STUDENT HAND BOOK

Applicable for students admitted into

B.Tech Program from 2018-2019

K L University

u/s 3 of UGC Act, 1956

Koneru Lakshmaiah Education Foundation

INSIDE

S.NO	DETAILS	PAGE NO
1.	Contact Details	3
2.	About University	4
3.	Program Educational Objectives (PEO) and Student Outcomes(SO)	24
4.	Academic Regulations	27
5.	Course Structure	47
a.	Procedure for allotment of Course Codes	48
b.	Humanities	50
c.	Basic Sciences	50
d.	Engineering Sciences	51
e.	Professional Core & Professional Electives – BT	52
f.	Professional Core & Professional Electives – CE	54
g.	Professional Core & Professional Electives – CSE	57
h.	Professional Core & Professional Electives – ECE	60
i.	Professional Core & Professional Electives – ECM	62
j.	Professional Core & Professional Electives – EEE	64
k.	Professional Core & Professional Electives – ME	67
l.	Professional Core & Professional Electives –PE	69
m.	Open Electives	71
n.	Management Electives	73
o.	Foreign Languages	73
p.	Term paper, Minor/Major Project & Practice School	74
q.	Courses for Minor Degree	75
r.	Courses for Honors	77
6.	Courses Vs SO Mapping	78
7.	Syllabus	96
a.	Humanities & Social Sciences	104
b.	Basic Sciences	117
c.	Engineering Sciences	136
d.	Professional Core and Professional Electives	169
e.	Open Electives	632
f.	Management Electives	668
g.	Honors	674

CONTACT DETAILS

Postal Address	
Official Communication	Koneru Lakshmaiah Education Foundation, Admin. Office, 29-36-38, Museum Road, Governorpet, Vijayawada. A.P., India. Pincode: 520 002.
Campus	K L University, Green Fields, Vaddeswaram, Guntur District, A.P., INDIA. Pincode : 522 502.
Phone Number	
Administrative Office	0866 - 2577715
Campus	0863-2399999
Fax Number	
Campus	0863-2388999

Note: *While every effort has been made to ensure that this book is accurate and up to date, it may include typographical or other errors. Changes are periodically made to this publication and will be incorporated in new editions.*

ABOUT UNIVERSITY

VISION:

To be a globally renowned university.

MISSION :

To impart quality higher education and to undertake research and extension with emphasis on application and innovation that cater to the emerging societal needs through all-round development of students of all sections enabling them to be globally competitive and socially responsible citizens with intrinsic values.

OBJECTIVES :

Focus	Objective
Academics	1. To offer academic flexibility by means of Choice based credit systems and the like. 2. To identify and introduce new specializations and offer programs in emerging areas therein 3. To incorporate into the curriculum the Application orientation and use high standards of competence for academic delivery 4. To design and implement educational system adhering to outcome based International models. 5. To introduce and implement innovation in teaching and learning process to strengthen academic delivery 6. To offer academic programs at UG, PG, doctoral, Post-Doctoral which are industry focused, and incorporates Trans-discipline, inter-discipline aspects of the education system 7. To deliver higher education that includes technologies and meeting the global requirements
Research	8. To promote inter-disciplinary studies and create needful facilities that enhance inter-disciplinary research and innovation 9. To create an ambience that is conducive for undertaking sponsored research, internal funded research and offering consultancy services to wide spectrum of originations 10. To establish centers of excellence in frontier areas of research, and design innovation centers with industry collaboration 11. To create environment to innovate and incubate the products and services that addresses the societal requirements

	12. To integrate research into all academic programs 13. To maintain high standards in achieving research outcomes 14. To promote International conferences / Seminars / Workshops / in collaboration with professional bodies for creation of avenues for research exchange
Extramural and extension	15. To generate means and avenues for carrying out extramural research for Industry and Academia 16. To organize extension activities covering literacy promotion, health awareness and improve the living standards of community 17. To make the research outcomes useful and applicable for the societal needs
Infrastructure	18. To promote and maintain state of the art facilities for academic delivery, research and co & extra-curricular facilities and develop congenial and eco-friendly fully residential campus 19. To create and strengthen focused and modern infrastructure that address the national needs through generation of dedicated funds from Industry, Government and research organizations,
Equity / Access	20. To provide and promote the opportunities to higher education to socially deprived communities and remove disparities by promoting women, differently abled and socially deprived 21. To provide equal access to meritorious both in terms of admissions and financial support
ICT	22. To lay emphasis on effective usage of ICT, WEB –resources and train the faculty on the latest advancements thereof and develop effective e-content 23. To develop and maintain world class ICT infrastructure and lay emphasis on its effective usage, extend regular training to both faculty and students on its latest advancements there by ensure interactive academic delivery
Examinations and evaluations	24. To introduce reforms in the examination and evaluation system that brings out knowledge application skills and competencies of the students and ensure transparency

Ecology and Environment	25. To Build into curriculum, issues related to social awareness about ecology and environment towards achieving greener society
Linkages	26. To promote collaborations with international and national organizations for advancements of academics, research, Technology transfer and Intellectual property rights. 27. To Indigenize the global technological solutions and develop the products, and services that transforms the standard of living of rural India 28. Design new products and services that address commercially attractive needs and opportunities while leveraging the available resources in the form of un-employed and under-employed Individuals
Employability	29. To provide skills through curriculum and training that are essential in fostering entrepreneurial thoughts, employability prospects and at the same time provides necessary support for incubating the innovations and assisting them for prospective commercialization. 30. To provide necessary business infrastructure that allows attracting and sustaining the industry to commence their business establishments within the University Campus and aid in life long sustenance of employment. 31. To develop industrial cluster that helps the students to start their industry after incubating the products at the incubating centers which will create Jobs 32. To develop National depositories for meeting the goals of National skill development council 33. Train people to profile neighborhood and communities for the needs and commercial opportunities that will support financially sustainable new businesses
Governance	34. To institute measures for transparent administration that aid in improving efficiency, accountability and reliance 35. To comply with regulations of all the statutory bodies. 36. To install professional managers who are global visionaries, thought leaders, and thinkers into the management of the University so as to contribute to the ideals of the University system

Quality	37. To continuously upgrade the faculty in curriculum design, teaching pedagogy, usage of ICT and various processes pertaining to academics, research and University administration 38. To develop mechanism that attracts talented, qualified and experienced faculty from across the globe for pursuing their academic and research careers at the University. 39. To consider and implement norms, metrics, standards, procedures and benchmarks for assessing and improving the quality in every aspect of University system and achieve quality certifications by National and International bodies. 40. To establish Internal quality Assurance cell (IQAC) and install a quality systems that is integral part of all the University processes 41. To continuously upkeep overall quality of the University based on aspects of regular feedback from the stake holders 42. To improve the quality of faculty through faculty incentives, awards and recognitions
Value orientation	43. To mold the students to possess professional ethics, moral values and intrapersonal skills that shape them into effective leaders and who are having the thoughts of equality and unanimity towards all walks and sects of life. 44. To inculcate the self-consistency, self-reliance and self-learning qualities for shaping the students to lead their life on their own. 45. To sharpen the critical thinking and reasoning skills by making students tackle problems and ideas that are yet to be tackled through application of their intellectual discovery. 46. Developing the students towards human intellectual achievement and make them rich in cultural experience 47. Students to be encouraged and provided with necessary support enabling them to choose and pursue careers of their choice & interest that make them professionally satisfied.
National development	48. To expand the University in all its modes of delivery so as to contribute to the Nation's increase in Gross Enrolment Ratio 49. To align the academic programs and courses to match the requirements of the National goals

	50. To develop technology that helps sustainable socio economic development

History

The President of Koneru Lakshmaiah Education foundation, Er.Koneru Satyanarayana, along with Late Sri.Koneru Lakshmaiah, founded the K L College of Engineering in the Academic year 1980-81. With the mighty vision and restless efforts of Er.Koneru Satyanarayana K L College of Engineering carved a niche for itself through excellence in engineering education, discipline and record numbers of placements and was the leading college in the state of AP. K L College of Engineering achieved NBA Accreditation for all its B.Tech. programs in 2004 and later re-accredited in 2007. K L College of Engineering was transformed into an autonomous engineering college in the year 2006. In 2008 this college received a record grade of 3.76 on a 4 points scale with "A" Grade from NAAC; and in February 2009, the college, through its founding society "Koneru Lakshmaiah Education Foundation" was recognized as Deemed to be University by the MHRD-Govt. of India, Under Section 3 of UGC Act 1956. This Deemed to be University is named as "K L University".

Location

Vijayawada is located on the banks of river Krishna in the state of Andhra Pradesh and has been historically a cultural, political and educational center. It is also a part of Andhra Pradesh Capital Region. The city is well connected by National Highway and Rail with Chennai (440 km), Hyderabad (275 km), Vizag (385 km) and is a central junction for trains running from North to South India. Daily flights operate from Hyderabad and Bangalore.

K L University is situated in a spacious 100-acre campus on the banks of Buckingham Canal of river Krishna, eight kilometers from Vijayawada city. Built within a rural setting of lush green fields, the institute is a virtual paradise of pristine nature and idyllic beauty. The campus has been aptly named "Green Fields" and the splendid avenue of trees and gardens bear testimony to the importance of ecology and environment. The campus ambience is most befitting for scholastic pursuits. The University has been situated on a built up area of around 15, 00,000 S. Ft.

ACCREDITATIONS:

- Declared as Deemed to be University u/s 3 of UGC Act 1956.

- Accredited by National Assessment and Accreditation Council (NAAC) of UGC as 'A' Grade with 3.16 CGPA on 4 point scale.
- Approved by All India Council for Technical Education (AICTE), New Delhi.
- ISO 9001 - 2008 Certified Institution.

FACILITIES :

Central Library: E-Resources

The Central Library is the largest, and holds materials to serve the whole University community. It has materials relevant to the Engineering, Science & Humanities courses offered by the University.

The library system contains more than one lakh and fifty thousand books and periodicals on all subjects related to the teaching and research interests of the University staff and students. The library has over 15,000 electronic journal titles, academic databases and 5000 eBooks. Access is available on campus on student computers and remotely.

A new library building will be opened shortly on par with international standard with modern IT facilities.

Every department of the college maintains their library to cater the needs of students and faculty. All foreign and Indian journals are made available in the department library for the convenience of faculty and students.

The libraries render following library services.

- Circulation of library documentary.
- Inter-library loan services.
- Photo copying services.
- Reference service.
- CD-ROM search services.
- Inter Net services.
- OPAC
- WEB OPAC
- Audio visual
- Online lectures

The Data Center

A State-of-the-Art Data center with advanced servers provides highly interactive learning environment with full-fledged hardware and software training facilities.

Hardware:

The configuration of high end stream of servers that provides various services is

Super Computer

HPC Infrastructure (Super Computer):

- 5.3 TERA Flops (CPU + GPU)

- HP SL 230 4* SL230s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA) providing -1.3TF
- HP SL 250 2* SL250s Gen8, (2 * 2.6 GHz, 32GB RAM, 2x500GB HD, 10G IB HCA + 2 NVIDIA K20 GPU providing -4TF. Master Node:
- HP DL 380P 1* DL380p Gen8 (2* 2.6Ghz, 64GB RAM, 2x2TB HD, 10G IB HCA).
- Compute Switch (48 Port Low latency switch)QLogic IB QDR 36 Port Switch.
- Intel® Composer XE for Linux.

The data centers consists of BYOD Servers& Backup Server, **Sun Servers, Dell and HP Blade Servers**, **Apple Server Xserve:**

SPECIAL LABORATORIES

The institute is equipped with various Industry Collaborated Labs

S. No	Discipline	Name of the Lab	Research Group Associated
1.	Computer Science and Engineering	CISCO	Computer Networks and security
2.	Computer Science and Engineering	IBM	Software Engineering
			Knowledge Engineering
3.	Computer Science and Engineering	Microsoft	Embedded Systems
			Software Engineering
			Knowledge Engineering
4.	Computer Science and Engineering	Adobe	Web technologies
			Image processing
5.	Computer Science and Engineering	Oracle	Knowledge Engineering
6.	Electronics Communication Engineering	NI Lab View	Communications Systems

Physical Education- Sports Facilities:

KL University encourages students to explore their latent talents by providing good games and sports facilities. The institute is equipped with the following.

- Athletic track
- Hockey Field
- Badminton Courts -4

- Tenni-koit Courts -2
- Cricket Field with Net practice - 3
- Volleyball Courts -4
- Tennis Courts - 2
- Handball Court
- Netball Courts - 2
- Throw ball courts - 2
- Beach Volleyball Court
- Football Field
- Basketball Courts – 2
- Kabaddi Courts – 2
- Table Tennis - 6
- Chess
- Caroms
- Kho Kho Court
- Soft Ball
- Archery

The University had State-of- the - Art Indoor stadium of 30000 sq.ft with:

- 4 wooden Shuttle Courts/ Basketball Court
- Yoga and Meditation Center
- Dramatics
- 8 Table Tennis Tables
- Hobby Center
- Gymnasium for Girls
- Gymnasium for Boys
- Multipurpose room with Chess, Carroms etc.
- Power lifting/Weight Lifting

Accommodation- Hostels

- KL University has separate hostels for boys and girls with well furnished rooms and modern amenities. The overall atmosphere is very conducive for the students to concentrate on studies.
- A state- of – the- art kitchen and spacious dining area has been provided for both the hostels.
- Generators have been provided as power back up.
- Emphasis has been laid on hygiene and cleanliness for healthy living. A customized menu caters to the student needs and it keeps changing according to their tastes.
- Teaching staff will have to address academic and personal problems of the students.
- Round-the-clock security, communication, dispensary facilities are also available.

The Girls Hostel

The girl's hostel is within the campus with a capacity of 1192 in 500 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available. Suite rooms with modern furniture and separate study room are also available.

The Boys Hostel

It is a short walk from the university with a capacity of 2040 in 780 rooms. Different rooms accommodating 2 per room, 3 per room with attached toilets as well as A.C. rooms are available.

➢ *Facilities in the Hostels*

Protected drinking water, state of the art kitchen, dining hall, newspapers, telephones, toilets and bathrooms are well maintained. Every student in the hostel is provided with a cot, study table, chair and a rack. Fan and light are also provided in each room.

- Gas & Steam based hygienic food preparation
- Palatable regional, national and international cuisines
- Cleanliness and Safety
- STD/ISD Facilities
- Medical Kits and First Aid Boxes
- Soft drinks, snacks, Fruits etc.
- Laundry
- Stationary shop

➢ Hostel Rules & Regulations

- Students are hereby informed that while staying in the hostel, it is essential to be responsible in maintaining dignity by upholding discipline. They must be obedient to the hostel warden/floor in – charges.
- Valuable items like jewelry etc., should not be kept with students while staying in the hostel. It is student's own responsibility to safeguard her/his Laptops, Money by locking suitcases and bags. If any loss is found, management will not take any responsibility.
- Student has to intimate to the hostel authorities before you giving police complaint against losses.
- Students are not allowed to indulge in smoking, consumption of Alcohol, Narcotic drugs etc., and defaulters will be strictly viewed upon.
- Students are directed that after locking their rooms they have to hand over the keys to security and can collect them on returning back to the hostel.
- Students must switch off Fans, Lights, Geysers, A/C's etc., before leaving their rooms.
- Visitors are not allowed inside the hostel at any time, however they are allowed into the visitor's hall with the prior permission of the warden. Only family members listed by the parents are allowed to contact the student. Visiting hours are up to 7.30 pm only and after 7.30 pm visitors are required to leave premises.
- Hostel students are not allowed to come into the hostel after 3.00 pm in case morning shift students and 6.00pm for day shift students. Those students who are utilizing

computer lab, library etc., after the times specified have to submit the permission slip to the security while entering into the hostel.

- During public holiday outings, those who seek permission to leave the hostel will have to obtain a written permission from warden. Permission will be given only to those students who get permission from parents to leave the hostel during holidays/outings. Moving out of campus without permission are strictly prohibited.
- Strict study hours from 7.30 to10.30 pm shall be maintained in the hostel. The hostellers must be in their allotted rooms during study hours.
- The general complaints of any kind should be noted in the complaint register, which is available at the hostel office. Registered complaints only will be entertained.
- Any health problem should be brought to the notice of Warden/Floor In – charge for necessary treatment.

Transportation:

- The institution runs 70 buses covering all the important points in Vijayawada City, Mangalagiri, Guntur & Tenali towns with a total seating capacity of 4000 students in two shifts.
- Transport is available 24 hrs in case of any emergency in the institute / hostels.
- Transportation is available for conducting industrial tours and visits etc.
- Regular transport facility available up to 10 PM.

Health Centre

A full-fledged health center with all the facilities is established to cater to the needs of the students, staff, Faculty and to the general public in the adopted villages. It consists of three doctors (Homoeopathy, Ayurvedic & Allopathy).

Cafeteria

- KL University has a spacious canteen with latest equipment and hygienic environment which provides quality food and prompts service and caters to needs of all the students and the staff.
- A central cafeteria of 1500 Sq.m. is available in the campus. Mini cafes and fast-food centers are available in various blocks.

- The canteen is open from 6:30 a.m. to 8:30 p.m. There is a wide variety of North-Indian and South-Indian cuisine and the students enjoy the pleasure of eating during the breaks. Cool aqua water for drinking is available.

Placements*:*

K L University has meticulously planned to make all its outgoing students employed. The University had installed the infrastructure, employed well experienced faculty, designed and delivered programs t**h**at help enhancing the communication and soft skills which are required for making the students employable. An excellent system is in place that considers all the issues that make a student employable. The University has been successful for the last 7 years, in employing all the students who have registered and eligible for placement through its offices located across the country. About 50 trained personnel work extensively to make the students ready for recruitment by the Industry.

