data for methanol –water and to compare it with literature data)
27. To determine the mass transfer coefficient by carrying out liquid-liquid extraction in a packed column (acetic acid- toluene-water system can be used)
28. To study the process of crystallization in a batch crystallizer and to plot a graph between weight of crystals versus temp.
29. Leaching: simple leaching- experiment with the given solute-solvent-inert system and compare the actual recovery with the theoretical recovery for constant solvent to feed ratio and varying no. of stages.
29. Cross current leaching- continuous – determination of the overall stage efficiency of the continuous cross current leaching unit
30. Counter current leaching- countercurrent leaching experiment with the given solute-solvent-inert system by batch simulation of a countercurrent cascade.
31. Determine the values of constants **K** and **n** for adsorption of a solute on the given adsorbent at room temperature and verify Freundlich Equation.
32. Determination of the values of constants **K** and **n** for adsorption of a solute on the given adsorbent at room temperature and verification of Freundlich Equation.

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Note: At least 6 experiments each in Group A and Group B shall be performed.

REFERENCES

1. **Shankar Srinivas**, *Mass Transfer Operations - A Lab Manual for Chemical Engineering* CEED, III Madras
2. **R.E. Trebal**, *Mass Transfer Operations*, MGH
3. **K.B. Radhakrishnan**, *A Laboratory Manual for Heat Transfer Operations Lab,* Published by the Department of Chemical Engineering, TKM College of Engineering, Kollam
4. **Jyothi S.N,** *Laboratory Manual for Heat Transfer Operations Lab,* Published by the Department of Chemical Engineering, TKM College of Engineering, Kollam.

08.708 MINI PROJECT, SEMINAR AND INDUSTRIAL TRAINING (B)

Credits: 02 **L/T/P: 0/0/2**

MINI PROJECT

Every student will be required to submit a project report in a typed form. The topic is to be selected by the student, but specifically approved by the faculty member who guides the student. The mini project work on the topic will consist of either some investigational work on an experimental set up or prototype equipment of some development work, computer simulation or design problem. Every student will be orally examined in the topic selected by the student on completion of the work.

The student will be required to submit three copies of his/her project report to the department office for record before the last working day of the semester (One copy each for the department library, participating faculty and students own

copy). So the work on the mini project shall be commenced in the very starting of the semester.

INDUSTRIAL TRAINING

Each student has to undergo a minimum of two weeks industrial training during the course in any reputed process industry assigned to him/her by the department and submit a report of the same to the department in the format prescribed by the department duly certified by the officer in charge of the training in the respective organization. The student shall be permitted to take up the training only in process industries or well established and reputed centers only after completing the third semester but before the expiry of the seventh semester. Each student has to submit a typed copy of the report of the training activities to the department. The report should be duly signed by the authorized officer in charge of the industry and approved by the faculty in charge of the department and to be submitted to the department immediately on completion of the training programme. The evaluation of the training programme undergone by the student needs to done only at the end of the seventh semester along with the evaluation of the mini project.

SEMINAR

Each student has to present a seminar for the duration specified by the department before the audience consisting of students and members of the faculty of the department on a topic which is selected by the student in consultation with the internal project guide. The student will be required to submit three copies of his/her seminar report to the department office for record (One copy each for the department library, participating faculty and students own copy).

MARKS DISTRUBUTION

Marks: Total Marks for Mini Project/ Seminar /Industrial Training: 100 (Internal Evaluation). The following guide lines may be used for distribution of marks.

Mini Project: Total marks for mini project: 40. The guide has to award a maximum of 20 marks based on the performance of the student during the course of execution of the work associated with the mini project. An evaluation committee constituted from among the faculty of the department has to award the marks out of a maximum of 20.

Industrial Training: Total Marks for industrial Training: 20 marks: An evaluation committee constituted from among the faculty of the department has to evaluate the student orally based on the training undergone by the student. This may be done along with the evaluation of the mini project and marks may be awarded based on a maximum of 20 marks exclusively for the industrial training.

Seminar: Total marks for seminar: 40. The guide has to award a maximum of 10 marks based on the sincerity, dedication and performance of the student during the course of literature survey and material preparation associated with the seminar. An evaluation committee constituted from among the faculty of the department has to award the remaining 30 marks based on the overall performance of the student in the seminar. The student's presentation skills, way of answering queries, time management, delivery of lecture may be used as parameters for evaluation.

EIGHTH SEMESTER

08.801 BIOPROCESS PLANT AND EQUIPMENT DESIGN (B)

Credits: 05 **L/T/P: 3/2/0**

(OPEN BOOK UNIVERSITY EXAMINATION)

MODULE I

Overview of introduction to principles involved in the design and construction of a process plant, piping and instrumentation; General design consideration, optimum design, property estimation and material and energy balance.
Design of heat exchange equipments for upstream and downstream operations in bioprocessing industries: Heat exchangers and condensers: Energy balance, heat duty consideration and process design (TEMA and IS 4503 standards) and drawing of double pipe, single pipe and multipass shell and tube heat exchangers and condensers.

Design and drawing of various types of evaporators employed in bioprocess operation: Evaporators: Standard vertical tube evaporator, single and multiple effect evaporators and forced circulation evaporator.

Design of thermal sterilization systems in fermentation processes: Process design of batch and continuous thermal sterilizers.

MODULE II

Design of mass transfer equipments for upstream and downstream operations in bioprocessing industries: Distillation columns: Detailed process design and drawing of perforated plate, bubble cap columns and packed towers.

Absorption columns: Detailed process design and drawing of perforated plate, bubble cap columns and packed towers.

Design of fermenters: Design considerations for maintaining sterility of process streams and process equipments; Process design of mechanically agitated fermenters (STR or CSTR) and non-mechanically agitated (bubble column and air lift) fermenters.

MODULE III

Storage Vessels: Specifications of Bioprocess equipment; Materials of construction for bioprocess plants. Drawing and design of storage vessels for non-volatile and volatile fluids.

Introduction to Indian standards for storage tanks and their use to design cylindrical and spherical vessels under internal pressure, fixed roof and open roof tanks. Design codes for Unfired pressure vessel: Pressure vessel codes IS 2825 - IS Code-Design of cylindrical and spherical shells under internal and external pressures.

VESSEL COMPONENT DESIGN
Design of vessel closures – Selection and design of Flat plates, Formed heads, torispherical and Hemispherical heads; Design of supports for vessels - Bracket, Lug, Leg, Saddle and Skirt supports.. A brief idea about the design of flanges and nozzles – Classification of flanges. Flange thickness calculation, Gasket selection and design, Bolt selection and calculation. *(Numerical problems need not be taught for the design of flanges, gaskets, nozzles etc.)*

REFERENCES

1. **Perry R.H. and Green D.W,** *Chemical Engineers Handbook, McGraw Hill*
2. ***Kern* Donald *Q.,*** *Process Heat Transfer,* McGraw Hill
3. **Coulson J. M. and Richardson J. F. (Eds.) R.K.Sinnott,** *Chemical Engineering*, *Volume 6: An introduction to Chemical Engineering Design,* Butterworth-Heinemann Ltd., UK. (Indian Edition: Asian Books Private Limited, New Delhi)
4. **Brownell and Young,** *Process Equipment Design-Vessel Design*, John Wiley
5. **Joshi M.V and Mahajani V.V**, *Process Equipment Design***,** McMillan India Ltd, Delhi..
6. **Bhattacharya B C,** *Chemical Equipment Design*, CBS
7. **Ludwig E E, *A**pplied Process Design for Chemical and Petrochemical Plants, (Vol. 1,2 and 3)*** , 3rd Ed., Gulf Publishing Company, Houston.
8. **Roger Harrison** *et al.*, *Bioseparations Science and Engineering,* Oxford University Press, 2003
9. **Najafpour,G.D.**,*Biochemical Engineering and Biotechnology*, Elsevier, 2007.
10. **Blanch, H. W. and Clark, D. S.,** Biochemical Engineering, Marcel Dekker, Inc., 1999.
11. **Van Winkle M,** *Distillation*, Ist Ed., McGraw Hill Company, New York, 1967.
12. ***Pressure Vessel Code* –** IS Code 2825, B.I.S., New Delhi, 1969.
13. *Heat Exchanger Design Code* IS 4503, BIS, New Delhi, 1969.

(OPEN BOOK UNIVERSITY EXAMINATION)

The following text books or attested copies of the books may be permitted in the examination hall. Apart from this attested copy of Moody charts and other charts/plots required for design of equipments may also be permitted in the exam hall. The copy of the relevant pages of the text book containing the empirical correlations and other monographs duly attested by the faculty member applicable for fermenter design may also be permitted in the examination hall.

