Evaluation Scheme & Syllabus
For

B.Tech. Fourth Year
(Biotechnology)

On
Choice Based Credit System
(Effective from the Session: 2019-20)
## DR. A.P.J. ABDUL KALAM TECHNICAL UNIVERSITY LUCKNOW

### Study and Evaluation Scheme
**B.TECH. BIO-TECHNOLOGY**
(Effective from the session: 2019-20)

#### 4th Year, 7th Semester

<table>
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<tr>
<th>S. No.</th>
<th>Subject Code</th>
<th>Subject Name</th>
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**Departmental Elective-III**
- RBT071: Genomics and Proteomics
- RBT072: Quality Control & Regulatory Affairs
- RBT073: Clinical Trials & Management
- RBT074: Bioprocess Economics & Project Management

**Departmental Elective-IV**
- RBT075: Biosafety, Bioethics, IPR & Patents
- RBT076: Agriculture Biotechnology
- RBT077: Biomaterials
- RBT078: Applications of Natural Products
RBT701: Environmental Biotechnology

Unit I

Environmental pollution: An overview, Land, water, air, and noise, Marine (introduction, sources, effects and measurements). Thermal Pollution, Nuclear and Radiation Pollution, Type of Radiation, Radioactivity in nature, Decay chains, Toxic Hydrocarbon, Radioactive waste sunk, Genetic Consequences.

Unit II

Biological waste treatments and biofuel production. Microbiology of waste water treatments Methanogenesis: methanogenic, acetogenic, and fermentative bacteria – anaerobic and aerobic digestion processes and conditions. Minimal national standards for waste disposal.

Unit III

Principles and design aspects of various waste treatments methods, with advanced bioreactor configuration: activated sludge process, trickling filter, fluidized expanded bed reactor, upflow anaerobic sludge blanket reactor, contact process, fixed / packed bed reactor, hybrid reactor, sequential batch reactor.

Unit IV


Unit V


Recommended Books:
UNIT I - INTRODUCTION TO BIOSEPARATION PROCESS

Role and importance of bioseparation in biotechnological processes: RIPP scheme, Problems and requirements of bioproducts purification - Properties of Biomolecules - Characteristics of fermentation broth - Biological activity, Analysis of purity - Process economics: Capital and operating cost analysis.

UNIT II - REMOVAL OF INSOLUBLES


UNIT III - ISOLATION OF PRODUCTS


UNIT IV - PURIFICATION OF BIOPRODUCT

Basic principles of Chromatographic separations: GC-HPLC-gel permeation-ion-exchange-affinity- reverse phase and hydrophobic interaction chromatography-Electrophoretic separation techniques: capillary - isoelectric focusing-2D gel electrophoresis - Hybrid separation technologies: GC-MS and LC-MS.

UNIT V - PRODUCT POLISHING


TEXT BOOKS
3. Protein: Biochemistry and Biotechnology by Gary Walsh (2002 John Wiley & Sons Ltd.)
5. Schuler & Kargi, Bio-process Engg. PHI
   5th Ed.2000
11. Muni & Cheryan, Handbook of Ultrafiltration

REFERENCES

RBT071: Genomics and Proteomics

<table>
<thead>
<tr>
<th>Unit</th>
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Unit I
Introduction Structural organization of genome in Prokaryotes and Eukaryotes; Organelle DNA-mitochondrial, chloroplast; DNA sequencing-principles and translation to large scale projects; Recognition of coding and non-coding sequences and gene annotation; Tools for genome analysis-RFLP, DNA fingerprinting, RAPD, PCR, Linkage and Pedigree analysis-physical and genetic mapping.

Unit II
Genome sequencing projects Microbes, plants and animals; Accessing and retrieving genome project information from web; Comparative genomics, Identification and classification using molecular markers-16S rRNA typing/sequencing, EST’s and SNP’s.

Unit III
Proteomics Protein analysis (includes measurement of concentration, amino-acid composition, N-terminal sequencing); 2-D electrophoresis of proteins; Microscale solution isoelectric focusing;
Peptide fingerprinting; LC/MS-MS for identification of proteins and modified proteins; MALDI-TOF; SAGE and Differential display proteomics, Protein-protein interactions, Yeast two hybrid system.