Counselling & Career Guidance

A special Counseling Cell consisting of professional student counselors, psychologists, senior professors counsels/helps the students in preparing themselves to cope with studies, perform well in the tests & various competitions. This Cell provides its services to the students in getting the solutions for their personal problems and also provides career guidance with the help of Industrial Relations and Placements (IRP) department.

A group of 20 students are allotted to a senior faculty member who counsels them regularly and acts as their mentor.

Social Service Wing

KL University has a social service wing which is used to channelizing the social service activities of the faculty, the staff and the students. It has adopted 5 nearby villages and conducts activities like medical camps, literacy camps and educates the villagers regarding hygiene and health care on a regular basis.

NSS Wing of Institute

Regularly organizes Blood donation camps, Blood grouping camps, Fund collection and distribution to poor children and old age homes, distribution of old clothes and free medicines to slum dwellers, tree plantations, AIDS awareness program, teaching basic computer skills to a target group of 500 people in villages.

Hobby Clubs

Wholly and solely managed by the students, the clubs have in the past contributed much to the cultural life of the campus and to the cultural evolution of the students, A number of student bodies and clubs operate in the campus like music society, dance club, drama society, literary and debating club, English press club, drawing club, painting club, mime club, computer club etc. Students manage entire activities and budget of the organization for the entire semester in advance. Around 4000 students are the active members of the Hobby Clubs.

Life Skills and Inner Engineering

KL University feels that it is its responsibility to mould the students as good human beings contributing to the country and to the society by producing responsible citizens. Along with the regular programs every student admitted into KLU undergoes a one week special life skills /orientation program. Through this program, KLU is producing the students with the clarity of thoughts and charity at hearts. Strict regularity, implicit obedience, courtesy in speech and conduct, cleanliness in dress and person is expected of each KLU student. Life skills and inner engineering teach a student his/her obligations towards GOD, himself /herself his/her country and fellow human beings. Every student is encouraged to practise his/her own religious faith and be tolerant and respectful towards other religions.

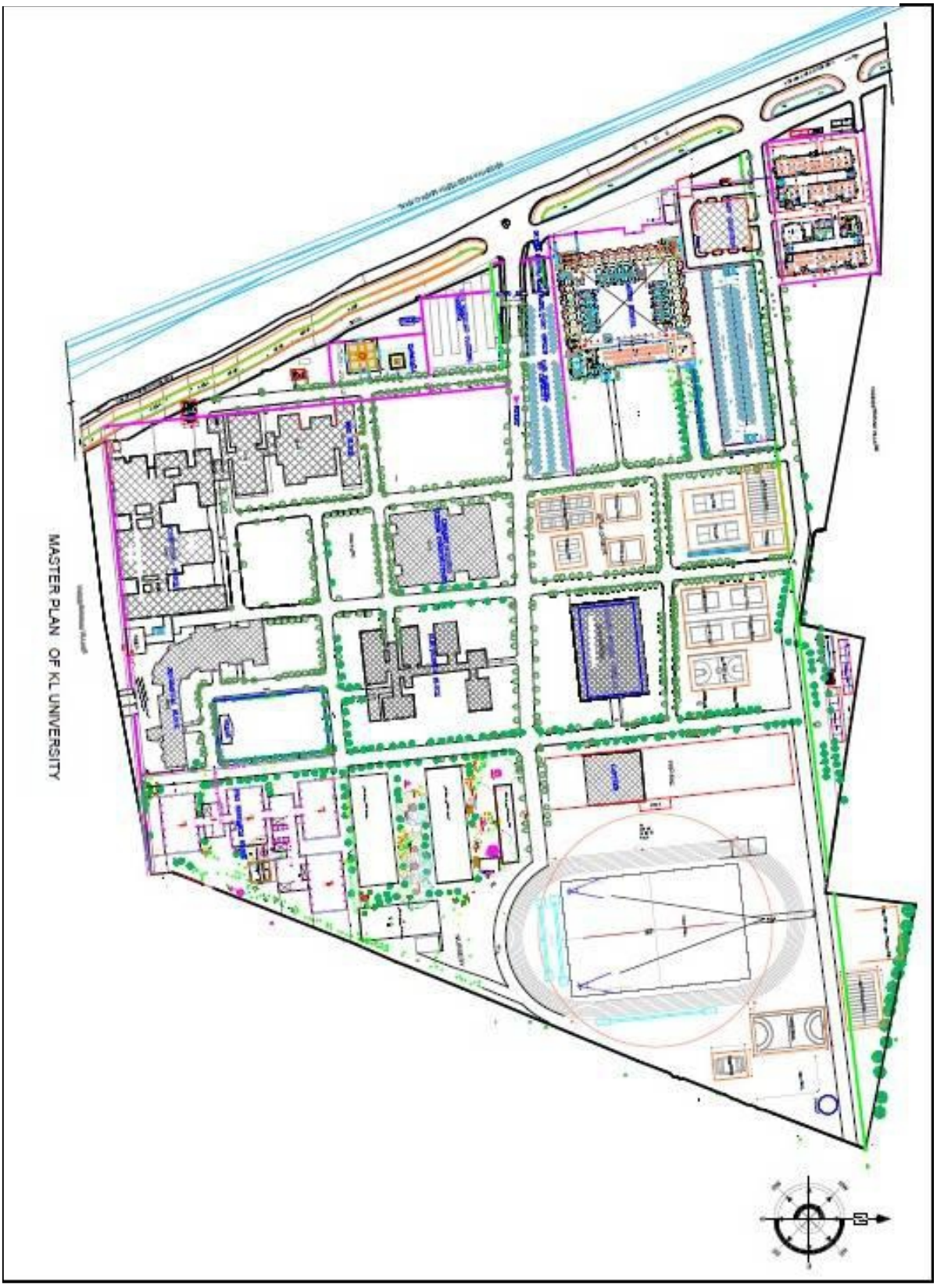
Technical Festival

KLU organizes various programs for the all round development of the students. The technical festival and project exhibition is being organized in the odd semester (October) every year to elicit the innovative ideas and technical skills of the students.

Cultural Festival

The cultural festival in the even semester (February) of every year is the best platform for the students for exhibiting their talents and creativity. Through these festivals KLU is imparting organizational skills, leadership skills, competitive spirit, and team behavior skills to our students. Along with the knowledge, KLU festivals are providing recreation to the student community.

HOD, ENGLISH	Dr.M. Latha	mlatha@kluniversity.in
HOD, BES	Dr.D. Haritha	haritha_donavalli@kluniversity.in
Head, Super Computer Centre & In-charge ERP Implementation Project	Prof.S. Venkateswarlu	somu23@kluniversity.in
Department of Visual Communications	Sri Jai Kishan Y	jaikishan@kluniversity.in
Professor In-charge (Training)	Sri T.Ravi Kumar	rktata@kluniversity.in
Professor In-charge (Centre for Competitive Examinations)	Mr.J. Somlal	jarupulasomu@kluniversity.in
Doctoral Admissions	Dr.K.L.Narayana	drkln@kluniversity.in
Foreign Student Admissions	Dr.J V Shanmukha Kumar	shanmukh_fed@kluniversity.in


MASTER PLAN OF KL UNIVERSITY

PROGRAM EDUCATIONAL OBJECTIVES (PEO)

AND

STUDENT OUTCOMES (SO)

PROGRAM EDUCATIONAL OBJECTIVES (PEO):

To be a globally renowned university, as per our vision, we need to produce quality products (graduates) into the market who have potential strengths to meet all the professional and personal challenges prevailing at global levels and who can serve in all the possible positions of their respective job domains and contribute towards holistic growth of their respective employment providers as well as the nation, world. The graduates must also possess cutting edge R&D skills in their domain areas.

This, is exactly what has been framed into the University's Mission and thereby the Mission has converged into the following **Program Educational Objectives (PEO)** which are best suited to Undergraduate Engineering programs, and are those that compliment the university vision, mission.

A. Practice engineering in a broad range of industrial, societal and real world applications.
B. Pursue advanced education, research and development, and other creative and innovative efforts in science, engineering, and technology, as well as other professional careers.
C. Conduct themselves in a responsible, professional, and ethical manner.
D. Participate as leaders in their fields of expertise and in activities that support service and economic development throughout the world.

These PEO are designed to be attained by all the graduates within 3 to 5 years of their graduation.

STUDENT OUTCOMES(SO):

a. an ability to apply knowledge of mathematics, science, and engineering
b. an ability to design and conduct experiments, as well as to analyze and interpret data
c. an ability to design a system, component, or process to meet desired needs within realistic constraints such as economic, environmental, social, political, ethical, health and safety, manufacturability, and sustainability
d. an ability to function on multidisciplinary teams
e. an ability to identify, formulate, and solve engineering problems
f. an understanding of professional and ethical responsibility
g. an ability to communicate effectively
h. the broad education necessary to understand the impact of engineering solutions in a global, economic, environmental, and societal context
i. a recognition of the need for, and an ability to engage in life-long learning
j. a knowledge of contemporary issues
k. an ability to use the techniques, skills, and modern engineering tools necessary for engineering practice.

The student outcomes have to be attained by the students in due course of the 4 years program either as part of their Core, Basic Sciences, Engineering Sciences or as part of their various levels of projects, compulsory courses of Humanities & Social Sciences areas.

ACADEMIC RULES & REGULATIONS

FOR

B. TECH PROGRAM

2018-19

ACADEMIC REGULATIONS FOR B.TECH. PROGRAM
2018-19

This document supplements the University's rules and regulations to provide assistance to all B.Tech students. It is required that every individual has to abide by these regulations.

1.0 TERMINOLOGY

Academic Council: The Academic Council is the highest academic body of the University and is responsible for the maintenance of standards of instruction, education and examination within the University. Academic Council is an authority as per UGC regulations and it has the right to take decisions on all academic matters including academic research.

Academic Year: It is the period necessary to complete an actual course of study within a year. It comprises of two consecutive semesters i.e., Even and Odd semester.

Audited Course: It is a course of study which neither has evaluation component nor a grade.

Backlog Course: A course is considered to be a backlog course if the student has obtained a failure grade (F).

Basic Sciences : The courses of foundational nature in the areas of Mathematics, Physics, Chemistry, Biology etc., are offered in this category.

Betterment : Betterment is a way that contributes towards improving the students' grade in any course(s). It can be done by either (a) re-appearing or (b) re-registering for the course.

Board of Studies : Board of Studies (BOS) is an authority as defined in UGC regulations, constituted by Vice Chancellor for each of the department separately. They are responsible for curriculum design and update in respect of all the programs offered by a department.

Branch of Study: It is a branch of knowledge, an area of study or a specific program (like Civil Engineering, Mechanical Engineering, Electrical and Electronics Engineering etc.)

Certificate course : It is a course that makes a student gain hands-on expertise and skills required for holistic development. It is a mandatory, non-credited course for the award of degree.

Change of Branch : Change of branch means transfer from one's branch of study to other.

Compulsory course : Course required to be undertaken for the award of the degree as per the program.

Course : A course is a subject offered by the University for learning in a particular semester.

Course Handout : Course Handout is a document, which gives complete plan of the course. It contains the details of the course viz. Course title, Course code, Pre-requisite, Credit structure, team of instructors, Course objectives, Course rationale, Course Outcomes and the relevant syllabus, textbook(s) and reference books, Course delivery plan and session plan, evaluation method, chamber consultation hour, course notices and other course related aspects. In essence, course handout is an agreement between students (learners) and the instructor.

Course Outcomes : The essential skills that need to be acquired by every student through a course.

Credit : A credit is a unit that gives weight to the value, level or time requirements of an academic course. The number of 'Contact Hours' in a week of a particular course determines its credit value. One credit is equivalent to one lecture hour per week or two hours per week of tutorials/ self-learning/ practical/ field work during a semester.

Credit point : It is the product of grade point and number of credits for a course.

Credit Transfer : The procedure of granting credit(s) to a student for course(s) undertaken at another institution.

Cumulative Grade Point Average (CGPA) : It is a measure of cumulative performance of a student over all the completed semesters. The CGPA is the ratio of total credit points secured by a student in various courses in all semesters and the sum of the total credits of all courses in all the semesters. It is expressed up to two decimal places.

Curriculum : Curriculum incorporates the planned interaction of students with instructional content, materials, resources, and processes for evaluating the attainment of Program Educational Objectives.

Degree : A student who fulfills all the Program requirements is eligible to receive a degree.

Degree with Specialization : A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of Professional elective courses in a specialized area is eligible to receive a degree with specialization.

Department : An academic entity that conducts relevant curricular and co-curricular activities, involving both teaching and non-teaching staff and other resources.

Detention in a course : Student who does not obtain minimum prescribed marks in continuous in-semester evaluation and /or minimum prescribed attendance in a course shall be detained in that particular course.

Dropping from the Semester : A student who doesn't want to register for the semester should do so in writing in a prescribed format before commencement of the semester.

Elective Course : A course that can be chosen from a set of courses. An elective can be Professional Elective, Open Elective, Management Elective and Humanities Elective.

Engineering Sciences : The courses belonging to basic evolutionary aspects of engineering from Mechanical Sciences, Electrical Sciences and Computing like Engineering Mechanics, Data structures, Network Theory, Signal Analysis etc...

Evaluation : Evaluation is the process of judging the academic work done by the student in her/his courses. It is done through a combination of continuous in-semester assessment and semester end examinations.

Grade : It is an index of the performance of the students in a said course. Grades are denoted by alphabets.

Grade Point : It is a numerical weight allotted to each letter grade on a 10 - point scale.

Honors Degree

A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of additional courses within the same program is eligible to receive an Honors degree.

Humanities Elective : A course offered in the area of Liberal Arts.

Industrial Training : Training program undergone by the student as per the academic requirement in any company/firm. It is a credited course.

Industrial Visit : Visit to a company/firm as per the academic requirement.

In-Semester Evaluation : Summative assessments used to evaluate student learning, acquired skills, and academic attainment during a course.

Make-up Test : An additional test scheduled on a date other than the originally scheduled date.

Management elective: A course that develops managerial skills and inculcates entrepreneurial skills.

Mini project : Mini Project is a credit-based course that a student has to undergo during his/her academic term, which involves the student to explore in a discipline belonging to their research interest within their program area.

Minor Degree : A student who fulfills all the Program requirements of her/his discipline and successfully completes a specified set of courses from another discipline is eligible to receive a minor degree in that discipline.

Multi- Section Course : Course taught for more than one section.

Open Elective : This is a course of interdisciplinary nature. It is offered across the University for all programs.

Over loading : Registering for more number of credits than normally prescribed by the Program in a semester.

Practice School : It is a part of the total program and takes one full semester in a professional location, where the students and the faculty get involved in finding solutions to real-world problems. A student can choose Project/Practice School during his/her 7^{th} or 8^{th} semester of his/her Academic Year to meet the final requirements for a degree.

Pre-requisite : A course, the knowledge of which is required for registration into higher level course.

Professional Core : The courses that are essential constituents of each engineering discipline are categorized as Professional Core courses for that discipline.

Professional Elective : A course that is discipline centric. An appropriate choice of minimum number of such electives as specified in the program will lead to a degree with specialization.

Program : A set of courses offered by the Department. A student can opt and complete the stipulated minimum credits to qualify for the award of a degree in that Program.

Program Educational Objectives : The broad career, professional, personal goals that every student will achieve through a strategic and sequential action plan.

Project : Course that a student has to undergo during his/her final year which involves the student to undertake a research or design, which is carefully planned to achieve a particular aim. It is a credit based course.

Project based laboratory : Project Based Laboratory is a student-centric learning methodology that involve students in design, problem-solving, decision making, and investigative activities; gives students the opportunity to work in teams, over extended periods of time; and culminate in realistic products or presentations

Re-Appearing : A student can reappear only in the semester end examination for the Theory component of a course, subject to the regulations contained herein.

Registration : Process of enrolling into a set of courses in a semester/ term of the Program.

Re-Registering : A student desiring to repeat a course is permitted to do so, subject to the regulations contained herein.

Semester : It is a period of study consisting of 15 to 18 weeks of academic work equivalent to normally 90 working days including examination and preparation holidays. The odd Semester starts normally in July and even semester in December.

Semester End Examinations : It is an examination conducted at the end of a course of study.

Single Section Course : Course taught for a single section.

Social Service : An activity designed to promote *social* awareness and generate well-being; to improve the life and living conditions of the society.

Student Outcomes : The essential skill sets that need to be acquired by every student during her/his program of study. These skill sets are in the areas of employability, entrepreneurial, social and behavioral.

Substitution of Elective course : Replacing an elective course with another elective course as opted by the student.

Summer term : The term during which courses are offered from May to July. Summer term is not a student right and will be offered at the discretion of the University.

Term Paper : A 'term paper' is a research report written by students that evolves their course based knowledge, accounting for a grade. Term paper is a written original research work discussing a topic in detail. It is a credit based course.

Under-loading : Registering for lesser number of credits than normally prescribed by the Program in a semester.

Withdraw from a Course : Withdrawing from a Course means that a student can drop from a course within the first two weeks of the odd or even Semester (deadlines are different for summer sessions). However s/he can choose a substitute course in place of it by exercising the option within 5 working days from the date of withdrawal.

2.0 B.Tech. ENGINEERING PROGRAMS ON OFFER

2.1 B. Tech Programs

The students are admitted into 4- year full time B. Tech Programs as enlisted in this section. However these academic regulations provide various flexibilities in earning a) Honors b) Specialization and c) Minor Degrees listed out in the succeeding sections.