1. *Steam tables and Psychometric Charts*
2. *Process Engineer's Equipment Design by M.V. Joshi, McMillan and Co., India, Delhi*
3. *Perry's Hand Book of Chemical Engineering, McGraw Hill (Relevant Editions)*
4. *Introduction to Chemical Equipment Design- Mechanical Aspects by B.C. Bhattacharya*
5. *IS Code for Unfired Pressure Vessels IS 4503, BIS, New Delhi, 1969.*

There will be two questions from each module. The question paper shall contain only numerical design problems with two questions from each module. The candidate has to answer one question from each module. Each question in module I and II carries 35 marks and that in Module III carries 30 marks.

The above information may be provided as instructions in the question paper and is to be given at the top of the question by the question paper setter.

08.802 BIOMATERIALS AND TISSUE ENGINEERING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction: Definition of biomaterials- Common biomaterials; Proteins, Carbohydrates and specialized polymers. Structure of Collagen and Fibroin- Production of these proteins by conventional cloning methods.

Carbohydrates: Modified carbohydrates acting as lubricants for biomedical applications; Polydextrose from bacteria; Carbohydrates modified from enzymes; artificial wood.

Biopolymers: Synthesis from simple biological monomers- Dextrans; Rubber like materials produced by bacteria and fungi- Polyhydroxybutyrate (PHB), Polycaprolactone (PCL); Production of Biopol(copolymer of PHB and PHV); Biodegradable polymers.

Industrial biopolymers: Production of polyphenol resins. Evaluation of properties of biopolymers - Tensile strength (elasticity and breaking strength); Hydration, visco- elastic properties; viscosity.

MODULE II

Bioceramics and Biocomposites: Classification of bio-ceramic materials for medical applications. Alumina and zirconia in surgical implants, bioactive glasses and their clinical applications, phosphate glass ceramics. Dense and porous hydroxyl apatite calcium phosphate ceramics, coatings and resorbable ceramics. Carbon as an implant. CMC and PMC composites. Characterization of bio-ceramics.

Types of composites and their advantages. Reinforcement: Glass, boron, carbon, organic and ceramic fibers, their structure, properties and processing. Matrix materials: Polymers, metal and ceramic matrices, their structure, properties and processing. Wettability and interface bonding ; Polymer matrix composites: Lamina, laminate composites. Properties of Biocomposites- Mechanical properties, thermal properties and load transfer. Macromechanics: Elastic behavior, fracture behavior, fatigue behavior, creep behavior of composites. Tribological and electrical behavior of composites. Degradation of composites due to various environmental conditions, corrosion resistance of composites. Designing with composites; Biological application of composites.

Characterization of biomaterials – definition, importance and application; Principles and general methods of compositional and structural characterization, techniques of X-ray, electron and neutron diffraction, EDAX, Thermal methods - DTA, TGA, DSC, DMA, temperature dependent rheology. Microscopy - optical, electron (TEM, SEM), Atomic force microscopy, optical profilometer and confocal laser scanning microscopy, Spectroscopy – UV-visible, fluorescence and phosphorescence IR, Raman and NMR spectroscopy, ESCA and Auger spectroscopy.

MODULE III

Tissue engineering: Introduction; structure and organization of tissues- Epithelial, connective; vascularity and angiogenesis, basic wound healing, cell migration, current scope of development and use in therapeutic and in-vitro testing.

Aspects of Cell culture- Different cell types, progenitor cells and cell differentiations, different kind of matrix, cell-cell interaction; cell expansion, cell transfer, cell storage and cell characterization, cell culture bioreactors; Molecular biology aspects- Cell signaling molecules, growth factors, hormone and growth factor signaling, growth factor delivery in tissue engineering, cell attachment: differential cell adhesion, receptor-ligand binding, Cell surface markers. Scaffold and transplant- Engineering biomaterials, Degradable materials, porosity, mechanical strength, 3-D architecture and cell incorporation. Engineering tissues for replacing bone, cartilage, tendons, ligaments, skin and liver. Basic transplant immunology, stems cells ; Case studies and regulatory issues-cell transplantation for liver, musculoskeletal, cardiovascular, neural, visceral tissue engineering. Ethical, FDA and regulatory issues.

REFERENCES

1. **Ratledge C and Kristiansen B,** *Basic Biotechnol*, Cambridge University Press, 2nd Edition, 2001
2. **Doi Y,** *Microbial Polyesters,* VCH Weinheim, 1990
3. **Sujata V. Bhat,** *Biomaterial*, **,** Springer, 2002.
4. **Buddy D. Ratner, Fredrick J. Schoen, Allan S. Hoffman, Jack E. Lemons** *Biomaterials Science: An Introduction to Materials in Medicine,* Academic Press, 2004.
5. **Jonathan Black,** *Biological Performance of materials,* Taylor and Francis, 2006
6. **Sharma C.P and Szycher M**, *Blood compatible materials and devices,* Technomic Publishing Co. Ltd., 1991.
7. **Piskin and A.S Hoffmann,** *Polymeric Biomaterials,* Martinus Nijhoff Publishers, 1986
8. **Park J B,** *Biomaterials - Science and Engineering,* Plenum Press, 1984.
9. **Larry L. Hench and June Wilson**, *An Introduction to Bioceramics,,* World Scientific Publishing Company;1 Edition 1993
10. **Sharon Brown , Ian Clarke, Paul Williams,** *Biocera*mics; Trans Tech Publications, Ltd.2002
11. **Kokubo T,** *Bioceramics and their clinical applications,* CRC; 2008
12. **Joon Park;** *Bioceramics: Properties, Characterization and Applications,* Springer, 2008
13. **Amar K. Mohanty Manjusri Misra Lawrence T. Drzal**, *Natural Fibers, Biopolyme and Biocomposites,* CRC; 1st Edition 2005.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** *compulsory short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.803 ENVIRONMENTAL POLLUTION, MONITORING AND CONTROL (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

A brief overview of the Parameters and standards of water and waste water. Major physico- chemical parameters; Need of standards for major pollutants; Types of pollutants; Significance of various parameters; Standards adopted by CPCB and SPCB; Drinking water quality standards; Effluent discharge standards for disposal on land, rivers and streams.

Water Pollution:

Water pollution sources and classification of water pollutants - Wastewater sampling and analysis, Bacteriological measurements. Water Pollutants, Effects, Monitoring and Quality standards: Pollution of water and soil, effect of pollutants on environment and health, water pollution laws and minimum national standards, monitoring, compliance with standards, Analysis.

Water Treatment Methods:

Methods of water treatment; Optimized design; Plant control and operational variables; Preliminary treatment process; Clarification; Coagulation; Aerobic oxidation; Anaerobic oxidation; Disinfection of water; Water softening; Reverse

osmosis; Electrodialysis and other treatment methods.

Waste water Treatments:

Physical treatments – Principle; Flow measurement; Screening; Grit removal; Chemical treatments; Principles of chemical treatment: coagulation, flocculation, sedimentation. Overview of treatment principles and theory of aeration, Municipal Sewer and Industrial Wastewater Treatment –Principles, operation and design aspects of: Activated Sludge process, Extended Aeration, Nitrification-denitrification, Trickling Filter, Mechanically aerated lagoons, Concepts of Waste stabilization ponds, Aquatic plant systems, Ranking of waste water treatment processes, common effluent treatment plant.

Biological treatments - Principles of biological treatment; Microbial growth and their kinetics for substrate removal; Biological unit processes: Aerobic suspended - growth treatment processes, aerobic attached-growth treatment processes, anaerobic suspended – growth treatment processes, anaerobic attached- growth treatment processes.

Reuse and recycle of water and waste water
Primary, secondary and tertiary treatments; Sludge dewatering and its disposal; Water reclamation and reuse; Removal of impurities; Removal of residual impurities; Effluent recycle and disposal.

Design and functioning of ETP

Concept of Effluent Treatment Plants (ETP); Need of ETP in industry; Concept of Common ETP (CETP); Major units in ETP and their functions; Design aspects of major ETP units.