Unit IV
Pharmacogenetics High throughput screening in genome for drug discovery-identification of gene targets, Pharmacogenetics and drug development

Unit V
Functional genomics and proteomics Analysis of microarray data; Protein and peptide microarray-based technology; PCR-directed protein in situ arrays; Structural proteomics

Texts/References:


RBT072: Quality Control & Regulatory Affairs

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Unit I
Concept and evolution of quality control and quality assurance. Quality control laboratory responsibilities: GLP protocols on non-clinical testing control on animal house, data generation, integration and storage, standard test procedure, retention of sample records. CPCSEA guidelines.

Unit II
Quality review and batch release document of finished products, annual product quality review and parametric release, Audits, quality audits of manufacturing processes and facilities, audits of quality control.

Unit III
Good documentation practices, route cause analysis, corrective action preventive action (CAPA), out of specifications (OOS) and out of trend (OOT), Clinical studies- ICH GCP (E6) guidelines, post marketing surveillance, Pharmacovigilance
Unit IV
BABE (bioavailability and bioequivalence) studies, Concepts and management of contract manufacturing guidelines, Statistical Tools for Quality Control and Precision, Tools of Problem Solving and Continuous Improvement

Unit V

References:

RBT073: Clinical Trials & Management

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</table>

Unit-I

Unit-II
Ethics In Clinical Research - Ethical issues in the conduct of clinical trials in India, Readiness of ethics committees, Independence of ethics committees, Training for ethics committee members. Informed consent process.
Unit-III
Regulatory Affairs In Clinical Research - Roles & Responsibilities, Pharmacovigilance researching, assessing and evaluating information from healthcare providers and patients. Pharmacovigilance is particularly concerned with adverse drug reactions. Adequacy of regulations to safeguard the clinical trial participants.

Unit-IV
Essential Documents & Regulatory Submission, Compliance And Audits - preparation, production and quality control of regulatory documents, creating editorial timelines and work flow specifications, scheduling and tracking documents, writing and proofreading. Development and updates on specifications for the design, tracking of regulatory documents and artwork used in regulatory documents.

Unit-V
Clinical Trial Monitoring - Fundamentals of Clinical Monitoring, the processes and procedures of monitoring a clinical trial, Clinical, Pharmacological (including pharmacodynamics and pharmacokinetic) or adverse Effects with the objective of determining safety and efficacy of the new drug. Clinical Data Management And Biostatistics – establishment of protocol-specific data review and entry guidelines to document data validation and formatting procedures.

RBT074: Bioprocess Economics and Project Management

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<thead>
<tr>
<th>UNIT I</th>
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</table>
Introduction to statistical process control and capability analysis: Chance and assignable cause of quality variation, Statistical basis of process monitoring: control chart, choice of control charts, analysis of control chart, variable of control charts, X bar and R chart, Attribute control chart, Determining process and measurement capability

| UNIT II | 8 |
DOE Approach to Medium Optimization: - traditional (linear) approach (OFAT) and multi-dimensional approach (Box-Bhenken Design, central composite design, Plackett-Burman Design, Downhill Method, Full factorial, Fractional factorial,);

| UNIT III | 8 |

| UNIT IV | 8 |

UNIT V

Text/Reference Books:
1. Douglas C Montgomery: Statistical Quality Control
2. Managerial Economics for Engineering: Prof. D.N. Kakkar
3. T.R. Banga: Industrial Engineering and Management
5. Khanna O.P.: Industrial Engineering

Departmental Elective-IV

RBT075: BIOSAFETY, BIOETHICS, IPR & PATENTS L T P
3 1 0

Unit 1: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS IN INDIA

Unit 2: BIOSAFETY-REGULATORY FRAMEWORK FOR GMOS AT INTERNATIONAL LEVEL
movement of GMOs-Benefits of becoming a party to the Cartagena Protocol- status of implementation in India.

Unit3: BIOETHICS Distinction among various forms of IPR, Prior art for a patent, Patenting live microorganism, Human Genome project and ethical issues, Animal cloning, human cloning and their ethical issues, Experimenting on animals. Public education of producing transgenic organism, legal and socioeconomic impacts of biotechnology, testing drugs on human volunteers, Hazardous materials used in biotechnology, their handling and disposal.