The student is awarded a B.Tech. degree provided s/he

a) Must successfully earn minimum of 165-175 credits, as stipulated in the program structure.
b) Must successfully complete a minimum of five (5) Professional Elective Courses, out of which three (3) must be from 3 different specialization areas offered by the program. However, in case of the program offering less than 3 specialization areas, s/he can complete more than one professional elective course from each of the specialization area but must ensure that s/he has completed a minimum of one course from each specialization area offered by the program.
c) Must successfully complete five (5) open electives courses
d) Must successfully complete three (3) certificate courses (four (4) in case of CSE students) in discipline domain areas, in addition to one from yoga / sports & games / fine arts.
e) Must successfully complete the term paper and Minor Project.
f) Must successfully complete the industrial training (internship) of four weeks duration.
g) Must successfully complete Major project or practice school.
h) Must have successfully taken social service activities for a minimum duration of 30 hours starting from 3rd semester onwards
i) Must have successfully obtained a minimum CGPA of 4.5 at the end of the program.
j) Must have finished all the above-mentioned requirements in less than twice the period mentioned in the Academic structure for each program, which includes deceleration period chosen by the student, deceleration imposed by University or debarred from the University.

The following B.Tech. Degrees are offered by the University.

1. Bachelor of Technology in Biotechnology (BT)
2. Bachelor of Technology in Civil Engineering (CE)
3. Bachelor of Technology in Computer Science & Engineering (CSE)
4. Bachelor of Technology in Electronics and Communication Engineering (ECE)

5. Bachelor of Technology in Electrical and Electronics Engineering (EEE)
6. Bachelor of Technology in Electronics and Computer Engineering (ECM)
7. Bachelor of Technology in Mechanical Engineering (ME)
8. Bachelor of Technology in Petroleum Engineering (PE)

2.2 B.Tech Degree with Honors

A student is eligible for B. Tech Degree with honors subject to the following.

a) S/he should have a CGPA of 8.5 or higher at the end of semester - 4.
b) S/he must pursue 5 additional courses, (covering not less than 20 credits) other than the courses required as per program, by separately registering for those courses.
c) S/he must pursue the additional courses by overloading during a semester or summer term.
d) S/he is eligible for the degree with honors only if CGPA of 8.5 or higher is maintained in each subsequent semester/term without attempting betterment after registering for Degree with Honors.
e) In case a student fails to meet the CGPA requirement for Degree with Honors at any point after registration, s/he will be dropped from the list of students eligible for Degree with Honors and they will receive B.Tech Degree only. However such students will receive a separate grade sheet mentioning the additional courses completed by them.

The following are the list of B.Tech(Honors) programs offered by the University

1.Bachelor of Technology (Honors) in Biotechnology (BT)
2.Bachelor of Technology (Honors) in Civil Engineering (CE)
3.Bachelor of Technology (Honors) in Computer Science & Engineering (CSE)
4.Bachelor of Technology (Honors) in Electronics and Communication Engineering (ECE)
5.Bachelor of Technology (Honors) in Electrical and Electronics Engineering (EEE)
6.Bachelor of Technology (Honors) in Electronics and Computer Engineering (ECM)
7.Bachelor of Technology (Honors) in Mechanical Engineering (ME)
8.Bachelor of Technology (Honors) in Petroleum Engineering (PE)

2.3 B.Tech Degree with specialization

A student is eligible to receive B. Tech Degree with specialization subject to the following:

a) S/he must successfully complete five (5) professional electives courses from a single specialized area and six (6) credits are earned by the student in addition to B. Tech Degree requirements,.
b) Must have completed term paper and Minor project in the same area of specialization; but this is to be done as part of the B. Tech Degree program requirement only
c) Attain a minimum CGPA of 6.75 at the end of the Program.

Degree with specialization is offered in the following areas:

Area of Specialization		**Eligible Departments**
1)	Bioinformatics	BT
2)	Genetic Engineering	BT
3)	Industrial and Food Bio Technology	BT
4)	Medical Bio Technology	BT
5)	Environmental and Water Resources Engineering	CE
6)	Geotechnical Engineering	CE
7)	Structural Engineering	CE
8)	Transportation Engineering	CE
9)	Software Engineering	CSE, ECM
10)	Networking &Communication	CSE, ECE, ECM
11)	Computational Intelligence	CSE, ECM
12)	Data Analytics	CSE, ECM
13)	Distributed & Cloud Computing	CSE, ECM
14)	e-Commerce	CSE, ECM
15)	Information Assurance & Security	CSE, ECM
16)	Internet of Things	CSE, ECM
17)	Platform- based Development	CSE, ECM
18)	Communication Systems	ECE, ECM
19)	Signal Processing	ECE, ECM, EEE
20)	VLSI	ECE, ECM, EEE
21)	Web Technologies	ECM, CSE

22)	Wireless Sensor Networks	ECM, CSE
23)	Embedded Systems	ECM, ECE, CSE, EEE
24)	Control Systems	EEE, ECE, ECM
25)	Energy Systems	EEE, ME
26)	Power Electronics	EEE
27)	Power Systems	EEE
28)	Automobile Engineering	ME
29)	Design & Manufacturing	ME
30)	Robotics & Mechatronics	ME, ECE, ECM, EEE
31)	Up-stream Engineering	PE
32)	Down-stream Engineering	PE

2.4 B.Tech Degree with a Minor

A student who fulfills the B. Tech program requirements of a discipline in which s/he was admitted, is awarded a B.Tech degree in that discipline. The University also offers flexibility for a student to successfully complete five (5) additional courses (necessarily comprising of professional core courses category) from another discipline, which collectively accounts to 20 credits. Having done so s/he gets eligibility for the award of a minor degree in that discipline.

3.0 ELIGIBILITY CRITERIA FOR ADMISSION INTO B.Tech. PROGRAMS

Candidates should have passed Intermediate or equivalent (10+2) Examination, from recognized school leaving certificate examination boards; with minimum of 60% marks or equivalent CGPA in Mathematics, Physics, and Chemistry in the case of all Engineering programs. In case of Bio Technology, the candidates who have passed with minimum of 60% or equivalent CGPA in Biology, Physics, and Chemistry are also eligible.

Apart from the above, the candidates should have secured a qualifying rank in the engineering admission eligibility test i.e., KLUEEE (Entrance Examination conducted by K L University) (or) EAMCET (or) JEE (Mains).

For foreign students who wish to study at the University, please refer to the “Foreign Student Admission Procedures” stated separately and comply with the study requirements of the Ministry of Human Resource Development, Govt.of India.

4.0 B.Tech PROGRAM CURRICULUM

For an academic program the curriculum is the basic framework that will stipulate the credits, category, course code, course title, course delivery (Lectures / Tutorials / Practice / Project/ Self Study / Capstone Design etc.), in the Choice Based Credit System. However all such are essentially designed, implemented and assessed on Outcome Based Education Framework.

4.1 Program Structure

a) B.Tech program is spread over a span of 8 semesters.

b) Each semester is of, approximately 18 weeks duration and each semester is classified as:
   - Odd Semester (July – December)
   - Even Semester (December/January – April/May).

c) In addition to the above mentioned semesters, the university may offer summer term during May and June.

d) All courses are offered under three categories vis-à-vis. even, odd and dual semester courses.

e) Subject to the maximum permissible limit in each course, as specified by the University from time to time, students have independence to choose courses of their own choice prescribed by the University.

f) From 3rd Semester, onwards a student can register for a maximum of 7 credited courses or 26 credits (whichever is less), this however is other than audited and certificate courses per semester. This is not applicable when student exercises the overloading option (while doing project work/practice school/Minor degree/Honors degree program/specialization).

g) A student can choose Major Project/Practice school only during 7th or 8th semester.

4.2 Course Structure

a) Every course has a Lecture-Tutorial-Practice (L-T-P) component attached to it.

b) Based upon the LTP structure the credits are allotted to a course using the following criteria.
   i. Every lecture hour is equivalent to one credit.
   ii. Every Tutorial/Practice hour is equivalent to half credit.
   iii. If the calculated value of credit is a fraction, it is rounded to the lower number.

4.3 Course Classification

Any course offered under B.Tech program is classified as:

a) Compulsory Courses

i. Basic Sciences
ii. Engineering Sciences
iii. Humanities
iv. Professional core

b) Elective courses:

i. Professional Elective
ii. Open elective
iii. Management elective
iv. Humanities and Social science Elective
v. Science elective.

4.4 Course Precedence:

a) Every course can have one or more of its preceding course(s) as prerequisite(s).
b) To register for a course, the student must successfully complete the course(s) earmarked as pre-requisite(s) for that course.
c) In any course if a student appears for semester end exam or is declared eligible for the same, s/he is deemed to have met the prerequisite.
d) The Dean Academics after consulting with Department concerned has the prerogative to waive the prerequisite (if it is satisfied through a test) if the student has gained sufficient proficiency to take up the course.
e) Professional electives and compulsory core courses can be chosen by the students of the respective disciplines only. However, the students of a particular discipline can register for specialization/ discipline / interdisciplinary minor / compulsory discipline courses of other disciplines provided they have met the pre-requisite or when pre requisite is waived by Dean Academics.
f) A student is not permitted to choose an open elective, if it covers more than 30% of content already done by him in any other course that s/he registered/ completed.
g) An elective course may be offered, only if a minimum of 20 students register for the course.

4.5 Summer Term Courses

The University may offer summer term courses, as per the necessity from time to time.

a) A student may register for course/s in each summer term by paying the stipulated fee. Students registering for more than one (1) summer course have to ensure that there is no clash in the time table. In any case, a student can register only for a maximum of 14 credits during summer term.

b) Summer course is not a right of the student and will be offered based on availability of faculty and other institute resources.

5.0 Evaluation process

A student's academic progress is examined through one or more of the following methods as decided by the Course Coordinator and duly approved by the Dean, Academic.

- Assignment
- Quiz
- Sessional
- Project Report
- Review
- Seminar
- Group Discussion
- In Class Participation / Active Learning
- Case Study Report
- Capstone Design Project
- Simulation
- Comprehensive Exam

a) The Sessional tests and the Semester-End Examinations will be conducted as per the Academic Calendar.

b) As per the necessity, the Supplementary examinations will be conducted at the discretion of Vice Chancellor.

c) Students may have to take more than one examination in a day either during Semester End Examinations /Supplementary examination.

5.1 In-Semester Evaluation

a) The process of evaluation should be continuous throughout the semester and involves components as listed in section 5.0.

b) The maximum distribution of marks for In-Semester evaluation must not exceed 50% of aggregate marks of the course.

c) The distribution of weightage for various evaluation components will be decided and notified by the course coordinator through the course handout after approval by the Dean Academic, at the beginning of the semester.

d) In order to maintain transparency in evaluation, answer scripts will be shown to the students for verification, within one week of conduct of exam. If there is any discrepancy in evaluation, the student can request the course coordinator to re-evaluate.

e) The solution key and scheme of evaluation for all examinations will be displayed in the appropriate web portal of the course, within 2 days after the conduct of examination, by the course coordinator.

f) No correction is permitted once the course coordinator submits the marks/grades to the Controller of Examination.

g) In case the student is unable to appear for any such examination owing to medical grounds, participation in extra/ co curricular activities representing University/ state/ country; make up examination may be conducted as per the discretion of the Director / Principal of concerned College/ school.

5.1.1 Attendance Policy:

In every course, student has to maintain a minimum of 75% attendance to be eligible for appearing in Semester end examination of the course, for cases of medical issues and other unavoidable circumstances the students will be condoned if their attendance is between 65% to 75% in every course,subjected to submission of medical certificates, medical case file and other needful documents to the concerned departments. However in case of a student having less than 65% attendance in any course, S/He shall be detained in the course and in no case such process will be relaxed.

There are no specific marks attached to attendance as such, however if the course coordinator of a course desires to award certain marks, for attendance in a course She/He can do so based on following guidelines, which thereby must be clearly reflected in respective course handouts, well before the commencement of the course work for such courses, which must be duly approved by the Dean Academic:For any course, not more than 5% marks can be allotted for attendance.

The distribution of marks is as follows:

95 to 100%	:	5 marks
90 to 95%	:	4 marks
85 to 90%	:	3 marks
80 to 85%	:	2 marks
75 to 80%	:	1 marks

Below 75% (even in case of condonation "0" marks)

The marks, if allotted for attendance will have to be considered for all L-T-P components of a course cumulatively but not specifically for theory component for any course, however if the course is an elective, then the marks are for only theory owing to the L-T-P structure for such course being "X"-0-0.

5.2 Detention policy

a) In any course, a student has to maintain a minimum of 75% attendance and must secure a minimum of 40% marks in In-Semester Examinations to be eligible for appearing to the Semester End Examination, failing to fulfill these conditions will deem such student to have been detained in that course.

b) However the following are the special cases where the lack of attendance can be condoned:
   i. Up to a maximum of 10% on medical grounds, in which case the student must submit the medical certificate from any recognized medical practitioner.
   ii. Up to a maximum of 10% if the student represents the University / State / Country in any Extra / Co-curricular activities.
   iii. The maximum extent to which a student can be condoned is 10%, and any student with less than 65% is deemed to be detained.

5.3 Semester end examination

a) The minimum weightage for Semester End Examination is 50% of the aggregate marks in the ratio of credits allotted for Lecture (L) +Tutorial (T) to Practical (P).

b) The pattern and duration of such examination will be decided and notified by the Course Coordinator through the Course handout, after approval from the Dean Academic.

c) In order to maintain transparency in evaluation, answer scripts will be shown to the students for verification upon request. If there is any discrepancy in evaluation, the student can request the course coordinator to re-evaluate.

5.4 Reports/Grades

5.4.1. Grading Process

a) At the end of all evaluation components based on the performance of the student, each student is awarded based on ***absolute grading system***. The list of absolute grades and its connotation are given below:

GRADE	GRADE POINTS	**RANGE**	
O (Outstanding)	10	85	100
A+(Excellent)	9	80	<85
A(Very Good)	8	65	<80
B+(Good)	7	60	<65
B(Above Average)	6	50	<60
C(Average)	5	45	<50
P (Pass)	4	40	<45
F(Fail)	0	<40	-
Ab (Absent)	0	-	-

b) The SGPA is the ratio of sum of the product of the number of credit s with the grade points scored by a student in all the courses and the sum of the number of credits of all the courses undergone by a student, in a semester.

i.e SGPA $(S_i) = \sum(C_i \times G_i) / \sum C_i$

where *'C_i'* is the number of credits of the i^{th} course and *'G_i'* is the grade point scored by the student in the i^{th} course.

c) The CGPA is also calculated in the same manner taking into account all the courses undergone by a student over all the semesters of a program,

i.e. CGPA = $\sum(C_i \times S_i) / \sum C_i$

where 'S'$_i$ is the SGPA of the i^{th} semester and *'C_i'* is the total number of credits in that semester.

d) The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

e) CGPA can be converted to percentage of marks : 10 X CGPA - 7.5

f) A student who obtains 'F' grade has to reappear for all the components of Semester End examination.

g) Audit/Certificate courses are graded as satisfactory or non-satisfactory only.

h) At the end of each semester, the University issues grade sheet indicating the SGPA and CGPA of the student. However, grade sheet will not be issued to the student if he/she has any outstanding dues.

5.5 Betterment

a) A student may reappear for semester end examination only in the theory part of the course for improving the grade, subject to the condition that, her/his CGPA is ≤ 6.75. In the case of reappearing, the grade obtained in reappearance or the earlier grade whichever is better will be considered.

b) A Student can re-register in any course at any time before the completion of his/her program provided the University permits.

c) A student cannot reappear for semester end examination in courses like Industrial Training, courses with their L-T-P Structure 0-0-X, Minor Project, Major Project, Practice School and Term Paper.

d) The student ceases to be eligible for award of B.Tech. degree with Honors, B.Tech degree with First class and distinction, in case s/he takes up the betterment option.

6.0 REGISTRATION PROCESS

For every course, the student has to undertake the registration process prior to commencement of the course-work, based on the following conditions;

a) Registration into a course will be permitted only for such courses, which are offered by the program in that particular semester.
b) In case a course has pre-requisites, all of them must be fulfilled.
c) The University has the right to refuse registration process if a student does not turn up on the day of registration.
d) Registration shall not be permitted after the fifth working day from the scheduled date of commencement of classes.
e) Students can register for a maximum of 26 credits in a semester of their choice to meet their program requirements.
f) In case of students, who wish to register for more credits through Overloading or less credits through Under-loading, have to seek prior permission from Dean-Academic.
g) Students, who have opted for minor degree, Honors program or degree with specialisation, can register for more number of credits in a Semester through Overloading.
h) The University reserves the right to withdraw any elective course offered within one week of the commencement of the semester if sufficient numbers of students have not registered or for any other reasons. In such cases, the students are permitted to register for any other elective course of their choice provided they have fulfilled the eligibility conditions.
i) The University reserves the right to cancel the registration of a student from a course or a semester or debar from the degree on disciplinary grounds.
j) Within one week of the commencement of the semester, a student is permitted to substitute an elective course subject to availability with prior approval from Dean-Academic. However, a student is not permitted to withdraw from compulsory course and substitute the same with an elective course.
k) A student is solely responsible to ensure that all conditions for proper registration are satisfied, and there are no timetable clashes. The registration may be cancelled for a course or the entire semester either by the student or by the University if any irregularity is found at a later stage.

7.0 CHANGE OF BRANCH

A student admitted to a particular Branch of the B.Tech program will normally continue studying in that branch until the completion of the program. However, in special cases the University may

permit a student to change from one branch to another after the second semester, provided s/he has fulfilled admission requirement for the branch into which the change is requested.

The rules governing change of branch are as listed below:

a) Top 1% (based on CGPA until 2nd semester) students will be permitted to change to any branch of their choice.
b) Apart from students mentioned in clause (a) above, those who have successfully completed all the first and second semester courses and with CGPA ≥ 8 are also eligible to apply, but the change of Branch in such case is purely at the discretion of the University.
c) All changes of Branch will be effective from third semester. Change of branch shall not be permitted thereafter.
d) Change of branch once made will be final and binding on the student. No student will be permitted, under any circumstances, to refuse the change of branch offered.