MODULE II

Air and noise pollution control technologies:
A brief overview of the Parameters and standards of noise, air pollutants. Standards adopted by CPCB and SPCB; Primary pollutants-particulate matter , dust ,smoke fumes, mist, fog and aerosol, oxides of sulphur , nitrogen oxides. Secondary pollutants -sulphur trioxide , Peroxyacetyl nitrate, ozone, aldehydes etc. Meteorology and plume Dispersion; Lapse rate : Temperature lapse rate , adiabatic lapse rate. atmospheric stability- inversion, radiation inversion, subsidence inversion, double inversion .plume behaviour.Laws governing behavior of air pollutants; Thermodynamics of major air pollutants; Air Pollution Control Methods and Equipment: Primary and secondary air pollutants, standards, sampling, Particulate matter control equipment; Settling chamber; Cyclones; Fabric filter; Electrostatic precipitator; Wet scrubber- Design aspects; Control of gaseous pollutants; Control technologies for controlling oxides of sulphur and nitrogen and carbon. Principle, design and working of catalytic converters; Use of catalytic converters in vehicular pollution control;

Noise Pollution and Control: Sound pressure, Power and Intensity - Measures of Noise- Outdoor noise propagation- Indoor Noise propagation- Noise Control Principle and working and use of noise meter; Legislative control of noise; Noise reduction and control techniques.

MODULE III

Innovative techniques for prevention and control of Pollution

Use of solar radiation in industrial effluent treatment; Solar detoxification process; carbon adsorption; Adsorption media filters; Micro-screening and other low cost treatment methods; Removal of chromium, phenol, mercury, nitrogen etc. from industrial effluents.

Specialized aspects: Oil pollution – treatment with micro-organisms, xenobiotics, degradative capabilities of microorganisms with reference to toxicology, pesticides, herbicides, polyaromatic hydrocarbons, .Anaerobic and aerobic composting, Vermiculture, Wetland Management, Membrane based waste water treatment processes – case studies.

Introduction to Bioremediation, Types of Bioremediation, Environmental Nanotechnology Research - Nanotechnology for Bioremediation of Heavy metals – New Bioremediation Technologies to Remove Heavy Metals and Radionuclides using Fe (III), Sulfate and Sulfur Reducing Bacteria - Bioremediation of Petroleum Sludge using Bacterial Consortium and Biosurfactant - Biofilms in Porous Media
Bioremediation of surface soil and sludges, Bioremediation of subsurface material, In situ technologies, Ex-situ technologies, Phytoremediation, Bioaugmentation of naturally occurring microbial activities:- Environmental modification- use of co-substrates, oxygen supplementation (Composting and aerobic bioreactors, in situ aeration).

BIOOXIDATION and MICROBIAL 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.

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1. **Mackenzie Davis, Susan J. Masten,** *Principles of Environmental Engineering and Science,* 1st Edition, McGraw-Hill College, 2003.
2. **MacKenzie L. Davis, David A. Cornwell,** *Introduction to Environmental Engineering,* 4th Edition, McGraw-Hill College, 2006.
3. **Joseph A. Salvato,** *Environmental Engineering and Sanitation*, 4th Edition, Wiley, 1992.
4. **Tom D. Reynolds, Paul Richards,** *Unit Operations and Processes in Environmental Engineering,* 2nd Edition, Thomson Learning, 1995.
5. **Gilbert M. Masters,** *Introduction to Environmental Engineering and Science,* 2nd Edition, Prentice Hall publication, 1997.
6. **Gerard Kiely,** *Environmental Engineering,* McGraw-Hill College, International Edition, 1997.
7. **Jerry Nathanson**, *Basic Environmental Technology: Water Supply, Waste Management and PollutionControl,* 5th Edition, Prentice Hall, 2003.
8. **W. W. Nazaroff, William W. Nazaroff, Lisa Alvarez-Cohen,** *Environmental Engineering Science,* John Wiley and Sons Inc, 2000.
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10. **Jerry A. Nathanson,** *Basic Environmental Technology: Water Supply, Waste Management and Pollution Control,* 5th Edition, Prentice Hall, 2007.
11. **Verma Y.B.G, Brauer. H,** *Air Pollution Control Equipment,,* Springer, Verlag Berlin, 1981.
12. *M.N. Rao and H.V.N. Rao, Air Pollution,* Tata McGraw Hill, New Delhi, 1993.
13. **Rao C.S,** *Environmental Pollution Control Engineering, 2nd Edition,* New Age International Publishers, 2006.
14. **Sincero A. P. and Sincero G.A,** *Environmental Engineering: A Design Approach,* Prentice Hall of India PvtLtd, N.Delhi.1996
15. **Mahajan S.P,** *Pollution Control in Process Industries,* Tata McGraw Hill, New Delhi, 1985
16. Tchbanoglous and F.L. Burton, *Metcalf and Eddy's Wastewater Treatment-Disposal And Reuse* (Third Ed.),TMH publishing Co Ltd, N. Delhi, 1996.
17. **Jogdand S.N,** *Environmental biotechnology,* 1995. Himalaya Publishing House, Bombay, Delhi, Nagpur.
18. **Baker, K.H.and Herson, D.S,** *Bioremediation,* 1994 McGraw Hill, Inc.New York.

The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10 compulsory** *short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
No charts, tables, codes are permitted in the Examination hall if necessary relevant data is given along with the question paper by the question paper setter.

08.804 MANAGERIAL ECONOMICS FOR PROCESS ENGINEERS AND PRINCIPLES OF INDUSTRIAL MANAGEMENT (B)

Credits: 04 **L/T/P: 3/1/0**

MODULE I

Introduction to Engineering economy,- Engineering Decision - makers, Problem solving Decision making. Interest and Interest Factors - Interest rate, simple interest and Compound interest factors.

Equivalence and cost comparisons : Time value of money and equivalence, Equations that are used in economic analysed, Compound interest as an operator, Unacost, Hoskolds formula, Cost comparisons, Present Worth Comparison, Conditions for present worth comparisons, Basic Present worth comparisons, Present worth equivalence, Net Present worth, Assets with unequal lives, infinite lives, Future worth comparison, Unacost and capitalised cost.

Depreciations and taxes: Purpose of Depreciation as cost, Nature of depreciations - Methods for determining depreciation - Straight line method - sinking fund method - Declining balance method - Double declining balance method - Sum of digits methods - Units of production method.

Taxes and depreciation method - Comparison of depreciation methods - Cost comparison after taxes, Present worth after taxes three continuous interest and discounting, Logic for continuous interest, Continuous interest as an operator, Uniform flow, Flow changing at an exponential rate, flow declining in a straight line to Zero - Discounting with improving performance, Unaflow - Capital recovery factor, Capitalised cost-taxes.

MODULE II

Technical advancement and inflation : Displacement Vs replacement, One year more of existence, More than one year of existence, Uniform gradient series delay value of an existent inflation, Cost comparison under inflation, unaburden, high inflation rates, Inflation and technological advancements.

Capital requirements and cost of production for process plants - Equipment for process plants, cost index, Nelson refinery construction index - Material cost indices - Process equipment cost index - Material cost indices - Process equipment cost index - Labour cost index - equipment costs - Williams six-tenths factor.

Cost Estimation: Capital investments, Factors affecting investment and production costs, Fixed capital investment and working capital, Estimation of capital investment, direct cost and indirect costs, Types of capital cost estimates, Order of magnitude estimates, study estimates, preliminary estimate definitive estimate and detailed estimate,

Cost factors in capital investment, Cost and installation of purchased equipment, Estimating equipment costs by scaling 6/10 Factor Rule,. insulation costs, Instrumentation and controls, Piping, Electric installation, Building, Yard improvements, Service facilities, Land design engineering and supervision, construction expenses contractors fee, Contingencies, Start up expenses, Methods for estimating capital investment. Estimation of total product cost, Different costs involved in the total product for a typical Chemical Process plant. Estimation of total product cost, Manufacturing costs, general expenses - Direct production costs, Fixed costs, plant over head cost, administration expenses - Distribution and marketing expenses.

MODULE III

Financial statements: Balance sheet and profit and loss accounts - Ratios used for comparing the balance sheet and profit and loss account.

Break even and minimum cost analysis, Types of costs, Cost analysis, Economic production charts, Differential analysis of economic production charts, criteria in the use of break-even and minimum cost analysis.

Profitability: Investment evaluation, Profitability standards, mathematical methods for profitability evaluation: pay out time, pay out time with interest, rate of return on original investment, return on average investment, discounted cash flow, Net Present worth, Venture worth.