Unit 4: INTELLECTUAL PROPERTY RIGHTS Concept of property, rights, duties and Jurisprudential definition, Introduction to patent, copy right, trademarks, Design, geographical indication. History and evolution of IPR, Economic importance of IPR, Indian patent act 1970 (amendment 2000), Distinction among various forms of IPR, invention step, biopiracy and bioprospecting- Appropriate case studies. Infringement/violation of patent, remedies against infringement (civil, criminal, administrative)

Unit 5: PATENTS AND PATENT LAWS Plant and Animal growers rights patents trade secrets, and plant genetic recourses GATT and TRIPS, Dunkels Draft Patenting of biological materials, Current Issues of Patents for higher animal and higher plants, patenting of transgenic organisms, isolated genes and DNA sequences.

REFERENCES:
2. Intellectual property rights and Bio-Technology (Biosafety and Bioethics), Anupam Singh, Ashwani Singh, NPH, New Delhi
4. Singh K, Intellectual Property rights on Biotechnology, BCIL, New Delhi
UNIT I : Agriculture and Agricultural Biotechnology, Clonal Germplasm: Micropropagation, In vitro production of pathogen and contaminant free plants. (6)

UNIT II Biotechnology- Methods of Crop Improvement: Genetic Engineering of Crop Plants, Transgenic Plants, Molecular Markers, QTL Mapping. (6)

UNIT III : Microbes in Agriculture and Food: Applied Microbiology in the future of mankind, moving frontiers of applied microbiology, microbial enzymes and their applications in food processing and agrochemical industries, agro-waste utilization, biodegradable polymers and their applications, microbial polysaccharides; Production and utilization of essential amino-acids, chemicals from micro-algae. (12)

UNIT IV : Metabolite Production: Production of Secondary Metabolites, Production of foreign compounds in transgenic plant, Achievements and recent developments of genetic engineering in agriculture. (8)

UNIT V : Biofertilizers and Bioremediation: Microbial Biopesticides, Biofungicides, Herbicides, and Agricultural antibiotic Biotechnology in Agriculture: Ethical Aspects and Public Acceptance, Animal farming. (8)

Reference Books:
1. Biotechnology by B.D.Singh, Kalyani Publication
2. Biotechnology – Fundamentals and applications by S.S.Purohit, Student Edition
3. Agricultural Biotechnology-Arie Altman, CRCPress

RBT077: Biomaterials

Unit I: Introduction and overview of biomaterials Definition of biomaterials – biologically derived materials or materials compatible with biology. Biomaterials: Classification of bio-materials (based on tissue response), Tissue engineering, Biosensor. (8)

Unit II: Interactions of materials Interactions of materials with human body, biocompatibility of materials, metals (stainless steels, cobalt-chromium alloys, titanium based alloys, nitinol), Ceramics (carmons, alumina, resorbable ceramics, surface reactive
ceramics), bio polymers (collagens, elastin, mucopolysachharides, cellulose and derivatives, chitin and other polysaccharides and composites as biomaterials. (8)

Unit III: Tissue Grafts and Soft Tissue applications Tissue graft and rejection process, skin grafts, connective tissue grafts, blood, fluid transfer implants, urological practise, microencapsulation of live animal cells, bulk space fillers, percutaneous devices. Materials for hard tissue replacement: orthopaedic implants, dental implants. (8)

Unit IV: Cardiovascular Implants and Ophthalmology Cardiovascular implants (blood clotting, blood rheology, blood vessels, heart, aorta and valves, lungs), cardiac pacemakers, Ophthalmology, materials for artificial organs transplant and extracorporeal device, Orthopaedic implants (joint replacement, knee joint replacement, temporary fixation devices). (8)

Unit V: Legal Issues Recent developments in biomaterials, legal issues related to development of biomaterials. (8)

Text/Reference Books:

2) Biomaterials, Medical Devices & Tissue Engineering: An Integrated Approach by Silver F.H., Chapman and Hall publication.
6) Biomaterials by Temenoff Johnna S., Dorling Kindersley India Pvt Ltd.
Unit-I: Sources of crude drug: Biological, marine, Mineral and plant tissue culture as source of natural products. Various methods of extraction and isolation of phytopharmaceuticals namely infusion, decoction, maceration, percolation, hot continuous extraction, successive solvent extraction, supercritical fluid extraction, steam distillation, Counter-current Extraction, Ultrasound Extraction (Sonication). Parameters for selection of suitable extraction process. (8)