8.0 CREDIT TRANSFER

a) Credit transfer from other University to K L University or vice versa is permitted only for under graduate program.
b) Credit transfer from K L University to other University: Student studying in K L University can take transfer to another University under the following conditions:
    i. K L University has signed MOU with the University.
    ii. However, a student, after seeking transfer from K L University can return to K L University after a semester or year. Based on courses done in the other University, equivalent credits shall be awarded to such students.
c) Credit transfer from another University to KL University: A student studying in another University can take transfer to K L University under the following conditions:
    i. When a student seeks transfer, equivalent credits will be assigned to the student based on the courses studied by the student.
    ii. The student, when transferred from other Universities, has to stick to the rules and regulations of K L University.
    iii. To graduate from K L University, a student must study at least half of the minimum duration prescribed for a program at KLU.

9.0 ACADEMIC COUNSELING BOARD (ACB)

Academic Counseling Board is constituted by the Dean, Academic, for each program separately. This board shall comprise of the Chairman, Board of Studies, of the relevant program, two (2) Professors and two (2) Associate Professors.

A student will be put under Academic Counseling Board in the following circumstances:

(i) Has CGPA of less than 6.00.

(ii) Has 'F' grade in multiple courses.

The students under Academic Counseling Board may not be allowed to register for all regular courses in the semester, based on the recommendation of Academic Counseling Board and decision of Dean, Academic.

10.0 BACKLOG COURSES

A course is considered to be a backlog if the student has obtained 'F' grade in the course; the student has to re-appear for all components of semester end examinations in that course. However, student must successfully complete such a course in a maximum of four (4) consecutive attempts, failing which s/he must re-register for that course or a substitute course. The decision for substitute course shall be obtained from the Dean, Academic, based on the recommendations of the Board of Studies.

11.0 RUSTICATION

A student may be rusticated from the University on disciplinary grounds, based on the recommendations of any committee or examination committee, by the Vice Chancellor.

12.0 AWARD OF DEGREES

A student having cleared all the courses and met all the requirements for the award of degree with

1) CGPA between 4.5 to 5.5 will be awarded Pass class
2) CGPA < 6.75 will be awarded second class
3) CGPA ≥ 6.75 will be awarded first class

4) CGPA ≥ 7.5 will be awarded first class with distinction provided the student has cleared all the courses in first attempt, and must have fulfilled all the program requirements in four (4) years duration.

13.0 AWARD OF MEDALS

University awards Gold and silver medals to the top two (2) students based on CGPA. However,

1. the grade obtained by betterment, will not be considered for this award.
2. s/he must have obtained first class with distinction for the award of Gold or silver medal.

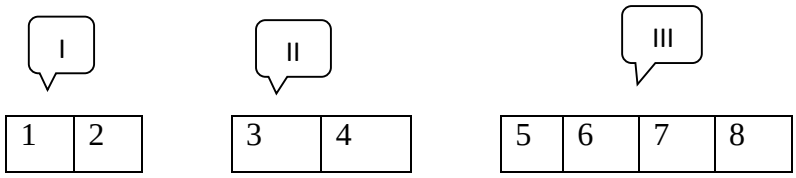
Any of the above rules can be altered at the discretion of the Vice Chancellor in special situations.

COURSE STRUCTURE

PROCEDURE FOR ALLOTMENT OF COURSE CODES

The Course code contains three main segments (I, II, III) as illustrated below.

`



Segment I:

The first two letters represent Year of beginning /approval of Regulations.

Ex. A course with code starting with 15 represents a course belonging to 2015 regulations.

Segment II:

Third and fourth letters represents the acronym of offering discipline of the course.

Acronym	Name of Discipline		Acronym	Name of Discipline
BT	BIOTECHNOLOGY		CY	CHEMISTRY
CE	CIVIL ENGINEERING		EN	ENGLISH
CS	COMPUTER SCIENCE AND ENGINEERING		MB	MANAGEMENT
EC	ELECTRONICS AND COMMUNICATIONS ENGINEERING		CM	COMMERCE
EM	ELECTRONICS AND COMPUTERS ENGINEERING		HM	HOTEL MANAGEMENT
EE	ELECTRICAL AND ELECTRONICS ENGINEERING		GN	GENERAL
ME	MECHANICAL ENGINEERING		AR	ARCHITECTURE
PE	PETROLEUM ENGINEERING		LA	LAW
MT	MATHEMATICS		PY	PHARMACY
PH	PHYSICS		FA	FINE ARTS
CH	CHEMICAL ENGINEERING		IE	INTER DISCIPLINARY ENGINEERING

Segment III:

- Fifth letter represents level of the course.

  Ex: 1 represents level 1 course (normally will be completed in first year), 2 represents level 2 course (normally will be completed in Second year), 3 represents level 3 course (normally will be completed in third year), 4 represents level 4 course (normally will be completed in fourth year)

- Sixth letter represents offering semester.

  Ex. 0 : indicates the course is offered in both odd and even semesters

  1 : indicates the course is offered only in odd semester

  2 : indicates the course is offered only in even semester

- Last two letters (7^{th} and 8^{th}) indicates serial number of the course.
  - All compulsory courses to be sequenced from 01 to 50.
  - Professional/ Management/ Foreign language electives to be sequenced from 51 to 99.
  - Open electives to be sequenced from A1 to A9, B1 to B9 and so on…

DEPARTMENT OF BIOTECHNOLOGY

Bridge / Refresher Courses										
No	**Course Code**	**Course Title**	**Uni/Sch/ Dept**	**Type**	**L**	**T**	**P**	**S**	**Cr**	**CH**
1		Bridge/ Refresher Course in Mathematics	SCH ELEC	BS	0	0	2	0	0	2
2		Bridge/ Refresher Course in Physics	SCH ELEC	BS	0	0	2	0	0	2
3		Bridge/ Refresher Course in Chemistry	SCH ELEC	BS	0	0	2	0	0	2
4		Bridge/ Refresher Course in English	SCH ELEC	HSS	0	0	2	0	0	2
Total					**0**	**0**	**8**	**0**	**0**	**8**
Induction Courses (Non Credit)										
1	18IN1001	Fundamentals of Mathematics	SCH CORE	BS	5	0	0	0	0	5
2	18IN1002	Basics of Physics	SCH CORE	BS	5	0	0	0	0	5
3	18IN1003	Introduction to Engineering	SCH CORE	ES	5	0	0	0	0	5
4	18IN1004	Human Values	SCH CORE	HSS	5	0	0	0	0	5
5	18IN1005	SWEAR Analysis	SCH CORE	ES	5	0	0	0	0	5
6	18IN1006	Cocurricular Activities	SCH CORE	GN	5	0	0	0	0	5
Total					**30**	**0**	**0**	**0**	**0**	**30**
S E M E S T E R - 1										
1	18MT2001	Basic Mathematics	SCH CORE	BS	3	0	0	0	3	3
2	18SC1104	Foundations of Computational Mathematics	SCH CORE	BS	0	0	2	0	1	2
3	18SC1105	Logic and reasoning	SCH CORE	BS	0	0	2	0	1	2
4	18SC1101	Problem solving & computer programming	SCH CORE	ES	3	0	2	0	4	5
5	18UC1101	Basic English	UNI CORE	HSS	0	0	4	0	2	4
6	18SC1106	Technical Skill - 1 (Coding)	SCH CORE	SK	0	0	0	6	1.5	6
7	18CY1001	Engineering Chemistry	SCH ELEC	ES	3	0	2	0	4	5
8	18BT1002	Engineering Graphics&Design for Biotechnologists	SCH ELEC	ES	0	0	4	0	2	4
9	18GN1107	Cocurricular Activity -1	SCH CORE	CCA	0	0	0	2	0.5	2
10	18GN1101	Counseling -1	SCH CORE	CNS	0	0	1	0	0	1
Total					**9**	**0**	**17**	**8**	**19**	**34**
S E M E S T E R - 2										
1	18SC1103	Single Variable Calculus and Matrix Algebra	SCH ELEC	BS	3	0	0	0	3	3
2	18UC1202	English Proficiency	UNI CORE	HSS	0	0	4	0	2	4
3	18SC1207	Technical Skill -2 (Coding)	SCH CORE	SK	0	0	0	6	1.5	6

4	18SC1202	Data Structures	SCH CORE	ES	3	0	2	0	4	5
5	18BT1003	Workshop Practices for Biotechnologists	SCH ELEC	ES	0	0	4	0	2	4
6	18BT1201	Cell Biology	DEP CORE	PC	3	1	0	0	4	4
7	18PH1001	Engineering Physics	SCH ELEC	ES	3	0	2	0	4	5
8	18GN1208	Cocurricular Activity -2	SCH CORE	CCA	0	0	0	1	0.5	1
9	18GN1202	Counseling -2	SCH CORE	CNS	0	0	1	0	0	1
Total					**12**	**1**	**13**	**7**	**21**	**33**
S E M E S T E R - 3										
1	18BT2105	Biochemistry	DEP CORE	PC	3	0	2	0	4	5
2	18BT2106	Microbiology	DEP CORE	PC	3	0	2	0	4	5
3	18ES2101	Process Engineering Principles	SCH ELEC	ES	2	1	0	0	3	3
4	18MT2011	Biostatistics	SCH ELEC	BS	2	1	0	0	3	3
5	18UC2103	Professional Communication Skills	UNI CORE	HSS	0	0	4	0	2	4
6	18TS1001	Skilling for Engineers-1(Medical Lab Technology)	SCH ELEC	SK	0	0	0	8	2	8
7	18UC0009	Ecology & Environment	UNI CORE	HSS	2	0	0	0	2	2
8	18GN2109	Cocurricular Activity -3	SCH CORE	CCA	0	0	0	2	0	2
9	18GN2103	Counseling -3	SCH CORE	CNS	0	0	1	0	0	1
Total					**12**	**2**	**9**	**10**	**20**	**33**
S E M E S T E R - 4										
1	18BT2107	Bioanalytical Techniques	DEP CORE	PC	3	0	2	0	4	5
2	18BT2108	Molecular Biology	DEP CORE	PC	3	1	0	0	4	4
3	18BT2109	Immunology	DEP CORE	PC	3	0	2	0	4	5
4	18ES2103	Biochemical Thermodynamics	SCH ELEC	ES	3	1	0	0	4	4
5	18UC2204	Aptitude Builder - 1	UNI CORE	HSS	0	0	4	0	2	4
6	18TS1002	Skilling for Engineers-2 (Process Engineering Tools)	SCH ELEC	SK	0	0	0	8	2	8
7	18UC0008	Indian Constituition	UNI CORE	ES	2	0	0	0	2	0
8	18GN2210	Cocurricular Activity -4	SCH CORE	CCA	0	0	0	2	0	2
9	18GN2204	Counseling -4	SCH CORE	CNS	0	0	1	0	0	1
Total					**14**	**2**	**9**	**10**	**22**	**33**
S E M E S T E R - 5										
1	18ES2102	Transport processes in Biological systems	SCH ELEC	ES	3	0	2	0	4	5
2	18BT3110	Bioinformatics	DEP CORE	PC	3	0	2	0	4	5
3	18BT3111	Genetic Engineering	DEP CORE	PC	3	0	2	0	4	5

4	18BT3112	Fermentation Technology	DEP CORE	PC	3	0	2	0	4	5
5	18BT3113	Biochemical Reaction Engineering	DEP CORE	PC	3	0	2	0	4	5
6	18UC3105	Aptitude Builder - 2	UNI CORE	HSS	0	0	4	0	2	4
7	18BT3150	Technical Proficiency & Training -1 (Genomics)	SCH CORE	SCH	1	0	0	0	**1**	4
8	18TS1003	Skilling for Engineers-3 (Animal Cell Culture)	SCH ELEC	SK	0	0	0	8	2	8
9	18UC0007	Indian Heritage & Culture	UNI CORE	ES	2	0	0	0	2	0
10	18IE2246	Industrial Training	SCH CORE	PR	0	0	0	0	2	0
11	18GN3111	Cocurricular Activity -5	SCH CORE	CCA	0	0	0	2	0	2
12	18GN3105	Counseling -5	SCH CORE	CNS	0	0	1	0	0	1
Total					**18**	**0**	**15**	**10**	**29**	**44**
S E M E S T E R - 6										
1	18BT3201	Plant Biotechnology	DEP CORE	PC	3	0	2	0	4	5
2	18BT3202	Downstream Processing	DEP CORE	PC	3	0	2	0	4	5
3		Professional Elective 1	DEP ELEC	PE	3	0	0	0	3	3
4		Professional Elective 2	DEP ELEC	PE	3	0	0	0	3	3
5		Professional Elective 3	DEP ELEC	PE	3	0	0	0	3	3
6	18BT3250	Technical Proficiency & Training-2 (Bioprocessing)	SCH CORE	SCH	1	0	0	0	**1**	4
7	18TS1005	Skilling for Engineers-4 (Advanced Instrumentation)	SCH ELEC	SK	0	0	0	8	2	8
8	18UC3206	Campus to Corporate	UNI CORE	HSS	0	0	4	0	2	4
9	18IE3247	Term Paper	SCH CORE	PR	0	0	4	0	2	4
10	18GN3212	Cocurricular Activity -6	SCH CORE	CCA	0	0	0	2	0	2
11	18GN3206	Counseling -6	SCH CORE	CNS	0	0	1	0	0	1
Total					**16**	**0**	**13**	**10**	**24**	**42**
S E M E S T E R - 7										
1		Professional Elective 4	DEP ELEC	PE	3	0	0	0	3	3
2		Professional Elective 5	DEP ELEC	PE	3	0	0	0	3	3
3		Open Elective - 1	UNI ELEC	OE	3	0	0	0	3	3
4	18IE4048/ 18IE4050	Project (Part I) / Practice School	SCH CORE	PR	0	0	0	24	6	24
5		Foreign/ Non Native Language	UNI ELEC	HSS	2	0	0	0	2	0
6		Management Elective	SCH ELEC	HSS	3	0	0	0	3	3
7		Universal Human Values & Professional Ethics	UNI CORE	HSS	1	0	2	0	2	3
Total					**15**	**0**	**2**	**24**	**22**	**39**
S E M E S T E R - 8										

1		Open Elective - 2	UNI ELEC	OE	3	0	0	0	3	3
2		Open Elective - 3	UNI ELEC	OE	3	0	0	0	3	3
3	18IE4049/ 18IE4050/ 18IE4051	Project (Part II) / Practice School/ Internship	SCH CORE	PR	0	0	0	24	6	24
Total					**6**	**0**	**0**	**24**	**12**	**30**
GRAND TOTAL					**128**	**5**	**92**	**95**	**169**	**314**

PROFESSIONAL ELECTIVES

GENETIC ENGINEERING										
1	18BT3251	Molecular Genetics	DEP ELEC	PE	3	0	0	0	3	3
2	18BT3252	Transgenic Technology	DEP ELEC	PE	3	0	0	0	3	3
3	18BT3253	Molecular Expression Technology	DEP ELEC	PE	3	0	0	0	3	3
4	18BT3254	Genomics and Proteomics	DEP ELEC	PE	3	0	0	0	3	3
5	18BT4150	Molecular markers and Diagnostics	DEP ELEC	PE	3	0	0	0	3	3
6	18BT4151	Gene and the Environment	DEP ELEC	PE	3	0	0	0	3	3
7	18BT4152	Microbial Genetics	DEP ELEC	PE	3	0	0	0	3	3
8	18BT4153	DNA Forensics	DEP ELEC	PE	3	0	0	0	3	3
INDUSTRIAL BIOTECHNOLOGY										
1	18BT3255	Microbial Technology	DEP ELEC	PE	3	0	0	0	3	3
2	18BT3256	Pharmaceutical Biotechnology	DEP ELEC	PE	3	0	0	0	3	3
3	18BT3257	Metabolic Engineering	DEP ELEC	PE	3	0	0	0	3	3
4	18BT3258	Bioresource Technology	DEP ELEC	PE	3	0	0	0	3	3
5	18BT4154	Bioprocess Economics and Plant Design	DEP ELEC	PE	3	0	0	0	3	3
6	18BT4155	Enzyme Engineering	DEP ELEC	PE	3	0	0	0	3	3
7	18BT4156	Bioprocess Validation and cGMP	DEP ELEC	PE	3	0	0	0	3	3
8	18BT4157	Food Technology	DEP ELEC	PE	3	0	0	0	3	3
9	18BT4158	Pharmacovigilance and Safety	DEP ELEC	PE	3	0	0	0	3	3
BIOINFORMATICS										
1	18BT3259	PERL and Bioperl programming	DEP ELEC	PE	3	0	0	0	3	3
2	18BT3260	Biomedical Informatics	DEP ELEC	PE	3	0	0	0	3	3
3	18BT3261	Molecular Modelling and Drug Design	DEP ELEC	PE	3	0	0	0	3	3
4	18BT3262	Structural Biology	DEP ELEC	PE	3	0	0	0	3	3
5	18BT4159	Systems Biology	DEP ELEC	PE	3	0	0	0	3	3
6	18BT4160	Applied Bioinformatics	DEP ELEC	PE	3	0	0	0	3	3
7	18BT4161	Python and R Programming	DEP ELEC	PE	3	0	0	0	3	3
8	17BT4162	Data Base Management System	DEP ELEC	PE	3	0	0	0	3	3
MEDICAL BIOTECHNOLOGY										
1	18BT3263	Stem cell technology	DEP ELEC	PE	3	0	0	0	3	3
2	18BT3264	Healthcare Biotechnology	DEP ELEC	PE	3	0	0	0	3	3

3	18BT3265	Cancer Biology	DEP ELEC	PE	3	0	0	0	3	3
4	18BT3266	Neurobiology	DEP ELEC	PE	3	0	0	0	3	3
5	18BT4163	Bioelectronics & Biosensors	DEP ELEC	PE	3	0	0	0	3	3
6	18BT4164	Tissue Engineering	DEP ELEC	PE	3	0	0	0	3	3
7	18BT4165	Virology	DEP ELEC	PE	3	0	0	0	3	3
8	18BT4166	Nanobiotechnology	DEP ELEC	PE	3	0	0	0	3	3