REFERENCES

1. **Peters and Timmerhaus,** *Plant Design and Economics for Chemical Engineers,* McGraw Hill , New York , 4th Edition, 2003.
2. **Davies, G.S.** *Process Engineering Economics* CEED IIT Madras.
3. **Kenneth King Humphrey,** *Jelen's Cost and Optimization Engineering,* McGraw Hill, Third Edition, 1991
4. **Robert S. Aries and Robert D.Newton,** *Chemical Engineering Cost Estimation,* Chemonomics, New York, 1951.
5. **John Happel and Donald G. Jordan,** *Chemical Process Economics*, Marcel Decker, 1975.
6. **Vibrandt, F C,** *Chemical Engineering Plant Design,* McGraw Hill
7. **Holand , E.A., Watson, F.A. and Wilkinson, J.K.,** *Introduction to Process Economics,* John Wiley and Sons.
8. **Paneerselvam R,** *Engineering Economics,* PHI, Eastern Economy Edition
9. **Tuesen.G,** *Engineering economy*, PHI, 2002
10. **Ulrich , G D,** *A Guide to Chemical Engineering Process Design and Economics,* John Wiley, 1984.
11. **Guthrie K M,** *Process Plant Estimation, Evaluation and Control,* Craftsman Solano Beach, California, 1974.

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13. **Valle Riestra,** *Project Evaluation in Chemical Process Industries,* McGraw Hill
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The question paper consists of Part A and Part B. Part A is for 40 marks. Part A consists of **10** compulsory *short answer questions each carrying 4 marks covering the entire syllabus.*
Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08.805 ELECTIVE-IV (EL 4A)
NANO-ENGINEERING OF BIOMATERIALS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction to; Nanotechnology. its emergence and challenges classification of nano-materials: Zero, one, two and three dimensional nano-structured materials. Supramolecular Chemistry: Definition and examples of the main intermolecular forces used in supramolecular chemistry. Self-assembly processes in organic systems. Main supramolecular structures. Types of Nanomachines and nanotechnology-periodic table-Atomic structure molecules and phase Energy-Molecular and Atomic size-surfaces and dimensional space-Top down and bottom up.

Instrumentation for nanoscale characterization: Basic characterization techniques; Electron microscopy; Atomic force microscopy; Photon correlation spectroscopy. The measurable properties and resolution limits of each technique, with an emphasis on measurements in the nanometer range.

MODULE II

Methods of Synthesis of Nanometerials: Bottom-up (building from molecular level) and top-down (breakdown of microcrystalline materials) approaches. Biologically-Inspired nanotechnology basic biological concepts and principles that may lead to the development of technologies for nano engineering systems. Coverage will be given to how life has evolved sophisticatedly; molecular nanoscale engineered devices and discuss how these nanoscale biotechnologies are far more elaborate in their functions than most products made by humans.

Synthesis of nano-particles through homogenous and heterogeneous nucleation, kinetically confined synthesis of nano-particles synthesis of nano-wire, rod, tubes and thin films. Special nano-materials: carbon, carbon fulrenes and carbon, nano-tubes, nano and microporous materials, core shell structure and nano-composites. Electrical, magnetic, optical, thermal and mechanical properties of nano-structured materials. Applications of naon-materials in molecular electronics, nano-electronics, catalysis, photoelectrochemical cells, photonics, quantum well, quantum dot and quantum wire devices.

MODULE III

Introduction to Nanobiotechnology: Introduction to Bio-Nanotechnology, Cellular nanostructures, self-assembly of colloidal nanostructures of biological relevance, bioactive nanoparticles (respiratory surfactants, magnetic nanoparticles), Nanoparticles for drug delivery (including solid lipid nanoparticles, synthetic and biopolymeric nanoparticles), carbon nanotubes, polymeric nanofibers, Implications in neuroscience, tissue engineering and cancer therapy and Environmental and safety aspects of bio-nanotechnology. Introduction to Nanotechnology, Multilayer Thin Film: Polyelectrolyte multilayers, coated colloids, smart capsules, LbL self-assembly, Colloids and Colloid Assemblies for Bio-nanotechnology, Nanoengineered biosensors, Fiber Optic Nanosensors in medical care, Semiconductor and Metal Nanoparticles: Synthesis and Applications, Nanotechnology in Tissue Engineering, Microemulsions and Drug Delivery in Nanotechnology.

REFERENCES

1. **Jean-Marie Lehn,** *Supramolecular Chemistry,* Wiley VCH, 1995
2. **Jonathan Steed and Jerry Atwood,** Supramolecular Chemistry, John Wiley and Sons, 2004
3. **Jacob Israelachvil**, *Intermolecular and Surface Forces*, Academic Press, London, 1992.
4. Rao **C.N.R., Muller A., Chutham A.K,** *The Chemistry of Nanoparticles Synthesis, Properties and Applications, Vol 1 and Vol 2,* WILEY-VCH

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7. **William A. Goddard III, Donald W Brenner, Sergey E. Lyshevski, Gerald J. Iafrate,** *Handbook of Nanoscience, Engineering and Technology,* CRC Press Taylor and Francis Group, 2007
8. **Bhushan**, *Handbook of Nanotechnology,* Springer–Springer,2007
9. **Challa Kumar,** *Nanomaterials for Cancer Diagnosis and Therapy, Vol 6 and 7*, WILEYVCH, 2007
10. **Challa Kumar**, *Nanodevices for Life Sciences, Vol 4*,WILEY-VCH, 2006
11. **Gero Decher and Joseph B. Schlenoff,** *Multilayer Thin Films*, Wiley-VCH Verlag GmbH and Co. KGaA, 2003
12. **David S. Goodsell,** *Bionanotechnolog, Lessons from Nature*, Wiley-Liss, 2004.
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14. **Christof M. Niemeyer and Chad A. Mirkin,** *Nanobiotechnology: Concepts, Applications and Perspectives* by Wiley-VCH; 1 edition, 2004
15. **Guozhong A.O,** *Nano structure and nano-materials,* Imperial College Press, London
16. **Poole P, Jr and Frauk J. Owens,** *Introduction to Nano technology*, Charles P, Wiley Interscience, New Jersey, 2003.
17. **Carl C. Koch. Noyes,** *Nano-structured materials: Processing, properties and Potential Applications*, William Andrew Publishing New York.
18. **David S. Goodsell,** *Bionanotechnology: Lessons from Nature,* Wiley
19. **Pradeep.T,** *Nano: The Essentials,* Tata McGraw-Hill Publishing Company Ltd, 2007.
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Part B is for 60 marks. There will be two questions from each module. The candidate has to answer one question of 20 marks from each module.
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08-805 ELECTIVE-IV (EL4 B)

PHYTOCHEMICALS AND HERBAL CLINICAL GENETICS AND CYTOGENETICS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Crude Drugs: Scope and Importance, Classification (Taxonomical, Morphological Chemical, Pharmacological); Cultivation, Collection and processing of Crude Drugs.
Medicinal and aromatic plants: Cultivation and Utilization of Medicinal and Aromatic Plants in India. Genetics as applied to Medicinal herbs.
Tissue culture of medicinal Plants: Plant Tissue Culture as source of medicines, Plant Tissue Culture for enhancing secondary metabolite production; Anticancer drugs, Biogenesis of Phytopharmaceuticals.

Methods of plant analysis: Methods of extraction and isolation, methods of separation, methods of identification, analysis of results and applications.
Analysis of phytochemicals: Methods of Drug evaluation (Morphological, Microscopic, Physical and Chemical). Preliminary screening, Assay of Drugs – Biological evaluation/assays, Microbiological methods.

Chemical Methods of Analysis and Detection of Adulterants: Chemical estimations, Spectrophotometry and Fluorescence analysis. Drug adulteration – Types of adulterants.

MODULE II

Types of Phytochemicals:Sugars and their derivatives;Phenolic compounds and Terpenoids;Organic acids and lipids; Alkanes and related hydrocarbons, polyacetylenes, sulphur compounds; Nitrogen compounds.
Applications of Phytochemicals: Application of phytochemicals in industry and healthcare; Biocides, Biofungicides, Biopesticides.

Plant Cytogenetics: Architecture of the chromosome – prokaryotic and eukaryotic chromosomes– lasmids, episomes,

transposomes; Genomes of mitochondria and plastids – Euchromatin and heterochromatin – Chromatin and nucleosome – B-chromosomes and special types of chromosomes; Structural changes in chromosomes – Duplications, Deficiencies, Inversions and Translocations – classification, identification, meiotic pairing, breeding behaviour and role in evolution of structural changes.

MODULE III

Numerical changes in chromosomes : Haploidy – classification, methods of production, identification and utility. Polyploidy – Auto and Allopolyploidy, their classification, meiotic pairing, production, utility and role in evolution; Aneuploidy – trisomy, tetrasomy, monosomy and nullisomy. Chromosome banding techniques – Different types and their application. In-situ hybridization. Induced mutation in plants and their application. Alien gene transfer through chromosome manipulation – whole genome, individual chromosome, individual gene. Molecular markers and their utility – PCR, RAPD, RFLP, AFLP, VNTR, SSR.