Unit-II: Phytochemical Screening: Screening of alkaloids, saponins, cardenolides and bufadienolides, flavonoids and leucoanthocyanidins, tannins and polyphenols, anthraquinones, cynogenetic glycosides, amino acids in plant extracts. Important therapeutic classes: antimicrobial, antidiabetics, hepatoprotectives, immunomodulators, anti-cancer. (8)

Unit-III: Herbal cosmetics: Importance of herbals as shampoos (soapnut), conditioners and hair darkeners, (amla, henna, hibiscus, tea), skin care (aloe, turmeric, lemon peel, vetiver); Colouring and Flavouring agents from plants; Utilization of aromatic plants and derived products with special reference to sandalwood oil, mentha oil, lemon grass oil, vetiver oil, geranium oil and eucalyptus oil. (8)

Unit-IV: Nutraceuticals and Health Foods: Classification of Nutraceuticals, Health foods: Source, Chemical constituents, uses, actions and commercial preparations of, following health foods, Alfalfa, Bran, Angelica, Chamomile, Corn oil, Fenugreek, Feverfew, Garlic, Ginseng, Ginkgo, Honey, Hops, Safflower oil, Soyabean Oil, Turmeric. Concept and examples of Adaptogens .(10)

Unit-V: Quality control of herbal drugs as per WHO, AYUSH and Pharmacopoeial guidelines-Extractive values, ash values. Determination of heavy metals, insecticides, pesticides and microbial load in herbal preparations. (6)

Text / Reference Books:
2. Wagner and Bladt, Plant Drug analysis, Springer U.K.
3. A.R.Kashi, Industrial Pharmacognosy, Universities press
4. S.S.Agrawal, Herbal drug technology, Universities press
7. Craker L., Herbs, Spices And Medicinal Plants, CBS Publishers
RBT751: Environmental Biotechnology Lab

1. Study of laboratory equipments used in Environmental Biotechnology lab.
2. To perform the waste Water Sampling by Random Sampling Method
3. Preparation of stocks solutions.
4. Estimation of Biological Oxygen Demand (BOD) of waste water.
5. Estimation of Chemical Oxygen Demand (COD) of waste water.
6. Estimation of Dissolved Oxygen
7. Estimation of Total Hardness in given Water Sample.
8. Estimation of Total dissolved and suspended solid in waste water
9. Alkalinity& Acidity of waste water
10. Estimation of optimum dosage of ferric chloride for removal of suspended matter
11. Nitrogen estimation by Kjeldahl method,
12. To determine the amount of total Coliform in the water sample

RBT752: Bioseperation & Down Stream Processing Lab

1. Characteristics of Bioproducst: Flocculation and conditioning of broth
2. Mechanical separation: Filtration and Centrifugation
3. Cell disruption
4. Membrane based seperation
5. Protein precipitation and its seperation: Aqueous two phase extraction, Ultra filtration and Adsorption
6. Chromatography seperation based on size, charge, hydrophobic interaction
7. Gel analysis/ assay for dialysed product
8. Product crystallization and drying
## Study and Evaluation Scheme

### B.TECH. BIO-TECHNOLOGY

(Effective from the session: 2019-20)

4th Year, 8th Semester

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### Departmental Elective-V

- RBT081: Experimental Biotechnology (NPTEL)
- RBT082: Tissue Engineering (NPTEL)
- RBT083: Introductory mathematical models for biologists (NPTEL)
- RBT084: Database Design (NPTEL)

### Departmental Elective-VI

- RBT085: Biostatistics & design of experiments (NPTEL)
- RBT086: Integrated waste management for smart cities (NPTEL)
- RBT087: Industrial Biotechnology (NPTEL)
- RBT088: Computer aided drug design (NPTEL)
Experimental Biotechnology - Web course

COURSE OUTLINE

COURSE DETAIL

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<th>Module*</th>
<th>Topics and Contents</th>
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<td>1. Introduction</td>
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<td>2. Spectroscopic experiments</td>
<td>Spectroscopic techniques: UV-Visible spectroscopy, Fluorescence spectroscopy, CD spectroscopy, IR spectroscopy. Protein estimation, DNA estimation, unfolding, Protein unfolding, CD, IR</td>
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<td>3. Electrophoretic experiments</td>
<td>Electrophoresis: Principle, performing electrophoresis techniques, application of electrophoresis in analyzing macromolecules.</td>
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<td>4. Chromatographic experiments</td>
<td>Chromatographic techniques, Principles, Column chromatography, HPLC</td>
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<td>5. Immunological experiments</td>
<td>Antibody generation and purification. Immuno-assays to detect and quantify antigens.</td>
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<tr>
<td>7. Molecular cloning</td>
<td>Preparation and transformation of competent cells; Small scale isolation of recombinant plasmid, Analysis of the recombinant plasmid using restriction Endonucleases.</td>
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*Mid course examination after module 3 and finals after the completion of module 6.
**Numbers of lectures are tentatively fixed.