COURSE Vs STUDENT OUTCOMES MAPPING

Program Articulation Matrix

HUMANITIES & SOCIAL SCIENCES							PO												PSO	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
18UC1101	Basic English	0	0	4	2	Nil	✓				✓					✓				
18UC1202	English Proficiency	0	0	4	2	Nil	✓			✓	✓			✓	✓	✓				
18UC2103	Professional Communication Skills	0	0	4	2	Nil	✓				✓			✓	✓	✓				
18UC0009	Ecology & Environment	2	0	0	2	Nil						✓						✓		
18UC2204	Aptitude Builder - 1	0	0	4	2	Nil	✓				✓	✓	✓			✓				
18UC3105	Aptitude Builder - 2	0	0	4	2	Nil	✓				✓			✓		✓				
18UC3206	Campus to Corporate	0	0	4	2	Nil	✓			✓	✓	✓	✓	✓	✓	✓				
	Universal Human Values & Professional Ethics	1	0	2	2	Nil														
BASIC SCIENCES							**PO**												**PSO**	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
18MT2001	Basic Mathematics	3	0	0	3	Nil					✓						✓			
18SC1104	Foundations of Computational Mathematics	0	0	2	1	Nil	✓													
18SC1105	Logic and reasoning	0	0	2	1	Nil	✓													
18SC1103	Single Variable Calculus and Matrix Algebra	3	0	2	4	Nil	✓													
18MT2011	Biostatistics	2	1	0	3	Nil	✓				✓									

18BT1001	Biology for Engineers	2	0	0	2	Nil									✓		✓				

ENGINEERING SCIENCES							**PO**												**PSO**	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
18SC1101	Problem solving & computer programming	3	0	2	4	Nil	✓				✓						✓			
18CY1001	Engineering Chemistry	3	0	2	4	Nil	✓		✓	✓			✓							
18BT1002	Engineering Graphics & Design for Biotechnologists	0	0	4	2	Nil	✓		✓	✓			✓							
18SC1202	Data Structures	3	0	2	4	Nil	✓	✓		✓										
18BT1003	Workshop Practices for Biotechnologists	0	0	4	2	Nil	✓													
18PH1001	Engineering Physics	3	0	2	4	Nil	✓													
18ES2101	Process Engineering Principles	2	1	0	3	Nil	✓													
18ES2103	Biochemical Thermodynamics	3	1	0	4	Nil	✓	✓									✓			
18UC0008	Indian Constituition	0	0	2	1	Nil														
18ES2102	Transport processes in Biological systems	3	0	2	4	Nil	✓	✓									✓			
18UC0007	Indian Heritage & Culture	0	0	2	1	Nil														

PROFESSIONAL CORE							**PO**												**PSO**	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
18BT1201	Cell Biology	3	1	0	4	Nil		✓		✓										
18BT2105	Biochemistry	3	0	2	4	Nil		✓		✓	✓								✓	

18BT2106	Microbiology	3	0	2	4	Nil		✓			✓						✓		✓	
18BT2107	Bioanalytical Techniques	3	0	2	4	Nil			✓								✓		✓	
18BT2108	Molecular Biology	3	1	0	4	Nil	✓				✓			✓						
18BT2109	Immunology	3	0	2	4	Nil	✓	✓			✓						✓			✓
18BT3110	Bioinformatics	3	0	2	4	Nil			✓									✓		
18BT3111	Genetic Engineering	3	0	2	4	Nil			✓									✓		✓
18BT3112	Fermentation Technology	3	0	2	4	Nil	✓				✓									✓
18BT3113	Biochemical Reaction Engineering	3	0	2	4	Nil	✓				✓									✓
18BT3201	Plant Biotechnology	3	0	2	4	Nil	✓							✓						✓
18BT3202	Downstream Processing	3	0	2	4	Nil	✓				✓							✓		✓
PROFESSIONAL ELECTIVE							**PO**												**PSO**	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
18BT3251	Molecular Genetics	3	0	0	3	17BT3111	✓				✓						✓			
18BT3252	Transgenic Technology	3	0	0	3	17BT3111	✓				✓			✓						
18BT3253	Molecular Expression Technology	3	0	0	3	17BT3111	✓				✓						✓			
18BT3254	Genomics and Proteomics	3	0	0	3	17BT3111	✓				✓			✓						
18BT4150	Molecular markers and Diagnostics	3	0	0	3	17BT3111	✓					✓								
18BT4151	Gene and the	3	0	0	3	17BT3111	✓				✓						✓			

	Environment																			
18BT4152	Microbial Genetics	3	0	0	3	17BT3111	✓				✓						✓			
18BT4153	DNA Forensics	3	0	0	3	17BT3111	✓				✓						✓			
18BT3255	Microbial Technology	3	0	0	3	17BT2106	✓				✓						✓			
18BT3256	Pharmaceutical Biotechnology	3	0	0	3	17BT2106			✓	✓							✓			
18BT3257	Metabolic Engineering	3	0	0	3	17BT2106	✓				✓			✓						
18BT3258	Bioresource Technology	3	0	0	3	17BT2106	✓				✓									
18BT4154	Bioprocess Economics and Plant Design	3	0	0	3	17BT2106		✓	✓		✓									
18BT4155	Enzyme Engineering	3	0	0	3	17BT2106	✓				✓							✓		
18BT4156	Bioprocess Validation and cGMP	3	0	0	3	17BT2106	✓				✓							✓		
18BT4157	Food Technology	3	0	0	3	17BT2106		✓	✓											
18BT3259	PERL and Bioperl programming	3	0	0	3	17BT3110			✓	✓							✓			
18BT3260	Biomedical Informatics	3	0	0	3	17BT3110		✓			✓						✓			
18BT3261	Molecular Modelling and Drug Design	3	0	0	3	17BT3110		✓	✓								✓			
18BT3262	Structural Biology	3	0	0	3	17BT3110			✓	✓							✓			
18BT4158	Systems Biology	3	0	0	3	17BT3110	✓				✓									
18BT4159	Applied Bioinformatics	3	0	0	3	17BT3110			✓	✓							✓			
18BT4160	Python and R Programming	3	0	0	3	17BT3110	✓				✓									

18BT4161	Data Base Management System	3	0	0	3	17BT3110			✓	✓							✓			
18BT3263	Stem cell technology	3	0	0	3	17BT2015		✓						✓			✓			
18BT3264	Healthcare Biotechnology	3	0	0	3	17BT2015	✓				✓									
18BT3265	Cancer Biology	3	0	0	3	17BT2015		✓			✓	✓								
18BT3266	Neurobiology	3	0	0	3	17BT2015	✓				✓			✓						
18BT4162	Bioelectronics & Biosensors	3	0	0	3	17BT2015			✓			✓		✓						
18BT4163	Tissue Engineering	3	0	0	3	17BT2015			✓			✓		✓						
18BT4164	Virology	3	0	0	3	17BT2015			✓			✓								
18BT4165	Nanobiotechnology	3	0	0	3	17BT2015			✓			✓		✓						
OPEN ELECTIVE							**PO**												**PSO**	
Course code	**Course Name**	**L-T-P**			**Cr**	**Pre-Req.**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**1**	**2**
	Foreign Language	2	0	0	2	Nil														
	Management Elective	3	0	0	3	Nil														
	Open Elective -1	3	0	0	3	Nil	✓				✓						✓			
	Open Elective -2	3	0	0	3	Nil	✓				✓						✓			
	Open Elective -3	3	0	0	3	Nil	✓				✓						✓			
SKILLING							**PO**												**PSO**	

Course code	Course Name	L-T-P			Cr	Pre-Req.	1	2	3	4	5	6	7	8	9	10	11	12	1	2
17GN1204	Coding skills for Engineers	0	0	10	5	Nil	✓	✓												
17TS1001	Skilling for Engineers - 1 (Medical Coding)	0	0	8	2	Nil			✓		✓			✓						
17TS1002	Skilling for Engineers - 2 (Instrumentation)	0	0	8	2	Nil			✓		✓			✓						
17TS1003	Skilling for Engineers - 3 (Docking)	0	0	8	2	Nil	✓				✓									
17TS1004	Technical Proficiency & Training -1 (Genomics)	1	0	0	1	Nil	✓				✓									
17TS1005	Skilling for Engineers - 4 (Import & Export)	0	0	8	2	Nil	✓				✓									
17TS1006	Technical Proficiency & Training -2 (Bioprocessing)	1	0	0	1	Nil	✓				✓									
	Industrial Training	0	0	0	2	Nil	✓				✓									
15IE3247	Term Paper	0	0	4	2	Nil	✓				✓									
15IE4048/ 15IE4049	PRACTICE SCHOOL/PROJECT (Part-1)	0	0	24	6	Nil	✓				✓									
15IE4048/ 15IE4050	PRACTICE SCHOOL/PROJECT (Part-2)/INTERNSHIP	0	0	24	6	Nil	✓				✓									

BASIC ENGLISH

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Apply the practical knowledge of using action words in sentence construction.	10	3
CO 2	Apply and analyse the right kind of pronunciation with regards to speech sounds and able to get different types of pronunciations	10	3
CO 3	Apply the concept of fundamental principle of counting to solve the problems on linear, circular permutations and also for the problems on selections. Apply the concept of probability, while doing the problems on Leap year & Non-Leap year problems, coins, dice, balls and cards.	1	3
CO 4	Analyze the given conditions and finding out all the possible arrangements in linear & circular order. Analyze the given numbers or letters to find out the hidden analogy and apply that analogy to find solutions. Finding the odd man out by observing the principle which makes the others similar.	5	4

Syllabus:

Interactive Grammar: Action Words-Modifiers, Intensifiers, Connectives.
Sentence Skills: Tense, Voice, Case, Gender, Reported Speech, Syntax, Types of Sentences, Syntactic Ordering
Introduction to the Sounds of English: Basic English Sounds, Distinctive Sounds of English, Assimilation, Contraction, Elision, Twinning, Stress, Syllables, Word- stress, Tone and Intonation- Rising, Falling, Rise-fall and Fall-rise.

Language Laboratory Interactive: Esca talk, JAM, Ranking, Shrinking Story, Desperate Decision, Listening for Specifics, Pronunciation Practice.

Quantitative Aptitude: Permutations and Combinations, Probability

Reasoning: Number and Letter Analogy, Odd Man out, Analytical Reasoning-I

Reference Books:

1. Kerry Patterson, Joseph Grenny, Ron McMillan:Crucial Conversations: Tools for Talking When Stakes Are High.Switzler: Paperback – Animated, September 9, 2011.
2. Douglas Stone, Bruce Patton, Sheila Heen, and Roger Fisher :Difficult Conversations: How to Have Conversations that Matter the Most .Paperback – November 2, 2010
3. R.K. Bansal, J.B. Harrison: Spoken English. Delhi: Orient Black Swan.2009.
4. Language LaboratoryTeacher Manual, KLEFU

ENGLISH PROFICIENCY

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Apply the concepts of accurate English while writing and become equally at ease in using good vocabulary and language skills.	8, 9, 10	3
CO 2	Understand the importance of pronunciation and apply the same day to day conversation.	8, 9, 10	3
CO 3	Apply the concepts of Ratios, Percentages, Averages and Analysing the given information, a student is required to understand the given information and thereafter answer the given questions on the basis of comparative analysis of the data in the form of tabulation, bar graphs, pie charts, line graphs. Analyse the given data to find whether it is sufficient or not.	1, 4	3
CO 4	Apply the basic functionality of Clocks and Calendars to find the solutions for the problems. Analyze the given symbols to understand the hidden meaning of the given expression and finding the solutions. Analyze the given conditions and finding out all the possible arrangements in linear & circular order.	1, 5	4

Syllabus:

Writing Skills:How to Write a Definition, Defining Technical Terms**,**Product and Process Description. Advanced Grammar Skills**:** Transformation of sentences,Phrases,Clauses,Sentences—Simple, Compound, Complex Sentences,Concord,Lexis 1**:** Synonyms**,** Antonyms, Analogies, Sentence Equivalence-One-Word Substitutes.**Language Laboratory Interactives:** Debate, Blind-fold, Role Play, Situation Reaction Test**--**Build an Island nation. **Quantitative Aptitude**: Data Interpretation, Data Sufficiency. **Reasoning**:Symbols and Notations, Clocks and Calendars, Analytical Reasoning-II

Reference Books:

1. Dictionary of Technical Terms
2. Dr. Meenakshi Raman and Dr. Sangeetha Sarma: *Technical Communication*.Oxford University Press: Delhi.2016.
3. The Ultimate Verbal and Vocabulary Builder. Texas: Lighthouse Review.2000.
4. Rajeev Vasisth: *Interactive Vocabulary Drills*. New Delhi: Arihant Publications Limited. 2011.
5. Language LaboratoryTeacher Manual, KLEFU

PROFESSIONAL COMMUNICATION SKILLS

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Able to spot the common grammatical errors related to Sentence Structure, Preposition, Concord, Relative and Conditional Clauses, and Parallel Structures. The learner should be efficient to construct a context-determined text in addition to learning Technical Writing Skills. One should be enabled to use English Language efficiently in the written medium to communicate Personal as well as Professional.	9, 10	3
CO 2	Able to read, understand, and interpret a text intrinsically as well as extrinsically. The learner can browse a text quickly to come-up with a gist and personal interpretation. One is able to create a healthy work-environment and prove to be an asset or one of the most reliable resources to the Organization. As a professional, one is mature to bridge the gulf between the existing behavior/ lifestyle and the expected corporate behaviour cum lifestyle.	8	4
CO 3	Apply the concepts of Time and Work, the students will be able to solve the questions related to Men-Time-Work, problems based on wages, pipes and cisterns. Apply the concepts of Time and Distance and solve the problems related to average speed, relative speed, problems based on trains, boats, circular tracks, races and games.	1	3
CO 4	Apply Venn diagrams to the given statements to find out whether the given conclusions can be deducted from the given statements. Apply the logical implications and also the negations of various connectives to find the solutions. Analyze the given data and representing the data in the form of Venn Diagrams to find relations between any given set of elements.	1,5	3

Syllabus:

Grammarand Usage: Error Analysis.WritingSkills**:**Topic sentence, Linkers, Connectors and Transition, Paragraph Writing, Letter Writing. Reading Comprehension: Techniques, Skimming and Scanning, Vertical Reading, Reading Perception Tests (RPT): (Graphic) Reading Perception Tests (RPT), Semantic Interpretation of the Text, Reading Speed Enhancement.**Soft Skills**: Interpersonal Skills**,** AdjustingYour Attitude**-**Arrogance has no Place in the Workplace, Cultural Sensitivity in the Workplace**,** Corporate Culture: Learning How to Fit In.**Quantitative Aptitude:** Time and Work, Time and Distance. **Reasoning:** Deductions, Logical Connectives, Venn Diagrams.

Reference Books:

1. Gajendra Singh Chauhan and SmitaKashiramka. *Technical Communication.* Delhi*:*Cengage Learning India.2018.
2. Andrea Penruddocke and Christopher A. Warnasch.English for the Real World.USA:Living Language.2004
3. GeraldJ Alfred, Charles T Brusaw and Walter E.Oliu. *Hand Book of Technical Writing*. USA:Betford.2000.
4. Asher Cashdan: *Language, Reading and Learning*.Oxford:Basil Blackwell.1979.

ECOLOGY AND ENVIRONMENT

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand the importance of Environmental education and conservation of natural resources.	6	1
CO 2	Understand the importance of ecosystems and biodiversity.	12	1
CO 3	Apply the environmental science knowledge on solid waste management, disaster management and EIA process.	6	3

Syllabus:

The Multidisciplinary nature of Environmental Studies - Natural Resources- Forest resources - Mining its impact on environment - Water resources - Mineral resources-. Energy resources - Land resources- Soil erosion - Ecosystems - Biodiversity and its ConservationEnvironnemental Pollution - Soil waste management - Electronic waste management, biomedical waste management - Disaster management –.Environmental Legislation Environmental Impact Assessment Process.

Text Books:

1. Anubha Kaushik, C.P.Kaushik, “Environmental Studies” , New Age International, (2007).
2. Benny Joseph, “Environmental Studies”, Tata McGraw-Hill companies, New Delhi, (2009).