REFERENCES

1. **Kokate C. K, Purohit A. P and Gokhale S. B,** *Pharmacognosy* Nirali Prakashan, 4th Ed, 1996.
2. *Natural Products in medicine: A Biosynthetic approach*, Wiley, 1997.
3. **Hornok,L (ed.)**, *Cultivation and Processing of Medicinal Plants,* Chichister, U.K, J. Wiley and Sons, 1992
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5. **Harbone J. B,** *Phytochemical Methods – A guide to modern techniques of plant analysis,* Springler publications, 3/e, 2005.
6. **Gupta, P.K,** C*ytogenetics,* Rastogi and Company, Meerut.
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08.805 ELECTIVE-IV (EL4 C)
METABOLIC REGULATION AND ENGINEERING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction: Identification of metabolic regulation is a key point in metabolic engineering. Basic concepts of Metabolic Engineering – Overview of cellular metabolism – Different models for cellular reactions, induction – Jacob Monod model and its regulation, Differential regulation by isoenzymes, Feed back regulation.

Synthesis of Primary Metabolites: Amino acid synthesis pathways and its regulation at enzyme level and whole cell level, Alteration of feed back regulation, Limiting accumulation of end products.

Biosynthesis Of Secondary Metabolites: Regulation of secondary metabolite pathways, precursor effects, prophase, idiophase relationship, Catabolite regulation by passing control of secondary metabolism, producers of secondary metabolites, applications of secondary metabolites.

MODULE II

Bioconversions: Applications of Bioconversions, Factors affecting bioconversions, Specificity, Yields, Co-metabolism, Product inhibition, mixed or sequential bioconversions, Conversion of insoluble substances.

Regulation Of Enzyme Production: Strain selection, Genetic improvement of strains, Gene dosage, metabolic pathway manipulations to improve fermentation, Feed back repression, Catabolite Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways

MODULE III

Metabolic Flux: Integration of anabolism and catabolism, metabolic flux distribution analysis in bioprocess, material balance, kinetic types, equilibrium reaction. Experimental determination method of flux distribution, Metabolic flux

analysis and its applications, Thermodynamics of cellular processes.

Metabolic Engineering With Bioinformatics : Metabolic pathway modeling, Analysis of metabolic control and the structure metabolic networks, Metabolic pathway synthesis algorithms, Applications Of Metabolic Engineering: Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomass conversion.

REFERENCES

1. **Wang.D.I.C Cooney C.L, Demain A.L, Dunnil.P. Humphrey A.E. Lilly M.D,** *Fermentation and Enzyme Technology,* John Wiley and Sons, 1980.
2. **Stanbury P.F. and Whitaker A,** *Principles of Fermentation Technology,* Pergamon Press, 1984.
3. **Zubay G,** *Biochemistry,* Macmillan Publishers, 1989.

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08.805 ELECTIVE- IV (EL4 D)
ETHICS AND INTELLECTUAL PROPERTY RIGHTS IN BIOTECHNOLOGY

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Biosafety and Bioethics: Bioethics: Social and ethical issues in Biotechnology, Legality, morality and ethics, the principles of bioethics: autonomy, human rights, beneficence, privacy, justice, equity etc. Ethical considerations in genetic engineering, Ethics in genetic testing and screening, medical safety, Legal implications and public concerns in Human gene therapy, genetic modifications and food uses.

Biotechnology and Bioethics: The expanding scope of ethics from biomedical practice to biotechnology, ethical conflicts in biotechnology - interference with nature, fear of unknown, unequal distribution of risks and benefits of biotechnology, bioethics vs. business ethics, ethical dimensions of IPR, technology transfer and other global biotech issues.

MODULE II

Application in clinical trial management; Risk assessment; Research ethics and Bioethics - Principles of research ethics; Ethical issues in clinical trials; Use of humans in Scientific
Experiments; Ethical committee system including a historical overview; the informed consent; Introduction to ethical codes and conduct; Introduction to animal ethics; Animal rights and use of animals in the advancement of medical technology; Introduction to laws and regulation regarding use of animals in research.

INTELLECTUAL PROPERTY RIGHTS IN BOTECHNOLOGY: WTO: As an international agency controlling trade among nations. WTO with reference to biotechnological affairs, TRIPs.

General Introduction: Juriprudential definition and concept of property, rights, duties and their correlation; History and evaluation of IPR – like patent design and copyright. Patent claims, the legal decision – making process, ownership of tangible and intellectual property.

MODULE III

Basic Requirements of Patentability Patentable subject matter, novelty and the public domain, non obviousness

Special issues in Biotechnology Patents Disclosure requirements, Collaborative research, Competitive research, Plant biotechnology: Indian patents and Foreign patents, Plant variety protection act, The strategy of protecting plants.

Patent Litigation Substaritive aspects of patent litigation, Procedural aspects of patent litigation, different Doctrines. Recent Developments in Patent System and Patentability of biotechnological inventions.

IPR issues in Indian Context: Intellectual property rights and Intellectual Property protection, patents and methods of application of patents, Trade Secrets copyrights, Trade Marks, legal implications, farmers rights, plant breeder's rights. International and National conventions on biotechnology and related areas. Role of patent in pharmaceutical industry, computer related innovations

Case studies Rice, Haldi, Neem, etc. and challenges ahead

REFERENCES

1. **Thomas, J.A., Fuch, R.L.** *Biotechnology and Safety Assessment* (3rd Ed), Academic Press, 2002.
2. **Fleming, D.A., Hunt, D.L,** *Biological safety Principles and practices* (3rd Ed). ASM Press, Washington.
3. **Sibley,** *The law and strategy of Biotechnological patents,* Butterworth publications.
4. **Ganguli,** *Intellectual Property Rights,* Tata McGrawhill
5. **Wattal,** *Intellectual Property Rights,* Oxford Publishing House.
6. **Smith J.E,** *Biotechnology, 3rd edition*, Cambridge Univ. Press, 1996.
7. **Santaniello, Evenson, Ziberman, Carlson,** *Agriculture and Intellectual Property Rights,* Univ. Press, 1998
8. **Thackerey,A** (ed), *Private Science : Biotechnology and the Rise of the Molecular Sciences,* Univ of Pennsylvania Press, Phil, 1998.
9. **Singh K,** *Intellectual Property Rights on Biotechnology,* BCll, New Delhi.
10. **Sasson A,** *Biotechnologies and Development,* UNESCO Publications, 1988.

Important Links:
http://www.w3.org/IPR/
http://www.wipo.int/portal/index.html.en
http://www.ipr.co.uk/IP_conventions/patent_cooperation_treaty.html
www.patentoffice.nic.in
www.iprlawindia.org/ - 31k - Cached - Similar page
http://www.cbd.int/biosafety/background.shtml
http://www.cdc.gov/OD/ohs/symp5/jyrtext.htm
http://web.princeton.edu/sites/ehs/biosafety/biosafetypage/section .html

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08.805 ELECTIVE-IV (EL4 E)

IMMUNOLOGY AND IMMUNOTECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction to Immunology: Properties of immune response, Innate and acquired immunity, active and passive immunity.
Cells and Tissues of Immune System: Lymphocytes, Classes of lymphocytes, antigen presenting cells, NK Cells, Mast Cells, Dendritic Cell, Organs of the Immune System- Bone marrow, Thymus, Lymph node, Spleen, CALT, MALT.
Molecular Immunology: - Molecular structure of antibodies, Classification, Isotypes. Synthesis, assembly and expression of immunoglobulin molecules, Nature of antigens, function and diversity, Generation of antibody diversity.Different characteristics of antigens, mitogens, Hapten, Immunogen, Adjuvants.
MHC: Discovery of MHC complex, Role of MHC, Structure of MHC molecule, Binding of peptides to MHC molecules, MHC restriction.

MODULE II

Assessment of cell mediated immunity**:** Identification of Lymphocytes and their subsets in blood. T cell activation parameters, estimation of cytokines, macrophage activation, macrophage microbicidal assays, in-vitro experimentation-

applications of the above technology to understand the pathogenesis of infectious diseases**.**
Molecular basis of Immunology: Molecular basis of antibody diversity, polyclonal and monoclonal antibodies, complement system, antigen-antibody reaction.
Immunopathology: Preparation and storage of tissues, identification of various cell types and antigens in tissues, isolation and characterisation of cell types from inflammatory sites and infected tissues, functional studies on isolated cells, immunocytochemistry -immunofluoresecence, immunoenzymatic and immunoferritin techniques, immuno-electron microscopy.
Immune response and tolerance: Regulation of immune response, immuno tolerance; hyper sensitivity, autoimmunity; graft versus host reaction. Immuno-deficiency and immuno- proliferate diseases.