References:
### COURSE OUTLINE

This course helps the learners to understand thoroughly the key concepts of tissue organization, remodeling and strategies for restoration of tissue function. This will enable them to design tissue regeneration and tissue injury repair strategies.

### COURSE DETAIL

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<td>1.</td>
<td>Introduction to tissue engineering, Cells as therapeutic agents with examples, Cell numbers and growth rates.</td>
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<td>3.</td>
<td>Cellular fate processes, Cell differentiation, Cell migration - underlying biochemical process.</td>
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<td>5.</td>
<td>Coordination of cellular fate processes - soluble signals, types of growth factors and chemokines, sending and receiving a signal, processing a signal, integrated responses, soluble growth factor receptors, Malfunctions in soluble signaling.</td>
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<tr>
<td>6.</td>
<td>Cell-extracellular matrix interactions - Binding to the ECM, Modifying the ECM, Malfunctions in ECM signaling. Direct Cell-Cell contact - Cell junctions in tissues, Malfunctions in direct cell-cell contact signaling. Response to mechanical stimuli.</td>
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<tr>
<td>7.</td>
<td>Measurement of cell characteristics - cell morphology, cell number and viability, cell-fate processes, cell motility, cell function.</td>
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<td>8.</td>
<td>Cell and tissue culture - types of tissue culture, media, culture environment and maintenance of cells in vitro, cryopreservation.</td>
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### Pre-requisites:
- Basic Biology
- Cell Biology

### Additional Reading:
- Articles in Journals: Biomaterials, Advanced Drug Delivery Reviews.

### Hyperlinks:
- [http://web.mit.edu/angeliab/](http://web.mit.edu/angeliab/)
- [http://faculty.virginia.edu/lauerman/index.htm](http://faculty.virginia.edu/lauerman/index.htm)

### Coordinators:
**Dr. S. Swaminathan**
Centre for Nanotechnology & Advanced Biomaterials SASTRA University
<table>
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<tr>
<th></th>
<th>Topic</th>
<th>Pages</th>
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<tr>
<td>9</td>
<td>Basic for Cell Separation, characterization of cell separation, methods of cell separation.</td>
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<tr>
<td>10</td>
<td>Biodegradable polymers in tissue engineering - biodegradable polymers and polymer scaffold processing.</td>
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<tr>
<td>11</td>
<td>Growth factor delivery, Stem cells.</td>
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</tr>
<tr>
<td>12</td>
<td>Gene therapy</td>
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<tr>
<td>13</td>
<td>Bioreactors for Tissue Engineering.</td>
<td>3</td>
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<tr>
<td>14</td>
<td>In vivo cell &amp; tissue engineering case studies: Artificial skin, Artificial blood vessels.</td>
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<tr>
<td>15</td>
<td>In vivo cell &amp; tissue engineering case studies: Artificial pancreas, Artificial liver.</td>
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<tr>
<td>16</td>
<td>In vivo cell &amp; tissue engineering case studies: Regeneration of bone, muscle.</td>
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<td>17</td>
<td>In vivo cell &amp; tissue engineering case studies: Nerve regeneration.</td>
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References:
RBT083: Introductory mathematical models for biologists (NPTEL)

**Mathematics for biologists**
Biotechnology

**Instructor Name:** Prof. Ranjith Badinshetirai  
**Institute:** IIT Bombay  
**Department:** Bioengineering

**About Instructor:** I am a faculty in the department of biosciences and bioengineering at IIT Bombay. My research area is computational biophysics. I do theoretical study of biological systems using methods from physics.

**Pre Requisites:**  
**Core/Elective:** Core  
**UG/PG:** Both  
**Industry Support:**

**Course Details:** It is an introductory mathematics course for biology students with the aim of training them to do quantitative analysis of biological systems.