APTITUDE BUILDER –I

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Apply the concept of Critical Reading and Analytical Reading and comprehend the key ideas and gist of a passage. Understand the importance of the presentation skills, analyze the given topic, and apply various strategies and the principles of grammar in written expression.	5,6	3
CO 2	Apply the concepts of grammar, various strategies and the usage of formal language in written expression. By using synonyms rewrite the same text in the same format and meaning. Write the gist of the given text.	7,10	3
CO 3	Apply the concepts of Numbers to solve the problems related to divisibility rules, problems based on Unit's digit, Remainders, Successive Division, Prime Factorization, LCM & HCF problems. Apply the concepts of Averages &Alligations, students will be able to solve the problems related to Averages as well as problems based on Mixtures.	1, 5	3
CO 4	Apply the various concepts of cubes to find out how to cut a cube to get the maximum number of smaller identical pieces, how to minimize the number of cuts required to cut a cube into the given number of smaller identical pieces, how to count the number of smaller cubes which satisfy the given painting scheme. Apply the principles of binary logic to solve problems involving truth-tellers, liars and alternators. Analyze the given data to form an ordered arrangement from an unorganized raw data.	1, 5	4

Syllabus:

Directed Listening and Thinking Activity (DLTA) Skills:
Reading, Listening, Thinking,Writing, Presentation - Method: Flipped Classroom.
Writing Skills**:**Paraphrasing,Summarizing,Notice, Circular, Agenda, Minutes, Memo

Body Language (Kinesics) :Postures, gestures,eye contact
Self-confidence:Self-esteem
SoftSkills: The Art of Compromise, Learn to Say: "I Don't Know", Being organized, Showing Self-awareness,An eye on success, being self-motivated, Showing self-awareness, Find Direction from Someone Who Is Lost: "The Drifter"
Self-Assessment for Attainable Career Objectives--Defining a Career Objective

Quantitative Aptitude: Numbers,Averages andAlligations, Mensuration

Reasoning: Cubes, Binary Logic, Ordering and Sequencing

Reference Books:

1.Daniel G.Riordan and Steven E. Pauley: *Technical Report Writing Today*. New Delhi*:* Biztantra.2004.
2.Ken Taylor.*Telephoning and Teleconferencing Skills*. Hyderabad:Orient Black Swan.2008.
3.E. Suresh Kumar, B. Sandhya.*Communication for Professional Success.* Delhi: Orient Black Swan.2013
4*Reasoning Trainer Plus*.:Hyderabad:Brain Mapping Academy.2012

APTITUDE BUILDER-II

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Apply the strategies and techniques learnt in carrying out conversations in different contexts. Analyse the different parameters and formats of written technical communication and apply in everyday work and life.	8, 10	3
CO 2	Analyse the concepts of critical and analytical reading skills. Apply the strategies and techniques learnt in handling interviews in different contexts.	8, 10	3
CO 3	Apply the concepts of Ratio & Proportion, Percentages, Profit &Loss, Simple & Compound Interest, students will be able to solve the problems based on Ratios, problems involving Percentages, problems related to cost price, selling price, profit, loss, marked price and discounts, problems involving interest.	1, 5	3
CO 4	Analyze the given series of numbers to predict the next number in the series. Analyze the given set of numbers or letters to find the analogy. Analyze the given data to find the code which is used to encode a given word and use the same code in the process of decoding. Apply the given set of conditions to select a team from a group of members.	1	4

Syllabus:

Critical Reading: Reading to Identify the Theme**,** Reading to Identify the Central Idea**;** Reading to Identify the Tone, Reading to Identify Writer's Attitude, Reading to Identify Parallel Ideas,leading to Identify Logical Conclusions.Writing Skills**:**Note- making and Note-taking, Report Writing.Presentation Skills- Preparing for the Presentation, Audience Analysis, Processing Information, Ice-breakers, Quotations, Presentation Structure**,** Say what you want to say- Say it, Say what you have said to say**,** Preparing for Question Hour,Funnel Effect and How to Overcome it.**Trinity Guild Hall -** Communication Skills - Graded Evaluation and Testing- 1-8 grades. **Quantitative Aptitude**:Ratio andProportion, Percentages, Profit and Loss, Simple Interest and Compound Interest**Reasoning**:Number and Letter Series, Number and Letter Analogy, Coding and decoding, Odd man out. Selections.

Reference Books

1. Dr. Meenakshi Raman and Dr. Sangeetha Sarma: *Technical Communication*.Oxford University Press: Delhi.2016.
2. M. Ashraf Rizvi: *Effective Technical Communication.* New Delhi:McGraw Hill Education(India) Private Limited
3. Tom Rath: Strengths Finder2.0. New York:Gallup Press.2007.
4. C. Weaver. *Reading Process and Practice*. Portsmouth US: Heinemann Educational Bokks.1988.

CAMPUS TO CORPORATE

Mapping of Course outcomes with Program Outcomes:

CO No	Course outcome's	Mapped PO	BTL
CO 1	Analyzebasicconcepts ofcriticalandanalyticalreasoningskills applystrategies to analyzeissues,arguments and some aspects ofcorporate communication.	5,6,9	3
CO 2	Creativity in writing of any given context like sending Emails, Reports, Proposals etc. Make the student to face HR interviews.	7,8,10	4
CO 3	Apply the concepts of Arithmetic, the students enhance their problem solving skills which helps themto succeed in campus drives, grooming the younglearners into the corporate world.	1, 4, 5	3
CO 4	AnalyzethebasicconceptsofCriticalandAnalyticalReasoning inmeetingthechallengesoftheprofessionalworld.	1, 5	3

Syllabus:

Lexis -2: Vocabulary-Analogies–Advanced Level, Words often Confused, WordClassification,Idioms and Phrases, Sentence Completions, Paragraph Jumble.Writing Skills**–**Resume, Email Writing, Company Profile, Briefing and Debriefing, Press note, Catch Phrases, Caption Writing. **Critical Thinking**:Engineering Ethics through Case Analysis: Ford Pinto, Chernobyl, Hyatt Residency,Bhopal Gas Tragedy, Boys of Football Team-Rescue Operation from the ThanLuangCave in Thailand. **Interview Skills:**Personal Interview-Concept and Practice**,**Telephone-Etiquettes, Email-Etiquettes,Dress code and Grooming, Preparing Portfolio,Group Discussion**,** Mock Interviews, Unconventional HR questions. **SimulatedTesting:** Co-Cubes, E-Litmus and Amcat Practice, Infosys Placement Papers, Wipro Placement Papers, CTS and Accenture Paper Pattern

Reference Books

1.Ken Taylor. *Telephoning and Teleconferencing Skills*. Hyderabad: Orient Black Swan.2008.

2.E. Suresh Kumar, B. Sandhya.*Communication for Professional Success.* Delhi: Orient Black Swan.2013

3. Judith Verify: *Succeeding at Interview*. Mumbai: Viva Books Private Limited.2000

4. Norman L. Frigon, Sr.&Harry K.Jackson, Jr. *The Leader- Developing the Skills and Personal Qualities.* Mumbai*:* Magna Publishing Co Ltd.2000.

BASIC MATHEMATICS

Mapping of Course Outcomes (CO) to Program outcomes:

CONo	Course outcomes	Mapped PO	BTL
CO1	Apply knowledge of mathematics, fundamentals in biological science problems	**5**	**1**
CO2	Identify the formulas, for solving complex engineering problems in sciences.	**5, 11**	**1**

Syllabus:

Ordinary Differential Equations and its Applications: Practical approach to differential equations, First order differential equations, Variable separable method, linear equations, Bernoulli's equation. Models for the real world problems: Newton's Law of Cooling, Law of natural growth and decay. System of first order differential equations (Prey-Predator models). Applications on Chemical reactions. **Numerical solutions of first order ODE :** Taylor's series method, Euler's method, Runge- Kutta method of fourth order.**Second and High order differential Equations :**Linear differential equations of higher order with constant coefficients, complimentary function, particular integral, method of variation of parameters, **Laplace Transforms and its applications**: Motivation, Definition, Linearity property, Laplace transforms of elementary functions, Shifting theorem, Laplace transforms of periodic,. Inverse Laplace transforms of derivatives and integrals, Convolution theorem, Application of Laplace Transforms in solving ordinary differential equations. **Partial Differential Equations:** Formation of Partial differential equations, direct integration method, models of first order partial differential equations.

Text Books:

1. Differential equations and their applications, ZAFAR AHSAN, PHI, Second edition.
2. Advanced Engineering Mathematics (Tenth Edition), Erwin Kreyszig,John-Wiley publications

Reference Books:

1. Higher Engineering Mathematics, By Dr. B.S. Grewal. Publisher: Khanna, New Delhi.
2. Elementry Differential Equations, By W.E.Boyce and R. Diprima.
3. Applied numerical methods with MATLAB for engineers and scientists, Steven C. Chapra, third edition, Tata McGraw-hill edition, New Delhi.
4. Differential equations and Mathematical Biology by D.S.Johns,Michael plank,B.D.Sleeman: C.R.C press

FOUNDATIONS OF COMPUTATIONAL MATHEMATICS

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Identify the quantities of Real world problems by using the concepts of arithmetic.	1	2
CO 2	Computing the areas of regular and irregular solids of real world problems.	1	2
CO 3	Identifying the numbers by successive division also finding the solution of equations.	1	2
CO 4	Estimating the roots of an equations and find the unknown values from the data by numerical methods	1	2

SYLLABUS:

Foundations in Arithmetic Real world applications in the concepts of Ratio, Proportion, variation, percentages, profit & loss, time & distance, time & work

Practical applications of common solids, irregular solids Computation of areas, volumes and other characteristics of both regular and irregular solids including Triangles, quadrilaterals, polygons, cylinders, cones etc., and their application in various engineering problems.

Fundamentals of Mathematics Simple Equations, Quadratic Equations, Fractions & Decimals, Classification of numbers, Divisibility rules, factorization, Division & Successive division, finding unit digits,Remainders in divisions involving higher powers.

Numerical Methods Solution of equations by Iteration: Bisection method and Newton-Raphson method, Lagrange's interpolation method, Numerical integration and differentiation.

Prescribed Text Books

1. Basic Engineering Mathematics**,** John Bird, Fourth Edition, Elsevier.

Reference Text Books

1. Quantitative Aptitude, R. S. Aggarwal, Schand Publications.
2. Quantitative Aptitude - G. L. Barrons.
3. Quantitative Aptitude - Abhijit Guha, Mc Graw Hills.

LOGIC AND REASONING

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Understand how to use Venn diagrams to find the conclusion of statements, solve puzzles using binary logic.	1	**2**
CO 2	Understand to solve problems on clocks, calendars and problems on Non verbal reasoning.	1	**2**
CO 3	Understand the available models for Venn diagrams with given data, solve problems relating to cubes and number and letter series.	1	**2**
CO 4	Understand the techniques used to solve problems puzzles using analytical reasoning on coding and decoding and blood relations	1	**2**

SYLLABUS:

Deductions: Introduction, expressing different types of statements using venn diagram, Definition of complimentary pairs, finding the conclusions using venn diagrams for two and more statements.**Logical Connectives:** definition of simple statements, Definition of compound statement, finding the implications for compound statements.**Binary Logic:** Definition of truth teller, Definition of liar, definition of an alternator, solving problems using method of assumptions, solving analytical puzzles using binary logic.**Clocks**: Finding the angle when the time is given, finding the time when the angle is known, relation between Angle, Minute an hour's exceptional cases in clocks.**Calendar:** Definition of a leap year, finding the number of odd days, Framing the year code for centuries, finding the date of any random calendar date.**Non-verbal reasoning:** Identification of hidden rule set in the given set of pictures and using that rule set to predict the next course of action, series and completion of incomplete patterns.**Venn Diagrams:** Representing the given data in the form of a venn diagram, problems on venn diagrams with two sets, problems on venn diagrams with three sets, problems on venn diagrams with four sets.**Cubes:** Basics of a cube, Finding the minimum number of cuts when the number of identical pieces are given, Finding the maximum number of pieces when cuts are given , problems on painted cubes of same and different colors**Number and letter series:** coding using the same set of letters, coding using the different set of letters, coding into a number of comparison and elimination**Analytical reasoning puzzles:** problems on Linear arrangements, problems on circular arrangements.**Coding and decoding:** coding using same set of letters, coding using different set of letters, coding into a number comparison and elimination.**Blood relations:** Defining the various relations among the members of the family, solving Blood relation puzzles, solving the problems on blood relation using symbols and notations.

Text Books

1. A modern approach to Logical reasoning, R S Agarwal, S. Chand Publications.

Reference Text Books

1. Logical Reasoning, Arun Sharma, Mc Graw Hill.
2. Analytical & Logical Reasoning, Peeyush Bhardwaj, Arihant Publications.

SINGLE VARIABLE CALCULUS AND MATRIX ALGEBRA

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Model the physical laws and relations mathematically as a first order differential equations, solve by analytical and numerical methods also interpret the solution.	**1**	**3**
CO 2	Model physical laws and relations mathematically as a second/higher order differential equations, solve by analytical method and interpret the solution.	**1**	**3**
CO 3	Obtain the Fourier series expansions of periodic functions and use the series to solve ordinary differential equations.	**1**	**3**
CO 4	Model physical problems mathematically as a system of linear equations and solve them by analytical and numerical methods. Also, determine the nature of Quadratic form using Eigen values.	**1**	**3**

Syllabus:

Differential Equations: Definitions and terminology and mathematical models used in differential equations. First-order and higher-order differential equations, along with the methods of solutions and their applications. Modeling with first and higher-order also systems of linear first-order differential equations. Solutions of first order ordinary differential equations by Numerical methods. **Fourier series**: Definitions and Fourier series for a periodic signal. Fourier series for simple functions. Fourier series of the summation of sinusoids directly from the definition by using Euler's formula. Solving particular solution to differential equation by Fourier series. **Matrix algebra**: Solving linear System of equations by Gauss-elimination, L U decomposition and Jacobi, Gauss Seidal iteration methods, orthogonal, symmetric, skew-symmetric, Hermitian, Skew-Hermitian and unitary matrices, Eigen values, Eigen vectors and their properties, Cayley -Hamilton theorem (without proof) and its applications, and quadratic forms.

Text books:

1. Advanced Engineering Mathematics, Erwin Kreyszig. John Wiley & Sons, Inc. 10 th Edition.
2. Advanced Engineering Mathematics, Greenberg, PHI Publishers, 2nd Edition.

Reference Books:

1. Differential Equations for Engineers, Wei-Chau Xie, Cambridge University Press, New York. R1

2. Higher Engineering Mathematics, BS Grewal. Publisher: Khanna, New Delhi. R2

3. Advanced Numerical Methods with MATLAB, SC Chapra, Tata McGraw-Hill. R3

BIOSTATISTICS

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Construct the probability distribution of a random variable, based on a real-world situation, and use it to compute expectation and variance	1, 5	2
CO 2	Predict the relationship between two variables and construct the linear and non-linear regression lines for the given data	1, 5	2
CO 3	Apply statistical tests for large and small samples to test the hypothesis.	1, 5	2
CO 4	Testing the hypothesis to analyze the variance by applying suitable design.	1, 5	2

Syllabus:

Probability and Random variables: Definitions of probability, Sample space, Axioms of probability, Conditional probability, Addition, Multiplication and Bayes' theorem. Random variables, Joint and marginal probabilities, Mathematical expectation. **Standard discrete and continuous distributions**: Definitions and simple properties of Binomial, Poisson, Geometric, Hyper-Geometric, Uniform, Exponential, Weibull and Normal distributions, Applications of the above distributions.**Correlation and Regression**: Correlation coefficient for grouped and ungrouped data, Rank correlation. Linear and Non-Linear Regression. **Tests of Hypothesis**: Sampling distributions- Point and interval estimation. Confidence limits for interval of mean and standard deviation. Small sample tests - Test for mean, variance using t, chi-square and F distributions. Chi-square test for independence of attributes and goodness of fit. Large sample tests-Test for mean with known and unknown standard deviation and test for standard deviation.

Analysis of Variance: General principles, Completely randomized design, Randomized block designs and Latin square design.

Text Books:

1. Richard A Johnson, "Miller & Freund's Probability and Statistics for Engineers", PHI, New Delhi, 11th Edition (2011).

Reference Books:

1. Ronald E. Walpole, Sharon L. Myers, Keying Ye, "Probability and Statistics for Engineers and Scientists", 8th Edition Pearson Pub.
2. S C Gupta and V K Kapoor, "Fundamentals of Mathematical Statistics", 11th Edition ,S Chand & Sons, New Delhi.

BIOLOGY FOR ENGINEERS

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Understand the basis of Life, Living organisms and human body systems	H, J	1
CO 2	Understand the importance of Diet and Nutrition	H, J	1
CO 3	Acquire the knowledge of beneficial and harmful Microorganisms and Biosensors	H, J	1

SYLLABUS

BASIC BIOLOGY: Introduction, Living organisms, Cell structure and Organelles, Organogenesis, Human Anatomy, **Systems of Life:** Digestion, Respiration, Circulation, Excretion, Reproduction, Thinking and coordination and Defense, **Diet and Nutrition:** Macro (Carbohydrates, proteins, lipids) - and Micronutrients (vitamins), Essential minerals and their role; deficiency symptoms; and their role; deficiency symptoms. **Microorganisms:** Classification of Microorganisms,beneficial and harmful effects of Bacteria, Fungi and Viruses. **Biosensors,** biomechanics and Medical Imaging technology, Applications of Biosensor in Food and Agriculture.

Books:

1. Advanced Biotechnology; Dr RC Dubey; S Chand Publications.
2. Elements of Biotechnology; P K Gupta; RASTOGI Publications.

PROBLEM SOLVING AND COMPUTER PROGRAMMING

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO1	Illustrate how problems are solved using computers and programming.	1	2
CO2	Interpret & Illustrate user defined C functions and different operations on list of data.	1	2
CO3	Implement Linear Data Structures and compare them.	5	2
CO4	Implement Binary Trees.	5	2
CO5	Apply the knowledge obtained by the course to solve real world problems.	11	2

Syllabus:-

Introduction to C language, Control structures, Functions, recursive functions**.**Storage classes and scope of variables. **Arrays-** passing arrays as parameters to functions. **Searching-** linear search, binary search, **Sorting-** Bubble sort, quick sort. Strings, operations on strings and Multidimensional arrays. Pointers, call by value Vs call by reference. Structures and Unions. Dynamic memory allocation. **Stack and Queue-** implementation of Stack, Queue, circular Queue. Infix, post-fix and prefix notations, Stack Applications -Evaluation of infix expression, conversion of infix to post-fix expressions using stacks. **Linked List-** Linked List vs Arrays, Creation, insertion, deletion of Singly linked list, Doubly linked list and Circular linked list. Linked list representation of Stack and Queues. **Trees-** Tree, Binary trees, Binary search tree: - Creation, Insertion, Deletion and Tree traversals.

Text Books:

1. Brian W. Kernighan, Dennis M. Ritchie, "The C Programming Language: ANSI C Version", 2/e, Prentice-Hall/Pearson Education-2005.
2. E. Balagurusamy , **"**Programming in ANSI C" 4th ed.,Tata McGraw-Hill Education, 2008 .
3. R. F. Gilberg, B. A. Forouzan, "Data Structures", 2nd Edition, Thomson India Edition-2005.