MODULE III

Antibodies and Immunodiagnosis: Monoclonal and polyclonal antibodies-their production and characterisation, Western blot analysis, Immuno electrophoresis, SDS-PAGE, purification and synthesis of antigens, ELISA-principle and applications, Radio Immuno Assay(RIA)-principles and applications, Non isotopic methods of detection of antigens -enhanced chemiluminescence assay.
Application of recombinant DNA technology for the study of the immune system, production of antidiotypic antibodies, catalytic antibodies, application of PCR technology to produce antibodies and other immuological reagents, immunotherapy with genetically engineered antibodies.

REFERENCES

1. **Goldsby R. A., Kindt T.J and Osborne B.A,** *Kuby Immunology* 4th Edition, WH Freeman, NY
2. **Ivan Roitt,** *Essentials of Immunology,* 6th Edition: Blakswell Scientific Publications, Oxford, 1988.
3. **Paul W.E.** (Eds.) *Fundamentals of Immunology*, Raven Press, New York, 1988.
4. **Harlow and David Lane,** Antibodies- *A laboratory Manual* Cold spring harbor laboratory.
5. **Chakravarty A. K.,** *Immunology and Immunotechnology*, Oxford University Press, 2006.
6. **Charles Janeway,** *Immunobiology: The Immune System in Health and Disease,* Garland Science, 2005.
7. *Richard Coico, Geoffrey Sunshine*, Immunology: A Short Course, John Wiley and Sons, 2007.

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08.805 ELECTIVE IV (EL4 F)

COMMERCIALIZATION, MARKETING AND MANGEMENT OF BIOTECH PRODUCTS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Need to commercialize biotechnology. discovery, market needs development process, success rates and costs etc. Creating and marketing the image of the biotechnology company. Art of negotiation and effective communication.

MODULE II

Role of venture capitalism, business plan, selection of CEO and personnel, real estate for a biotech start-up. How to portray management and role of a biotechnology manager, technology decision making and resource decision-making etc., Product marketing decision. Role of Research and development University-industry technology transfer arrangements, how and why a biotech company can benefit.

MODULE III

Positioning, power and importance of positioning of a company name and product, Workable marketing and the strength of distribution.
Effective advertising and marketing. Opportunities international, marketing and lessons to be learned. Indian and foreign prospective of biotechnology and current challenges for the biotechnology based products.

REFERENCES

1. **Al Rise and Jack Trout**, *Positioning: The Battle for your Mind, Mc Graw Hill 2000/* Warner Books, 1986.
2. **V. Moser and R.E. Cape**, *Biotechnology: The science and the business,* Harwood, 1999.
3. **Michael, J. E., Bruce, J. W. and Williom, J. S,** *Marketing Management. Tata McGrawHill*, New Delhi, 2004.
4. *Latest review articles and papers on the subject.*

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08. 806 ELECTIVE-V (EL5 A)
MOLECULAR MODELING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Introduction to molecular modelling. What are models used for? Areas of application–single molecule calculation, assemblies of molecules. Reaction of the molecules. Drawbacks of mechanical models as compared to graphical models. Co-ordinate systems two– matrix, potential energy surface.
Quantum Mechanics: Postulates of quantum mechanics, electronic structure calculations, ab initio, semi-empirical and density functional theory calculations, molecular size versus accuracy. Approximate molecular orbital theories.

MODULE II

Empirical force field models, molecular mechanisms, energy calculations, bond stretch, angle bending, torsional term, out plane bonding motions, electrostatic interaction- Van der waals interactions, Effective pair Potentials, Hydrogen Bonding, simulation of liquid water, miscellaneous interaction.

Molecular dynamics: Introduction, molecular dynamics using simple models. Dynamics with continuous potentials, Running Molecular Dynamics simulation – Constant dynamics – Time dependent properties – Constant temperature and constant dynamics. Conformation searching, Systematic search, Monte Carlo simulation methods.

Comparative protein modeling, modeling by homology-the alignment, construction of frame work ,selecting variable regions, side chain placement and refinement, validation of protein models –Ramchandran plot, threading and ab initio modeling.

MODULE III

Analog based drug design: Introduction to QSAR. lead module, linear and nonlinear modeled equations, biological activities, physicochemical parameter and molecular descriptors, molecular modeling in drug discovery.
Structure Based Drug Design: 3D pharmacophores , molecular docking, De novo Ligand design, Free energies and solvation, electrostatic and non-electrostatic contribution to free energies.
Further applications on the design of new molecules 3D data base searching and virtual screening, sources of data, molecular similarity and similarity searching, combinatorial libraries – generation and utility.

REFERENCES

1. **Hans Pieter, Heltje and Gerd Folkens,** Molecular Modelling, VCH.
2. **Leach A.R,** *Molecular Modeling-Principles and applications,* Longman, 1996
3. **Jonathan Goodman,** *Chemical Applications of Molecular Modelling*
4. **Guy H.Grant and Graham Richards W,** *Computational Chemistry*, Oxford University, Press.
5. **Haile J.M,** *Molecular Dynamics Simulation Elementary methods*, John Wiley and Sons ,1997

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08.806 ELECTIVE-V (EL5 B)

ENERGY ENGINEERING (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE 1

Classification and sources of energy; problems relating demand and supply of various energy sources. Coal : origin and formation, composition and classification, resources and production, exploration and mining; analysis and testing storage and handling; coal carbonization, briquetting, coal hydrogenation. Wood and wood products. Petroleum; origin, occurrence; Chemical composition. World reserve, production, refining operations, storage and conveying, testing and analysis different products from petroleum like naphtha, aviation gasoline, kerosene, diesel oil, gas oil, lubricating oil, asphalts etc., petroleum coke, oil shale and oil sand. Combusting methods; and systems, pulverised coal furnaces; cyclone furnaces, oil fired systems, gas fired systems, waste heat boilers.

MODULE II

Nuclear energy: basic aspects of nuclear radiation, fission and fusion, process reactor systems; BW/PW/HW reactor; gas cooled reactors, fast breeder reactor; thermal design; problems of nuclear power generations and remedial measures.
Solar energy: Facts and scope; solar radiation; radiation measuring instruments; basic flat collector; solar heat pump and heat engine cooling and refrigeration; solar pond; conversion of solar energy into electrical energy; solar thermal power generation; hydroelectric energy; problems of hydro-electric energy and remedial measures. Thermal power plants, generation cycles, energy from ocean tidal wave, ocean thermal source; geothermal energy; wet steam and water, hot dry rocks, electricity from exothermal; sources; wind energy; tunnel mills and conversion cycles.

MODULE III

Biogas plant and its design: KVIC plants, process kinetics, digester design, sludge treatment, energy from wastes. Developments in energy routes.

Conversion of heat to power : thermoelectric converters; thermo-electric refrigerators magneto-hydrodynamics; fuel cells; conversion of chemical energy into electricity, fuel cell performance; energy accounting utility and process system optimization, energy audit, energy economics, reducing energy loss, co-generation, efficiency improvement; energy conversion in petrochemical industries, polymer industries, natural organic industries, fertilizer industries etc.

REFERENCES

1. **Pandya S.B,** *Conventional Energy Technology - Fuels and chemical Energ,* TMH, 1987.
2. **Sharma S.P. and Chander Mohan**, *Fuels and Combustion*, TMH, 1984
3. **Kash Kori, C.,** *Energy Resources, Demand and Conservation with Special Reference to India,* TMH, 1975.
4. **TWidell J.T and Weir T,** *Renewable Energy Sources* ,Cambridge University Press
5. **Gulp Jr**., *Principles of Energy Conservation,* MGK, 1979.
6. **Pryde P.R.,** *Non Conventional energy resources*, John Wiley, 1983.
7. **Connolly, T.J,** *Foundation of nuclear engineering* John Wiley, 1978.
8. **Gray T.J. and Gashos G.K.,** *Tidel Power*, Plenum Press, 1972.
9. **Sarkar S**. *Fuels and Combustion,* Orient Longmahs, 1974.
10. **Duffie T.R. and Beckman, W.A.,** *Solar Energy Thermal Processes,* John Wiley, 1974.

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08.806 ELECTIVE-V (EL5 C)

MATHEMATICAL MODELING AND PROCESS SIMULATION OF BIOPROCESSES (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Approach to modeling, Unstructured and structured modeling, Deterministic and stochastic models, Segregated and unsegregated models, Shu's segregated models for Lactic acid fermentation.