### COURSE PLAN

<table>
<thead>
<tr>
<th>SL NO</th>
<th>Week</th>
<th>Module Name</th>
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</table>
| 1     | 1    | Need of mathematics  
|       |      | Functions and equations  
|       |      | 2D and 3D graphs  
| 2     | 2    | Derivatives, meaning of derivatives, numerical computation of derivatives  
| 3     | 3    | Second derivatives, maxima, minima, sketching functions  
| 4     | 4    | Integration with examples, numerical computation of integrals  
| 5     | 5    | Differential equations describing biological phenomena  
| 6     | 6    | Vectors, vector calculus, differentiation with vector signs  
| 7     | 7    | Diffusion, Normal equation, Fick's law, solutions  
| 8     | 8    | Fourier series, Fourier transforms, understanding scattering experiments  
| 9     | 9    | Basics of statistics, mean, standard deviation, distribution functions  
| 10    | 10   | Binomial, Poisson and Normal distributions in biology  
| 11    | 11   | Survey, sampling hypothesis testing z-test, t-test  
| 12    | 12   | Regression, curve fitting, Conclusion  

**Funded by:** Ministry of Human Resource Development, Govt. of India, New Delhi  
[ntel.ac.in](http://ntel.ac.in)
Database Design - Video course

Module 1: Introductory Concepts (1 session)
- Databases and Information Systems: An example usage context.
- Database system concepts and architecture.

Module 2: Semantic Database Design (3 sessions)
- High-level conceptual modeling, ER Model concepts, ER Diagrams.
- Cardinality constraints, Higher-order relationship, Enhanced ER Model (EER), Weak-entity types, Subclasses and Interference, Specialization and Generalization, Modeling of UNIFY types using categories.

Module 3: Relational Model, Languages, and Systems (7 sessions)
- Relational algebra (2 sessions): Relational model concepts, Relational integrity constraints, Update operations on relations, Relational algebra model.
- SQL (2 sessions): Data definition in SQL, Queries and update statements, Views, Integrity constraints, Specifying indexes, Embedded SQL.
- IBM DB2 case study (2 sessions): Architecture of DB2, Data definition and manipulation in UNQL.
- EER to Relational mapping (1 session).

Module 4: Database design using the relational model (4 sessions)
- Functional dependencies (3 sessions): Keys in a relational model.
- Concept of functional dependencies, Normal forms based on primary keys, Boyce-Codd Normal Forms.
- Further Dependencies (2 sessions): Multi-values dependencies and fourth normal form, Join dependencies and fifth normal form, Inclusion dependencies, Other dependencies and normal forms.

Module 5: Storage and Indexing Structures (6 sessions)
- Storage structures (3 sessions): Secondary storage devices, Buffering of blocks, File Organization, Heaps, Sorted Files, Hashing and overflow handling techniques, Dynamic hashing, Extensible hashing, Other file organizations.
- Indexing methods (3 sessions): Basic terminology, Primary indexes, Clustered index, Secondary index, Multilevel indexes, R-Tree, B-trees, B+-trees, Inserting and searching algorithms for B+-trees, Other indexing methods.

Module 6: Transaction Processing and Concurrency Control (6 sessions)
- Transaction Fundamentals (3 sessions): DCLP environments, Concurrency issues, need for transactions, necessary properties of transactions (ACID properties), Transaction states, serializability, Serial schedules, Conflict serializability, View serializability, Recoverability and non-recoverable schedules, Cascading rollbacks, Cascadeless schedules.
- Concurrency control (3 sessions): Serialized and non-serialized schedules, Testing for serializability, Locking, Lock compatibility matrix, Locking and serializability, Deadlocks and starvation, Two-phase locking (2PL) protocol, Consensus, strict and rigorous 2PL, Pre with lock conversions, Timestamp-ordering based protocol, Multi-versioning protocol, Multi-granularity locking, Deadlock prevention protocols, Wait-die and wound-wait schemes, Time-out based schemes, Deadlock recovery, Nested transactions.

Module 7: Database recovery techniques (3 sessions)
- Recovery concepts, Deferred updates techniques, Immediate update technique, Shadow pages, ARIES recovery algorithm.
- Database Security and Authentication (3 sessions): Discretionary access control, Mandatory access control and multi-level security, Statistical database security.
- Enhanced Data Models for specific applications (2 sessions): Active database concepts, Temporal databases, Spatial databases, Multimedia databases.