Reference Books:-

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2008, Third Edition, Pearson Education.
2. Horowitz, Sahni, Anderson Freed, "Fundamentals of Datastructures in C", 2nd Edition-2007.
3. Robert Kruse, C. L. Tondo, Bruce Leung, Shashi Mogalla, "Data structures and Program Design in C", 4th Edition-2007.
4. C for Engineers and Scientists – An Interpretive Approach by Harry H. Cheng, Mc Graw Hill International Edition-2010.
5. Jeri R. Hanly, Elliot B. Koffman, "Problem Solving and Program Design in C", 7/e, Pearson Education-2004.
6. Jean Paul Trembly Paul G.Sorenson, "An Introduction to Data Structures with applications", 2nd Edition.

ENGINEERING CHEMISTRY

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO 1	Describe some important design considerations in choosing a battery for a specific application.	1,3,7	2
CO 2	Predict potential complications from combining various chemicals or metals in an engineering setting	1,3	2
CO 3	Examine water quality and select appropriate purification technique for intended problem	1,7	2
CO 4	Explain the role of chemical kinetics in the formation and destruction of ozone in the atmosphere and predict the connection between molecular behavior and observable physical properties.	1,7	2
CO 5	An ability to analyze & generate experimental skills	1,4	3

SYLLABUS:

Energy and Chemistry: Energy Use and the World Economy, Defining Energy, Energy Transformation and Conservation of Energy, Heat Capacity and Calorimetry. Enthalpy, Hess's Law and Heats of Reaction, Energy and Stoichiometry. **Electro Chemistry:** Single electrode potential and its measurement, Electrochemical cells, EMF series, Nernst equation, Cell emf measurement, Reversible and irreversible cells, Concentration cells, Reference electrodes--Determination of pH using glass electrode. Gas Sensors: Capacitance Manometer and Mass Spectrometer. **Batteries:** Chemistry, construction and engineering aspects of Primary (mercury battery) and secondary (lead-Acid cell, Ni-Metal hydride cell, Lithium cells) and fuel cells– Hydrogen–Oxygen fuel cell, advantages of fuel cell. **Corrosion:** Causes and different types of corrosion and effects of corrosion. Theories of corrosion– Chemical, Electrochemical corrosion, Pitting corrosion, stress corrosion, Galvanic corrosion.Factors affecting corrosion– Nature of metal, galvanic series, over voltage, purity of metal, nature of oxide film, nature of corrosion product. Nature of environment- effect of temperature, effect of pH, Humidity, effect of oxidant. Cathodic protection, sacrificial anode, impressed current cathode, electroplating.**Water Chemistry**: Introduction, *Hardness:*Causes, expression of hardness – units – types of hardness, estimation of temporary and permanent hardness of water, numerical problems. Alkalinity and estimation of alkalinity of water, numerical problems. ***Boiler troubles*** – Scale & sludge formation, caustic embrittlement, Boiler corrosion, priming & foaming. **Softening of water**: Internal and external treatments -Lime soda, Ion exchange process. **Desalination-**reverse osmosis and electro dialysis.**Chemical Kinetics**: Ozone Depletion, Rates of Chemical Reactions, Rate Laws and theConcentration Dependence of Rates, Integrated Rate Laws, Temperature and Kinetics, Reaction Mechanisms, Catalysis, insight into Troposphere Ozone.**Molecules and Materials: polymers-** Types of polymerization-Mechanisms, Plastics – Thermoplastic resins and thermosetting resins - Preparation, properties and engineering applications of: polyethylene, PVC, Teflon, Bakelite, Urea Formaldehyde. Conducting Polymers: Polyacetylene, polyaniline, conduction, doping and applications. Carbon nano tubes and Applications.

Text Books:

1. EngineeringChemistry,Jain&Jain,DhanpatRaiPublishingCompany.NewDelhi.
2. Engineering Chemistry, O G Palanna, The Tata McGraw Hill, NewDelhi.

Reference Books:

1. ChemistryinEngineeringandTechnology,Volume2,JCKuriacose&JRajaram,TataMcGraw Hill,NewDelhi.
2. Chemistry for Engineers Rajesh Agnihotri, Wiley, NewDelhi.
3. EngineeringChemistry,B.Sivasankar,TheTataMcGrawHill,NewDelhi.
4. AtextbookofEngineeringChemistry,ShashiChawla,DhanpatRai&Co.NewDelhi.
5. Engineering Chemistry, C Parameswara Murthy, C V Agarwal and Andra Naidu, B S Publications,Hyderabad.
6. Engineering Chemistry, Shikha Agarwal, Cambridge University Press.

ENGINEERING GRAPHICS & DESIGN FOR BIOTECHNOLOGISTS

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
1	Describe some important design considerations in choosing a graphics for a specific application.	1,3,7	2
2	Acquire knowledge on orthographic projection	1,3	2
3	Examine projections of planes and solids	1,7	2
4	Explain the role of curves and sections	1,7	2
5	Analyze & generate experimental skills	1,4	3

Syllabus:

Introduction to Engineering Drawing : Principles of Engineering Graphics and their significance – Drawing Instruments and their Use- Conventions in Drawing – Lettering – Geometric Constructions – Scales: Plain and Vernier scales

Orthographic Projection in First Angle Projection: Principles of Orthographic Projections- conventions- First and Third Angle, Projections of Points and Lines inclined to both planes, True lengths, traces.

Projections of Planes & Solids: Projections of regular planes inclined to both planes. Projections of Regular solids inclined to one plane

Sections and Sectional Views:-Right Regular Solids - Prism, Cylinder, Pyramid, Cone

Engineering Curves used in Engineering Practice & their Constructions:

Conic Sections: Ellipse, Parabola, Hyperbola and Rectangular Hyperbola – oblong, concentric method

Special Curves: Cycloid, Epicycloid, Hypocycloid and Involute

Developments of solids: Development of surfaces of right regular solids – Prisms, Cylinder, Pyramid cone and their parts

Isometric Projections: Principles of Isometric Projection- Isometric Scale- Isometric view conventions- Isometric View of Lines, Plane Figures, simple problems

Transformation of Projections: Conversion of Isometric Views to Orthographic Views – Conventions

Introduction of Computer Graphics covering & Customisation & CAD Drawing

Demonstrating knowledge of the theory of CAD software, Drawing Area, Dialog boxes and windows, Shortcut menus, Command Line, Status Bar, Different methods of zoom, erase objects. scale settings,applying dimensions to objects and annotate; use of Layers, Create, edit and use customized layers.

Process flow and production Diagrams

Equipment symbols, Flow sheet symbols for detailed equipment and processes; Process flow diagrams for - thermochemical conversion of biomass to ethanol, - ionoSolv process, - ethanol purification process, - biodiesel production, - single cell oil production, - Penicillin production, - Amylase enzyme production

Text Books:

1. Engineering Drawing, N.D.Bhat/ Charotar
2. Engineering Drawing ,N.S.Parthasarathy,VelaMurali
3. Thermo chemical Conversion of Biomass to Liquid Fuels and Chemicals, Mark Crocker
4. Advances in Biodiesel Production: Processes and Technologies, R Luque, J A Melero

Reference Books:

1. Shah, M.B. & Rana B.C. (2008), Engineering Drawing and Computer Graphics, Pearson Education
2. Agrawal B. & Agrawal C. M. (2012), Engineering Graphics, TMH Publication
3. (Corresponding set of) CAD Software Theory and User Manuals
4. Basic Biotechnology, edited by Colin Ratledge, Bjorn Kristiansen

DATA STRUCTURES

Mapping of Course Outcomes (CO) to Program outcomes:

CO No	Course outcomes	Mapped PO	BTL
CO1	Apply measures of efficiency on algorithms and Analyze different Sorting Algorithms.	PO1, PO2, PSO1,PSO2	4
CO2	Analyze and compare stack ADT and queue ADT implementations using linked list and applications.	PO1, PO4, PSO1,PSO2	4
CO3	Analyze the linked implementation of Binary, Balanced Trees and different Hashing techniques.	PO1, PO4, PSO1,PSO2	4
CO4	Analyze different representations, traversals, applications of Graphs and Heap organization.	PO2, PO4, PSO1,PSO2	4
CO5	Develop and Evaluate common practical applications for linear and non linear data structures.	PO1, PO2, PSO1,PSO2	5

Syllabus:

Algorithm Analysis: Mathematical Background, Model, Analyze, Running Time Calculations, Lists**. Stacks and Queues:** Abstract Data Types (ADTs), The List ADT, The Stack ADT, The Queue ADT. **Trees:** Preliminaries, Binary Trees, The Search Tree ADT—Binary Search Trees, AVL Trees, Splay Trees, Tree Traversals (Revisited), B-Trees, Red black trees. **Hashing:** General Idea, Hash Function, Separate Chaining, Hash Tables without Linked Lists, Rehashing, Hash Tables in the Standard Library, Extendible Hashing. **Priority Queues (Heaps):** Model, Simple Implementations, Binary Heap, Applications of Priority Queues. **Sorting:** Preliminaries, Insertion Sort, A Lower Bound for Simple Sorting Algorithms, Shell sort, Heap sort, Merge sort, Quick sort, Indirect Sorting, A General Lower Bound for Sorting, Bucket Sort, External Sorting.**Graph Algorithms:** Definitions, Topological Sort, Shortest-Path Algorithms, Minimum Spanning Tree.

Text Books:

1. Mark Allen Weiss, Data Structures and Algorithm Analysis in C, 2010 , Second Edition, Pearson Education.
2. Ellis Horowitz, Fundamentals of Data Structures in C: Second Edition, 2015

Reference Books:

1. A.V.Aho, J. E. Hopcroft, and J. D. Ullman, “Data Structures And Algorithms”, Pearson Education, First Edition Reprint 2003.
2. Horowitz, Sahni, Anderson Freed, “Fundamentals of datastructures in C” , Second Edition-2007.
3. R. F. Gilberg, B. A. Forouzan, “Data Structures”, Second Edition, Thomson India Ed ition, 2005

4. Robert Kruse, C.L. Tondo, Bruce Leung, Shashi Mogalla, "Data Structures & Program Design in C", Fourth Edition-2007.

Lab Experiments:

1. Develop a set of programs to implement Linear and Binary searching techniques(both iterative and recursive)
2. Develop a set of programs to find the solution for the maximum subsequence sum problem with different time complexity solutions.
3. Develop a set of programs to implement below sorting techniques
    - Insertion Sort
    - Shell sort
    - Selection Sort
4. Develop a set of programs to implement below sorting techniques(Divide and conquer method)
    - Quick sort with median of three.
    - Merge Sort
5. Develop a Program to implement operations of doubly linked list
    - Create
    - Insert
    - Display
    - Delete
    - Search
6. Develop a program to perform operation on stack using linked list
7. Develop a program to perform operations on queue using linked list
8. Develop a program to implement Circular Queue using Array
9. Develop a program to implement Binary Search Tree with Traversal Operations
10. Develop a program to perform following operations on AVL tree
    a. Insertion
    b. Deletion
11. Develop a program to implement the following
    a. Separate chaining for collision handling
    b. Open Addressing Technique
12. Develop a program to implement Heap sort
13. Develop a program to implement
    a. Breadth First Search
    b. Depth First Search
    c. Dijkstra's Algorithm
14. Program to implement Minimal Spanning by
    a. Prim's algorithm
    b. Kruskal's algorithm

WORKSHOP PRACTICE FOR BIOTECHNOLOGISTS

1. Square fit
2. L-fit
3. Plus Joint
4. Lap T Joint
5. Tinsmithy-plain pipe& pipe –T-joint
6. House wiring-staircase&godown.

7. Drilling operation
8. Sand casting
9. Preparation of butt joint using arc welding.
10. Face & Plane turning operation

BT Specific

1. Conductive measurement in water using probe
2. Measurement of dissolved oxygen in water using sensor
3. Preparation of Buffers and measurement of PH
4. Sterilization Techniques (Autoclave and Laminar Flow)
5. Biochemical estimation of DNA /RNA/Protein using spectrophotometer
6. Estimation of DNA/RNA/Protein using Nanodrop
7. Role of web search engines for gene detection
8. Demonstration on Microscope
9. Workshop on Cell culture Instrumentation
10. Development of paper based capacitive sensor for the detection of Vitamins

ENGINEERING PHYSICS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Understands structure of crystalline solids, kinds of crystal imperfections and appreciates structure-property relationship in crystals.	PO1	2
CO2	Understands the deformation of materials in response to action of load, for identification of materials having specific engineering applications.	PO1	2
CO3	Understands the motion of electrons in microscopic level	PO1	2
CO4	Understand the properties of light and engineering applications of lasers	PO1	2
CO5	Apply the knowledge on structure and properties of materials while executing related experiments and develop some inter disciplinary projects	PO1	3

SYLLABUS:

Crystal Physics: Space lattice, basis, unit cell, Seven Crystal systems, Bravais lattice system, Crystal directions – Planes and Miller indices – Crystal parameters (for SC, BCC and FCC), Diffraction of X-rays by crystal planes – powder photograph method – Imperfections in crystals.**Mechanical properties of solids:** Stress-strain relationship – Hooke's law, Stress-strain diagram for various engineering materials – Ductile and brittle materials – Mechanical properties of Engineering materials (Tensile strength, Hardness, Fatigue, Impact strength, Creep) – Fracture.**Quantum mechanics:** Inadequacies of Classical Mechanics – Duality nature of electromagnetic radiation – De Broglie hypothesis for matter waves – Heisenberg's uncertainty principle –Schrödinger's wave equation – Particle confinement in 1D box (Infinite Square well potential). **Lasers and Fiber Optics:** Characteristics of Lasers – Lasing action – Working principle and components of Ruby, He-Ne laser, Applications. **Fiber Optics:** Principle of Optical fiber – Acceptance angle and acceptance cone – Numerical aperture –Types of optical fibers (Material, Refractive index and mode) – Fiber optic communication – Fiber optic sensors.

Text Books:

1. Callister William D., Material Science and Engineering - An Intoduction,. 6th edition, 2007, Wiley India Pvt.Ltd, ISBN-13: 978-0470556733.
2. Arthur Beiser, Perspectives of Modern Physics - McGraw-Hill, 1968- Science. ISBN 0-07-115096-X.
3. Thyagarajan. K., Ajoy Ghatak, Lasers**:** Fundamentals and Applications, 2nd edition, ISBN -13-9781441964410.

Reference Books:

1. Kittel. C, Solid State Physics, Wiley student 8th edition, *ISBN*: 978-0-471-41526-8.
2. Irving h. Shames, Cozzarelli. Francis A., Taylor & Francis group, Elastic and Inelastic Stress Analysis, *ISBN* 10: 0132454653.
3. Dekkar. A.J, Solid State Physics, Macmillan publishers, *ISBN* : 0333918339.

PROCESS ENGINEERING PRINCIPLES

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Describe the engineering calculations in Bioprocess Technology principles.	1	1,2
CO2	Employ the basic principles of ideal gas law for measuring no. of moles of various solutions	1	1,2
CO3	Employ the basic principles of material balance of a various reaction systems and Estimate the chemical and microbial kinetic parameters for better biomass and product formation e	1	1,2
CO4	Employ the basic principles of Energy balance of a various reaction systems and Estimate the chemical and microbial kinetic parameters for better biomass and product formation	1	1,2

Syllabus

Introduction to Engineering CalculationsPhysical variables; dimensions and Units; Measurement conventions: Density, specific gravity; specific volume, mole, chemical composition, vaporpressures,concentration,Stiochiometry.compositionofmixturesand solutions: molarity, molality, normality, weight fractions, mole fractions ,volumetric compositionlawsofchemicalcombinationIdeal gasesIdealgaslaw,differencesbetween idealandrealgases,applicationofidealgaslaw,Daltonslawofadditivepressures,amagats lawofadditive volumes,volumechangeswithchangein composition,purecomponent volume method,partialpressuremethod,gasesin chemicalreactions. Materialbalances Introductiontosystemandprocess;differencebetweensteadystateandequilibrium,Lawof conservationofmass:Typesofmaterialbalances,Procedure formaterialbalancecalculations with and without chemical reactions, yield, conversion, limiting and excess reactants. EnergybalancesBasicEnergyconcepts:lawofconservationofenergy,standardheatof formation,standardheatofreaction.latentheatofvaporizationand condensation,specific heat,sensibleheatofformation,heatofreaction,heatofcombustion Hess's law,effectof temperature and pressureon heat of reaction, kirchooff's law; Materialandenergybalances incellculture. Material balancefor continuous filtration, batch mixing, material balances with recycle, bypass and purgestreams. Energybalanceworked examples without reaction: coolingin downstream processing, continuous waterheater, and fermentation energybalance.