MODULE II

Structured kinetic models: Compartmental models (two and three), Product formation, Unstructured and structured models, Genetically structured models.

MODULE III

Stochastic model for thermal sterilization of the medium, Modelling for activated sludge process, Model for anaerobic digestion, Model for antibiotic production.

Process simulation techniques, Equation oriented approach, Equation oriented simulators (SPEED UP, ASCEND, FLOWSIM, QUASILIN, DYNSIM), simulation programs based on Euler's methods, Newton – Raphson methods, Runga – Kutta methods, Simulation of biochemical system models.

REFERENCES

1. **Shyam S. Sablani et al** (Eds*), Handbook of food and bioprocess Modeling techniques,* CRC
2. **Haerder A and Roels J. A,** *Application of simple structured Bioengineering,, Advances in Biochemical Engineering* Vol21, A. Fiechts (ed) Spring Verlag , Berlin, 1982.
3. **Bailey J.E and Ollis D.F,** *Biochemical Engg Fundamentals,* 1986, McGraw Hill
4. **Zeigler, B.P**. *Theory of Modeling and Simulation*,: Wiley, New York 1975.
5. **Francis G,** *Modelling and Simulation*

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08.806 ELECTIVE-V (EL 5 D)
BIOSTATISTICS (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Presentation of Data: Frequency distribution, graphical presentation of data by histogram, frequency curve and cumulative frequency curves.

Applications of statistics in biological sciences and genetics; Descriptive statistics; Mean; Variance; Standard deviation and coefficient of variation (CV); Comparison of two CVs; Skewness; Kurtosis
Probability – axiomatic definition; Addition theorem; Conditional probability; Bayes theorem; Random variable; Mathematical expectation; Theoretical distributions– Binomial, Poisson, Normal, Standard normal and Exponential distributions; Sampling- parameter, statistic and standard error; Census – sampling methods; Probability and non-Probability sampling; Purposive sampling; Simple random sampling; Stratified sampling.

MODULE II

Testing of hypothesis; Null and alternative hypothesis; Type I and type II errors; Level of significance; Large sample tests; Test of significance of single and two sample means; Testing of single and two proportions - Small sample tests: F-test – testing of single mean; Testing of two sample means using independent t test, paired t test; Chi square test: Test for goodness of fit – association of attributes – testing linkage – segregation ratio.

MODULE III

Correlation – Pearson's correlation coefficient and Spearman's rank correlation; Partial and multiple correlation – regression analysis; Sample linear and non linear regression; Multiple regression.

Experimental Designs: Principles of experimental designs, Completely randomized, Randomized block and latin square designs, Simple factorial experiments of 22, 23, 24 and 32 types, Analysis of variance – definition – assumptions – model; One way analysis of variance with equal and unequal replications; Two way analysis of variance; Non parametric tests – sign test – Mann Whitney 'U' test – Kruskal Wallis test.

REFERENCES

1. **Sundar Rao P.S.S, Richard P.H, Richard J.**, *An introduction to Biostatistics,* Prentice Hall of India (P) Ltd, New Delhi, 2003.
2. **Rangaswamy R,** *A text book of Agricultural Statistics,* New Age International (P) Ltd., New Delhi, 2000.
3. **Gupta S.P,** *Statistical Methods*, Sultan Chand and Sons, New Delhi. 2005.
4. **Panse V.G.Panse, Sukhatme P.V,** *Statistical methods for Agricultural Workers,* ICAR Publications, New Delhi, 2000
5. **Jerrold H. Zar,** *Bio Statistical Analysis*, Tan Prints (I) Pvt. Ltd., New Delhi, 2003.
6. **Chandel S.R.S,** *A Hand Book of Agricultural Statistics*, Achal Prakashan Mandir, Kanpur, 1999.
7. **Norman T.J. Bailey,** Statistical *methods in biology,* (3rd Edition, Cambridge University Press, 1995.

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08.806 ELECTIVE (EL5 E)
TOTAL QUALITY MANGEMENT (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

INTRODUCTION: Definition of Quality, Dimensions of Quality, Quality Planning, Quality costs – Analysis Techniques for Quality Costs, Basic concepts of Total Quality Management, Historical Review, Principles of TQM, Leadership – Concepts, Role of Senior Management, Quality Council, Quality Statements, Strategic Planning, Deming Philosophy, Barriers to TQM Implementation.

TQM PRINCIPLES: Customer satisfaction – Customer Perception of Quality, Customer Complaints, Service Quality, Customer Retention, Employee Involvement – Motivation, Empowerment, Teams, Recognition and Reward, Performance Appraisal, Benefits, Continuous Process Improvement – Juran Trilogy, PDSA Cycle, 5S, Kaizen, Supplier Partnership – Partnering, sourcing, Supplier Selection, Supplier Rating, Relationship Development, Performance Measures – Basic Concepts, Strategy, Performance Measure.

MODULE II

STATISTICAL PROCESS CONTROL: The seven tools of quality, Statistical Fundamentals – Measures of central Tendency and Dispersion, Population and Sample, Normal Curve, Control Charts for variables and attributes, Process capability, Concept of six sigma, New seven Management tools.
TQM TOOLS: Benchmarking – Reasons to Benchmark, Benchmarking Process, Quality Function Deployment (QFD) – House of Quality, QFD Process, Benefits, Taguchi Quality Loss Function, Total Productive Maintenance (TPM) – Concept, Improvement Needs, FMEA – Stages of FMEA.

MODULE III

QUALITY SYSTEMS: Need for ISO 9000 and Other Quality Systems, ISO 9000:2000 Quality System – Elements, Implementation of Quality System, Documentation, Quality Auditing, QS 9000, ISO 14000 – Concept, Requirements and Benefits.

Total Quality Environment Management and EMS 14000: Municipal pollution prevention Programmes – Environment Management System-14000- Systematic, Structured and Documented Response to Environmental Issues - Auditable and Time Targeted Environmental Improvement Programs.

Hierarchy of Environment Management Practices**:** Waste-specific pollution prevention: Waste pre - generation focus on minimization / recycling, Waste-specific pollution control treatment: pre - generation focus on disposal/ recycling-Waste-specific Post-release-to environment focus: recycling/ remediation

REFERENCES:

1. **Dale H.Besterfiled et at.,** *Total Quality Management*, Pearson Education Asia, 1999. Indian reprint, 2002.
2. **James R.Evans and William M.Lidsay,** *The Management and Control of Quality*, 5th Edition, South-Western (Thomson Learning), 2002
3. **Feigenbaum A.V.** *Total Quality Management,* McGraw-Hill, 1991.
4. **Oakland.J.S,** *Total Quality Management*, Butterworth Heinemann Ltd., Oxford. 1989.
5. **Narayana V and Sreenivasan, N.S.** *Quality Management–Concepts and Tasks*, New Age International 1996.
6. **Zeiri,** *Total Quality Management for Engineer*s Wood Head Publishers, 1991.
7. **Bishop P,** *Pollution Prevention: Fundamentals and Practice, McGraw-Hill, Singapore, 2000*
8. **Roy K,** *(Ed), Chemical Technology for better Environment,* Allied publishers Ltd, Chennai, 1998
9. **El Halwagy**, M. M, *Pollution Prevention through Process Integration: Systematic Design Tools,* Academic Press, N.Y. (1997)
10. **Anastas P.T and Warner J.C,** *Green Chemistry: Theory and Practice,* Oxford University Press. N.Y.1998

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08.806 ELECTIVE -V (EL5 F)
NOVEL ANALYTICAL METHODS IN BIOTECHNOLOGY (B)

Credits: 03 **L/T/P: 2/1/0**

MODULE I

Basic laboratory Instruments: Principle and working of pH meter, Laminar-air flow chambers, Centrifugation: Types of centrifuge machines, preparative and analytical centrifuges, differential centrifugation, sedimentation velocity, sedimentation equilibrium, density gradient methods and their applications; Dialysis, Ultra filtration, Seitz filter.
Microscopic identification of various microorganisms: Phase contrast Microscopy, confocal microscopy Fluorescent Microscopy, Electron Microscopy, Scanning Ion Conductance Microscopy, Video Micrography, Atomic force Microscopy. Flow Cytometry.

Electrophoresis: General principle, factors affecting electrophoresis – voltage, current, resistance, buffer–composition, concentration, pH. Gel electrophoresis: Types of gels (starch, agarose, polyacrylamide), Idea of electrophoresis unit, preparation of gel, sample application, running the samples, SDS-PAGE - Principle, apparatus and methods, gradient gels, Two dimensional gels, isoelectric focusing.