Module 8: Clustered databases and issues (3 sessions)
- Data fragmentation, replication and allocation in distributed databases, types of distributed database systems, Query processing in distributed databases, Concurrency control and recovery in distributed databases textbooks.

A joint venture by iSc and IIS, funded by MHRD, Govt. of India
Departmental Elective-VI

RBT085: Biostatistics & design of experiments (NPTEL)

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<th>Topics</th>
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INTEGRATED WASTE MANAGEMENT FOR A SMART CITY

PROF. BRAJESH KUMAR DUBEY
Department of Civil Engineering
IIT Roorkee

TYPE OF COURSE : Environ. Core | LU/PG
COURSE DURATION : 12 weeks (25 Jul 19 - 18 Oct 19)
EXAM DATE : 17 Nov 2019

INTENDED AUDIENCE : G.E., M.Tech, M.C.M. Tech, M.S., B.Tech, M.S., PhD, JSM, Professional and Academicians
PRE-REQUISITES : Environmental Science, Introduction to Environmental Engineering
INDUSTRIES APPLICABLE TO : Larsen and Toubro Ltd, Tata Group of Industries, Ranbaxy Group of Industries, ITILS Environment

COURSE OUTLINE:
This course has an emphasis on Integrated Waste Management aspects within the broad subject area of Integrated Waste Management for Smart Cities. The issues of Municipal Solid Waste (MSW), management, Construction and Demolition (C&D) Waste and Electronic Waste Management will be covered in this course. The topics will include: generation rates and waste composition, integrated waste management issues, collection, recovery, reuse, recycling, energy from waste, and bioremediation. Biological treatment of the organic waste fraction - anaerobic digestion, composting, and anaerobic digestion. The environmental impact of waste management and its relationship to the big picture sustainable development and smart city development will be discussed. A major focus of this course will be the role of MSW management within the various territories of the coast of India, including the coastal area, smart cities, and smart cities as well as those in India. The challenges of waste management for smart cities will also be discussed taking case studies from the list of 20 smart cities identified in the last phase for this program. This will be followed by overview of the Construction and Demolition (C&D) Waste and Electronic Waste (E-Waste) management issues in India in general and for the smart cities in particular. The new rules with respect to C&D Waste and E-Waste Management will be covered. The challenges of managing waste streams effectively will be discussed.

ABOUT THE INSTRUCTOR:
Dr. Rajesh Kumar Dubey is an Associate Professor in the Division of Environmental Engineering and Management at IIT Roorkee, India. Dr. Dubey has more than a decade of research, teaching, training and industrial outreach experience in the areas of integrated solid and hazardous waste management, life cycle assessment (LCA) and Sustainable Engineering. He has collaborated with UN agencies, World Bank, National Science Foundation, Ontario Ministry of Environment and Auckland Regional Council on various projects including that in the area of LCA.

COURSE PLAN:
Week 01: Introduction to Solid Waste Management
Week 02: Municipal Solid Waste Characteristics and Quantity
Week 03: MSW Rules 2016, Swachh Bharat Mission and Smart Cities Program
Week 04: Municipal Solid Waste Collection, Transportation, Segregation and Processing
Week 05: Disposal of Municipal Solid Waste
Week 06: Biochemical Processes and Composting
Week 07: Energy Recovery from Municipal Solid Waste
Week 08: Current Issues in Solid Waste Management and Review of MSW Management Status in First List of 20 Smart Cities in the Country
Week 09: Construction and Demolition (C&D) Waste Management - Overview
Week 10: E-Waste - Regulation, Benelictive Reuse of E-Waste Materials
Week 11: E-Waste Management - Issues and Status in India and Globally
Week 12: E-Waste Management Rules 2016 and Management Challenges
INDUSTRIAL BIOTECHNOLOGY

PROF. DEBABRATA DAS
Department of Biotechnology
IIT Kharagpur

TYPE OF COURSE:  : Run | Elective | UG
COURSE DURATION :  12 weeks (29 Jul'19 - 18 Oct'19)
EXAM DATE :  16 Nov 2019

INTENDED AUDIENCE : B.E/B.Tech, M.E/M.Tech
PRE-REQUISITES : Knowledge in microbiology, Biochemistry and mathematics in 10+2 level
INDUSTRIES APPLICABLE TO : DuPont India, IFB Agras Industry, IOC, ONGC, Dr. Reddy's Laboratories, Biocon, United beverages.

COURSE OUTLINE:
The course aims to provide fundamental insights to exploit enzymes and microbes for the manufacturing of products which have a huge industrial significance. It uniquely blends the science and engineering with various biochemical processes to obtain products of diverse fields such as chemicals, food, bioenergy etc. The course introduces bioreactors, its types, operation methods and provides an experimental demonstration of the same. Strategies to obtain higher yields, design of the reactors and production of biofuels from microorganisms are thoroughly explained. Students of various disciplines such as biotechnology, chemical engineering, food engineering, and pharmaceutical industries can be benefited from the course as it discusses the existing bioprocess applications such as wine and cheese making, antibiotics and vaccines etc. The course majorly focuses on the applications and allows students to gain practical knowledge rather than mere theory. Major bottlenecks for the operation of biochemical industries will be discussed.

ABOUT INSTRUCTOR:
Dr. Debabrata Das pursued his doctoral studies from Indian Institute of Technology (IIT) Delhi. He is a Senior Professor at IIT Kharagpur. He was also associated as MNRE Renewable Energy Chair Professor. He has pioneered the promising R&D of Bioenergy production processes by applying fermentation technology. Prof. Das is involved in three different areas of research: Gaseous energy recovery from organic wastes; algal bioenergy and CO2 sequestration; and microbial fuel cells. He is presently involved in teaching both undergraduate and postgraduate courses on Biochemical Reaction Engineering: Aspects of Biotechnology; Bioenergy; and Bioenergy Technology for the students of Department of Biotechnology; Department of Chemical Engineering; Department of Chemistry and School Energy Science and Engineering.

COURSE PLAN:
Week 01 : Introduction, Microbes and enzymes of industrial importance
Week 02 : Different types of bioreactors and bioreactor design
Week 03 : Microbial growth, substrate degradation and product formation kinetics, Tutorial 1
Week 04 : Instrumentation, sterilization of air, media and reactor
Week 05 : Upstream and Downstream processing
Week 06 : Production of Oxychemicals I
Week 07 : Production of Oxychemicals II
Week 08 : Production of Oxychemicals III
Week 09 : High fructose corn syrup, Cheese making, and Single cell production
Week 10 : Vaccines production and Metal leaching
Week 11 : Bioenergy- Gaseous fuels: Biogas, Biomethane and Microbial fuel cell; Liquid fuels: Bioethanol, Biodiesel and Biobutanol
Week 12 : Aerobic and Anaerobic wastewater treatment processes
COMPUTER AIDED DRUG DESIGN

PROF. MUKESH DOBLE
Department of Biotechnology & Bioengineering
IIT Madras

TYPE OF COURSE: Run | Core | UG/PG
COURSE DURATION: 8 weeks (29 Jul'19 - 30 Sep'19)
EXAM DATE: 29 Sep 2019

INTENDED AUDIENCE: B.E./B.Tech, M.E./M.Tech
PRE-REQUISITES: Prior knowledge of biochemistry, bioinformatics
INDUSTRIES APPLICABLE TO: Pharmaceutical industries/biopharma/biotech

COURSE OUTLINE:
Drug discovery and development is a time consuming and expensive process, taking about 10 years and costing about US 1.6 billion dollars. Several candidates that enter clinical trials fail because of several reasons. Computer assisted drug design can speed up the process, reduce surprises and predict the properties, thereby reduce the cost of R&D. The course will cover structure and target based design, molecular modeling, quantum mechanics, drug likeness properties, QSAR and pharmacokinetic and dynamics using several softwares that are freely available.

ABOUT INSTRUCTOR:
Prof. Mukesh Doble is a Professor at the Department of Biotechnology at IIT Madras. He has previously worked in Imperial Chemical Industries (ICI) and General Electric (GE) for 25 years. Areas of research are Biomaterials, Biopolymers, and Drug design. He has published 250 papers and 10 books and filed 10 patents (including two US). He has delivered online video courses in Downstream processes, Medical Biomaterials and Biostatistics and Design of Experiments.

COURSE PLAN:
Week 01: Introduction to drug discovery
Week 02: Structure and property
Week 03: ADME rules
Week 04: Force field/MM/CM
Week 05: Boundary conditions/Conformation
Week 06: QSAR/Pharmacophore
Week 07: Enzymes/proteins structures/docking
Week 08: PROD