MODULE II

Chromatographic Techniques–I: Introduction to chromatography: General principles, column chromatography–columns, stationary phases. Packing of columns, application of sample, column development, fraction collection and

analysis). Partition and adsorption chromatography (brief idea). Affinity Chromatography; Principle, materials matrix, selection of attachment of ligands, practical procedures, specific and non-specific elution, applications. Ion Exchange Chromatography: Principle, types of exchangers, materials, choice of exchangers and buffers and applications. Gel Filtration chromatography: Principle, idea of distribution coefficient, exclusion limit, fractionation range, bed volume, void volume, elution volume, chemical properties of gel and applications.

Chromatographic Techniques II: Gas Chromatography: Principle of GC system, solid support, capillary column, stationary phase, preparation and application of sample, separation conditions, detection systems and applications. HPLC: Principle, components of HPLC system, column, column packing, chromatographic solvents, pumping systems, detectors systems and its applications.

MODULE III

Spectroscopy: Spectroscopic Techniques; Introduction, Energy levels and transition of electrons, Types of spectra, Beers Lamberts law, molar and extinction coefficient, limitations of Beers Lamberts law. Visible and UV Spectrophotometry; Principles, Instrumentation and applications. Spectroflourimetry; Principle, Stoke's shift, quantum efficiency, instrumentation and applications.

Spectroscopy: Atomic and Flame spectrophotometry; Principles, Instrumentation and applications for flame emission / atomic absorption spectrophotometry and their comparative study. Mass spectrometry: Principles, Instrumentation and applications. Theory and applications of IR, NMR, Fluorescence, Atomic Absorption, Mass spectroscopy, CD, ORD, Mass, Raman Spectroscopy, ESR principles - instrumentation-applications, Beer-Lambert's law, Use of NMR in elucidation biosynthesis pathways.

Radioisotopic techniques: Use of radioisotopes in life sciences, radioactive labeling, principle and application of tracer techniques, detection and measurement of radioactivity using ionization chamber, proportional chamber, Geiger-Muller and Scintillation counters, autoradiography and its applications, Dosimetry, Immunoassay.

Thermal Analysis: Differential scanning calorimetry and differential analysis Instrumentation, Thermogravimetry, Methodology of Thermogravimetry, differential scanning calorimetry and differential thermal analysis.

REFERENCES

1. **Wilson K and Goulding K.H**., *A biologist's guide to Principles and Techniques of Practical Biochemistry.*
2. **Willard and Merrit,** *Instrumental Methods and Analysis*
3. **Ewing GW**, Instrumental Methods of Chemical analysis.
4. **Robert. M. Silverstein et al,** *Spectrometric identification of Organic Compounds,* 7th Edition, 1981.
5. **Vogel's,** *Text Book of Quantitative Chemical Analysis,* 6th Edition, 2004.
6. **John A. Adamovic,** *Chromatographic Analysis of Pharmaceuticals,* 2nd Edition.
7. **Raymond P. W. Scott,** *Techniques and Practice of Chromatography* –Vol. 70.
8. **Sethi P.D, Dilip Charegaonkar,** *Chromatography* –2nd Edition.
9. **Niessen W. M. A., Van Der Greef J,** *Liquid Chromatography– Mass Spectrometry,* Vol. 58.
10. **Kalsi.P.K,** *Spectroscopy of Organic Compounds*.
11. **Hanes,** *Gel Electrophoresis of Proteins- A Practical Approach,*
12. **Hamilton R. J. and Sewell P. A,** *Introduction to High Performance Liquid Chromatography*
13. **Gordon M. Message,** *Practical aspects of Gas Chromatography and Mass Spectrometry,* John Wiley and Sons, New York. 1984
14. **Chapman J.M and G.Ayrey,** *The use of radioactive isotopes in the life sciences*, George Allen and Unwin Ltd., London.

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08.807 BIOINFORMATICS LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

1) Demonstration of BLAST, FASTA and other search engines
2) Retrieval of sequences using ENTREZ
3) Sequence analysis using BLAST, Align, Lalign
4) Multiple sequence alignment and Phylogenetic analyzing using Clustal, ClustalW
5) Clustering and contig assembly tools
6) Restriction site analysis tools
7) Studying 3D structure using RasMol
8) Prediction of secondary structure of proteins
9) Prediction of tertiary structure (fold recognition, homology search)
10) Molecular modeling and dynamics: using small oligonucleotides and small proteins with known crystal structure (available from data bank)
11) Homology Modeling using Swiss PDB – Hb, Protease
12) Calculation of Phi and Psi angle - Hb, Protease
13) Docking: protein-protein; protein-small molecules
14) Potential energy calculation of regular structures
15) To mutate protein and energy minimization using Swiss PDB viewer
16) Gene prediction – Gene Finder
17) Comparative proteomics and genomics – Proteome calculator
18) Drug designing – using available data

08.808 DOWNSTREAM PROCESSING LABORATORY (B)

Credits: 03 **L/T/P: 0/0/3**

Tutorial: *Basic principles of downstream processing, brief overview of techniques and strategies used in bioseparations, recent developments in bioseparation technology.*

Experiments:

I. **Cell disruption:**
   1. *Ultrasonication*
   2. *Enzymatic cell Lysis*
   3. *Cell lysis using organic solvents*
   4. *Mechanical cell disruption* (Bead mills / Dyno mills)

II **Solid- liquid separations (Removal of insolubles):**
   1. *Flocculation*
      - Determination of optimum dosage of a flocculant required for recovery of microbial cells from aqueous systems.
      - Comparison of flocculating power of different flocculants.
   2. *Vacuum filtration/pressure filtration*

      - Batch pretreatment test- effect of flocculant dosage on filtration rates.

- Determination of various parameters for batch filtration of microbial cell suspensions/ fermentation broths.

III **Product isolation and enrichment:**

1. *Membrane separation processes*
    - Batch and continuous membrane filtration for isolation of proteins (Ultrafiltration) and microbial cells (Microfiltration)
    - Demonstration of diafiltration, complete recycle, batch concentration and purification modes of operation of membrane filtration equipment.
2. *Precipitation*
    - Isoelectric precipitation- Determination of Isoelectric point of proteins and isolation of proteins from aqueous systems by pH change.
    - Salting out: Determination of Cohn's constants, validation of Lyotropic series.
3. Organic solvent mediated precipitation: Concentration of proteins from aqueous systems by addition of organic solvents
4. *Extraction*
    - Aqueous two phase extraction of proteins/enzymes from aqueous systems.
    - Solvent extraction for concentration of antibiotics / organic acids from fermentation broths.
5. *Batch adsorption as a method of bioproduct isolation.*

IV **Product purification:**

1. *Chromatography*
    - Ion exchange chromatography
    - Gel filtration (Molecular sieving)
2. *Electrophoresis*

V **Product polishing:**

1. *Crystallization*
2. Vacuum drying

08.809 PROJECT AND COMPREHENSIVE VIVA- VOCE (B)

Credits: 03 **L/T/P: 0/0/3**

Every student will be required to submit a project report in a typed form, on a topic selected by the student, but specifically approved by the faculty member, who will guide the student or on a topic to be assigned by one or more faculty members.

The project work on the topic will consist of either some investigational work, computer simulation or design problem or experimental set up of some development work or prototype equipment. Every student will be orally examined in the topic incorporated in the project and in the related area of specialization.

The student will be required to submit three copies of his/her typed copy of the project report to the department office for record (One copy each for the department library, participating faculty and students own copy).

Maximum marks for internal evaluation: 50

Attendance: 10 marks: A maximum of 10 marks shall be awarded to the students having more than 90 % attendance at the centre where project work is carried out. Proportionate deductions may be made as is done in the case of internal evaluation for theory subjects following the university norms.

Guide's share: 20.

The guide has to award a maximum of 20 marks based on the performance of the student during the course of execution of the work associated with the project.

Evaluation Committee's share: 20

An evaluation committee constituted from among the faculty of the department has to evaluate the student based on oral evaluations on the basis of the project work during the different stages of the work and evaluated out of a maximum of 20 marks.

External Evaluation (University Examination- Viva-Voce): Maximum Marks: 100

Distribution of marks for University Examination (Viva-Voce):

General Subject Viva: A comprehensive viva should be conducted based on the various courses taken up and training programmes undergone by the student during the period of his/her undergraduate programme and evaluated based on a maximum of 50 marks:

Viva based on the project: The knowledge of the student in the work done for the project has to be evaluated by both the external and internal examiners in the viva-voce examination conducted with questions exclusively based on the project work and evaluated out of a maximum of 50 marks.