Reference books

1)Bioprocess EngineeringPrinciples, PaulineM.Doran, ELSEVIER publications.
2)Introduction to Biochemical Engineering, D GRao, McGraw Hill publications.
3)Bioprocess Engineering, basicconcepts, MichaelL.ShulerFikret Kar

BIOCHEMICAL THERMODYNAMICS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO 1	Acquire the knowledge of terminology and zeroth, first laws of thermodynamics.	1	1
CO 2	Determine entropy changes and apply second law of thermodynamics.	11	2
CO 3	Compute thermodynamic properties for fluids.	2	3
CO 4	Apply chemical engineering thermodynamics to phase and reaction equilibria and design thermodynamic models for microbial growth.	2	2

Syllabus :

Basic concepts -Systems and Processes, Homogeneous and Heterogeneous systems, Closed and Open systems, intensive and extensive properties state &n path functions, equilibrium state and phase rule, zeroth law of thermodynamics, heat reservoirs & heat engines reversible & irreversible process, internal energy enthalpy first law of thermodynamics and its limitations, P.V.T. Behavior of pure fluids, equation of state, Joule Thomson coefficient. Processes involving ideal gasses: constant Volume process, adiabatic process, polytropic process. Equation of state for real gases: Van der equation, redlich-kwong equation, redlick kwong-soave equation, virial equation.**Second law of thermodynamics** -General statement of II Law of thermodynamics, entropy & Heat, entropy &Temperature, the carnot principle, calculation of entropy changes, process involving ideal gases, adiabatic mixing process, Applications of the law of thermodynamics: Flow processes continuity equation, energy equation, Bernoulli's equation, steam ejector, joule-Thomson expansion, refrigeration, coefficient of performance, carnot cycle and limitations, liquefaction process, Linde process for gas liquefaction. **Thermodynamic properties of fluids -**Classification, work function, Gibbs free energy, fundamental property relations, maxevells equations classics-clapeyson equation, entropy-heat capacity relationships, Fugacity, standard state of Fugacity, fugacity coefficient, effect of temperature & pressure on fugacity,. Activity, effect of temp and pressure on activity. Properties of solutions: Partial molar properties and properties of solution, chemical potential, effect of temp & pressure on chemical potential fugacity in solutions, Lewis randall rule, Henry's law and dilute solutions, activity in solutions, activity coefficient, effect of pressure and temperature on activity coefficient. **Phase equilibria -** Criteria of phase equilibrium, phase equilibria in single and multi component systems, phase rule for non reacting systems, VLE, phase diagram for binary solutions, equilibrium diagrams, constant temperature equilibrium, Non-ideal solutions: Azeotrope, minimum & maximum B.P.azeotropes;Liquid-liquid equilibrium diagrams-binary liquid-liquid equilibria, Chemical reactions equilibria: Reaction stoichiometry, reaction coordination, criteria of chemical reaction equilibrium, equilibrium constant, equilibrium constant and standard free energy change, effect of temperature on equilibrium constant, **Biochemical thermodynamics-**Stoichiometry and energetic analysis of Cell Growth and Product Formation. Elemental balances, degrees of reduction of substrate and biomass , available electron balances, yield Coefficients of biomass and Product formation , Maximum possible yield. Thermodynamics of microbial growth.

Text books:

1. K.V.Narayanan," A text book of chemical engineering thermodynamics",edition, Phi learning (2009)

2.J.M.Smith, H.C.Vanness&Abbott, " Introduction to chemical engineering thermodynamics",edition, Mcgraw Hill Higher Education (2001-05-01)

Reference books:

1.Vern Schramm,"Methods In Enzymology, Volume 308 - Enzyme Kinetics And Mechanisms, Part E, Energetics Of Enzyme Catalysis, (Hardcover) ", Publisher: Elsevier (1999).

INDIAN CONSTITUTION

Syllabus:

Making of the Constitution: A brief analysis of National Movement. Constitutional Development with reference to Government of India Act 1909, 1919, 1935 and Indian Independence Act 1947. The Constituent Assembly of India.

Basic features of the Indian Constitution: the Preamble,Fundamental Rights,Directive Principles of State Policy – Fundamental Duties

Government of the Union : The Union Executive – the President and the Vice-President – The Council of Ministers and the Prime Minister – Powers and functions, The Union legislature – The Parliament – The Lok Sabha and the Rajya Sabha, Composition, powers and functions – the role of the Speaker.

Government of the State : The Governor – the Council of Ministers and the Chief Minister – Powers and Functions, The State Legislature – composition, powers and functions.

The Indian Judicial System: the Supreme Court and the High Courts – composition, Jurisdiction and functions, Judicial review, Judicial activism, Independence of Judiciary In India.

Election Commission: Role and Functioning, Chief Election Commissioner and Election Commissioners

Reference Books:

1. Indian Polity' by Laxmikanth
2. Indian Administration' by Subhash Kashyap
3. 'Indian Constitution' by D.D. Basu
4. 'Indian Administration' by Avasti and Avasti
5. 'Constitutional Law of India' by Seervai H.M.
6. 'Constitution Of India' by Shukla V.N.
7. 'The Indian Constitution: Cornerstone of a Nation' by Granville Austiin
8. 'Indian Constitutional Law' by M.P. Jain

TRANSPORT PHENOMENA IN BIOPROCESSES

Mapping of Course outcomes with program outcomes:

CO No.	Course Outcome	Mapped PO	B T L
CO 1	Understand principles of Momentum Transfer	1	2
CO 2	Understand principles of Heat Transfer	11	2
CO 3	Understand principles of Mass Transfer	2	2
CO 4	Apply unit operations of Momentum, heat and mass transfer in bioprocess	2	3

Introduction to Transport Phenomena – momentum, heat and mass transfer in bioprocessing. Momentum Transfer – Conservation of Mass, Conservation of Energy, Momentum Balance – Momentum Balance in a Circular Pipe, Flow Velocity Profile, Reynolds Experiment, Bernoulli's theorem, Hydrodynamic methods- orifice and venturimeter, weirs, Rotameters. Fermentation Broth Rheology – Viscosity, Rheological Properties of Fermentation Broths, Factors affecting broth viscosity. Heat Transfer – Various Modes of heat transfer, viz., conduction convection and radiation. Calculation of Heat-Transfer Coefficients. Application of heat transfer in Bioprocessing. Heat Management in Bioreactors, Relationship between heat transfer, cell concentration and stirring conditions. Mass Transfer – Diffusivity, theory of diffusion, analogy between mass, heat and momentum transfer, role of diffusion in bioprocessing. Definition of binary mass transfer coefficients. Convective mass transfer – Liquid-solid, liquid-liquid, gas-liquid mass transfers. Oxygen transport to microbial cultures – Gas liquid mass transfer fundamentals. Oxygen requirement of microbial cultures. Oxygen transfer by aeration and agitation. Determination of oxygen mass transfer coefficient by various methods. Evaporation of Biological materials- Introduction and properties; Adsorption – Types, nature of adsorbents, adsorption isotherms; Extraction- Liquid equilibria; Drying- Drying equilibria, terms, mechanisms; Crystallization- crystal geometry, rate of nucleation, crystal growth.

Text Books:

1. Arthur T. Johnson, Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems, John Wiley and Sons, 1998.
2. Pauline M. Doran, Bioprocess Engineering Principles, Academic Press, 1995.

Reference Books:

1. Christie J. Geankoplis, Transport processes and Unit Operations, Prentice-Hall International, Inc, 1993.
2. Blanch H.W and Douglas S. C, Biochemical Engineering, CRC Press, 1997.

TRANSPORT PHENOMENA IN BIOPROCESSES – LABORATORY

1. Determination of Type of flow- Reynold's experiment
2. Bernoulli's experiment
3. Determinationofcoefficient of discharge for Orifice meter
4. Determinationofcoefficient of discharge for Venturi meter
5. Composite wall apparatus
6. Heat transfer through lagged pipe apparatus
7. Heat transfer by natural convection
8. Heat transfer by forced convection
9. Diffusion of organic vapor in air
10. Single & multi stage liquid extraction
11. Adsorption
12. Crystallization

Text Book:

1. Arthur T. Johnson, Biological Process Engineering: An Analogical Approach to Fluid Flow, Heat Transfer, and Mass Transfer Applied to Biological Systems, John Wiley and Sons, 1998.

INDIAN HERITAGE & CULTURE

Introduction-Concept of Culture-Culture and Civilization-General Characteristics of Indian Culture-Importance of Culture-Unity in Diversity

History and Culture through the Ages – Fundamental Unity of Harappan and Vedic Culture – Jainism and Buddhism-Mauryan Period-Post-Mauryan Period-Gupta Period-Pallavas and Cholas

Advent of Islam in India-Islam and Sufism-Islamic Art and Architecture-Bhakti Movement-Vijayanagar Period-Art and Architecture and Literature

Rise of the West and its impact on India-Social and Religious reformers in the 18^{th} and 19^{th} centuries-Press and growth of modern Indian literature-Rise of Indian Cinema-Indian Independence

Reference Books:

1. Facets of Indian Culture- Spectrum Publications
2. Ancient India: National Council of Educational Research and Training
3. Medieval India: Part I & Part II: National Council of Educational Research and Training.
4. Modern India: National Council of Educational Research and Training.
5. An Advance History of India: R.C. Majumdar, H.C. Raychaudhuri & Kalikinkar Datt: Macmillan India Ltd.
6. The Wonder that was India: A.L.Bhasham.

CELL BIOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of cell and Nuclear Organization	1	2
CO 2	Compare Cell division and cell cycle	1	2
CO 3	Acquire the knowledge of tissues and Receptors	4	2
CO 4	Understand membrane Structure	1	2
CO 5	transport mechanisms	6	2

SYLLABUS:

Introductory cell- What are microorganisms? Differences between Eukaryotic and prokaryotic organisms. Structure and function of Prokaryotic and Eukaryotic cell – bacterial cell, plant cell, animal cell, Cyanobacterial cell. Cell organelles – plasma membrane, mitochondria, Golgi complex, E.R, Lysosomes, Ribosomes. **Membrane Structure and Transport-** The structural and functional organization of cell membrane, the extra cellular matrix of eukaryote's cell wall. Transport across cell membrane - passive and active transport, Na-K pump, Ca^{2+} ATPase pumps, Lysosomal and Vacuolar membrane ATP dependent proton pumps, Co-transport into prokaryotic cells, endocytosis, exocytosis, pinocytosis and phagocytosis. **Nuclear Organization-** Nuclear ingredients – Nuclear membrane, Nature of the genetic material, Nucleoproteins. Packaging of genetic material, Nucleosome model, Organization of Chromatin, Chromosome. Cytoskeleton – Microtubules, microfilaments. **Cell division and cell cycle-** Cell Division: Mitosis and Meiosis. Steps in cell cycle, Go-G1 transition, cell cycle check points, Chromosome movements, regulation of cell division. Cell differentiation: cortical Differentiation, nuclear differentiation and cell death. **Tissues & Receptors-** Meristems, Simple, complex and special tissues. Growth patterns, Cell growth and mechanisms. Embryonicdevelopment, Organogenesis, metamorphosis, Cell signaling–Membrane receptors, Cell – Cell interactions.

Text books:

1. P.S. Verma and V.K. Agarwal,"Cell biology, Genetic, Molecular Biology, Evolution and Ecology" edition, S. Chand and Company Ltd.
2. George H fried, "Biology scham series", edition, Mc Graw Hill.

Reference Books:

1. EDP Roberties & EMF Roberties ,"Cell Biology & Molecular Biology" Sauder College.
2. G P Talwar and L.M. Srivatsava ,"Textbook of Biochemistry and Human biology ",Eastern Economy Edition.

BIOCHEMISTRY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	B T L
CO1	Understand the functions and properties of biomolecules (carbohydrates, nucleic acids, proteins, lipids) in biological systems.	2	1
CO2	Understand the organization and biochemical reactions of biomolecules	2	1
CO3	Understand the importance of various metabolic pathways	2	1
CO4	Understand the importance of various biosignaling in biological systems	2	1
CO5	Perform techniques used in biochemistry to address biochemical problems	2	1,2

SYLLABUS:

Carbohydrates: Introduction to biomolecules; types of linkages/bonds; importance of biomolecules; Classification, structure and functions of monosaccharides (glyceraldehyde, ribose, glucose, galactose and fructose), disaccharides (maltose, lactose and sucrose); polysaccharides (starch, cellulose, glycogen) and heteropolysaccharides (hyaluronic acid and chondroitin sulfate). **Aminoacids and proteins:** Amino acid structures, three and one letter nomenclature, classification, biological properties of amino acids; physicochemical properties, reactions of amino acids; Importance of proteins in biological systems; primary, secondary, tertiary and quaternary structure and proteins. Synthesis of Peptides (solid phase peptide synthesis); **Lipids** Classification; Structure; physicochemical properties of different classes of lipids. **Nucleic acids:** Structure; properties and biological functions of nucleic acids. Typesof DNA and RNA. **Metabolism:** Introduction, IUBN Classification of enzymes, role of vitamins and coenzymes; basic metabolic pathways; glycolysis, Krebs cycle**,** Electron Transport Chain, Beta oxidation of fatty acids.

TextBooks:

1) Principles of BiochemistrybyAL Lehninger,Nelson &Cox, CBSpublications
2) BiochemistrybyU. Satyanarayana, Alliedand Books Pvt. Ltd. Kolkata

References:

1) Biochemistry. Jeremy M. Berg, John L. Tymoczko, Lubert Stryer
2) Voet and Voet biochemistry 5th edition
3) Principles of ***biochemistry***: By A. ***White***, P. Handler, and E. L. ***Smith*** (5th edition) pp 1296: McGraw-Hill Kogakusha Ltd., 1973,

BIOCHEMISTRY LAB

1. Qualitative analysis of Carbohydrates
2. Qualitative Analysis Of Amino acids and Proteins
3. Qualitative Analysis Of Lipids
4. Qualitative Analysis Of Nucleic acids
5. Estimation of Glucose by Benedict's test
6. Quantitative Analysis of Carbohydrates by Anthrone Method

7. Estimation of Aminoacids by Ninhydrin method
8. Estimation of Proteins by Biuret Method
9. Estimation of Protein by Lowry's Method
10. Estimation of DNA by Diphenylamine
11. Estimation of RNA by Orcinol method
12. Isolation of Caesin from Milk

MICROBIOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CONo	Course Outcome	Mapped PO	B T L
CO 1	Acquire the knowledge about chronological development, classification, cell structure, characteristics and diseases of microorganisms	2	2
CO 2	Construction of growth curve, identification of various factors affecting growth and outline about microbial growth estimation methods	11	3
CO 3	Compare various media, isolation, identification and sterilization methods of microorganisms	5	2
CO 4	Demonstrate various methods of microbiology such as sterilization, isolation, identification and characterization.	2	2

Syllabus

History and classification of microorganisms-Discovery of microorganisms; Theoryof spontaneousgeneration, Germtheoryof disease;Microbialtaxonomy anddiversity: Bacteriaandtheirbroadclassification-Majorcharacteristicsusedintaxonomy. MajorcontributorsinfieldofMicrobiology-Antonyvanleeuwenhoeks;LouisPasteur;Robert Koch;EdwardJenner;JosephLister;Winogradsky;Beijerinck.Microscope-Simple,Compound and Fluorescence. **Morphology &Cell structure of microorganisms-** Ultrastructureofbacteria,cellwall,flagella,pili,capsule,endosporeandcellinclusions.Viruses – Chemistry &Morphology (size, shape and symmetry), replication of viruses,lytic and lysogeniccycles.Yeasts&Molds–Morphology,lifecycle,economicimportanceoffungi(Eg. Aspergillus). Identification based on shape, staining reactions (Differential stain, Acid fast, capsule staining, Endospore staining).**Growth kinetics of microorganisms, Bacterial nutrition-**Nutritional classification of bacteria, Essential Macronutrients, MicronutrientsandGrowthfactors.Microbialgrowth**–**Growthcurveandfactorsaffectingthe growth– solutes,wateractivity,pH,Temperature,Oxygenconcentration,Osmoticpressure, Radiation.Bacterial growth; synchronousgrowthandmethodsofgrowthestimation.Onestep growth curve, Physiology ofArchaebacteria–thermophiles, psychrophiles, halophilesand methanogens. **Growthmediaandcontrolofmicroorganisms-** culturemedia-syntheticandcomplexmedia,solidifyingagents,typesofmedia.Isolationofpurecultures-spread,pourandstreakplatemethods;MaintenanceandPreservationofmicroorganisms.Control of microorganisms – Sterilization and disinfection, effects of physical (moist and dryheat, radiationandfiltration)and chemical agents.Antibiotics–classification,modeofactionand resistance.**Medicalmicrobiology-**Diseasereservoirs;Respiratory infectionscausedby bacteriaandviruses,(tuberculosis);Diseasetransmittedby animals(rabies)andinsects(malaria); Food and water-bornediseases (cholera); pathogenicfungi,Viriods& Prions.

Text books:

1. Pelczar MJ, ChanECS&KriegNR, "Microbiology" edition,TataMcGraw Hill, (Year)
2. Prescott &Dunn, "General Microbiology**",** edition,McGraw Hill publishers, (Year)

ReferencesBooks:

1. C.B.Power. General MicrobiologyVol I & II
2. Brock, **Biology ofmicroorganisms**PrenticeHall Int.Inc.

MICROBIOLOGY LABORATORY

1. Calibration ofmicroscope andIdentification ofAnimal, Plant and Bacterial cells
2. Sterilization techniques for preparation of pure culture media for cultivation of microorganisms andvalidation ofproof.
3. Preparationofculturemedianutrientbrothandnutrientmediaandpreparationof slants.
4. Culturingof Microorganismson slants and nutrient broth.
5. Isolation ofBacterialcultureusingstreakand pourplatemethods
6. Identification ofMicroorganisms
   (a) SimpleStainingtechnique
   (b)Differential stainingtesting
7. Microbiological Examination ofwater
8. A qualitative microbiological analysisfordeterminingthe qualityof MILK
9. Characterization ofbacterial strainbyBiochemical tests
10. Determination ofbacterial growth.
11. DeterminationZoneof inhibition of an antibiotic bycup method.
12. Determination ofMIC ofanytwoantibiotics on same bacteria.

Texts books:

1. Pelczar MJ, ChanECS&KriegNR, "Microbiology" edition,TataMcGraw Hill,
2. Prescott &Dunn, "General Microbiology**",** edition,McGraw Hill publishers

ReferencesBooks:

1. C.B.Power. General MicrobiologyVol I & II
2. Brock, **Biology ofmicroorganisms**PrenticeHall Int.Inc.

BIOANALYTICAL TECHINIQUES

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcome	Mapped PO	B T L
CO1	Understand the basic principles of different bio analytical methods	3	3
CO2	Knowledge about techniques related to electrophoresis & spectroscopy	3	3
CO3	An understanding of use of Radioisotopes in biological sciences and its ethical issues	3	3
CO4	An ability to perform centrifugation, chromatography, electrophoresis & spectroscopy techniques	11	3

Syllabus:

Centrifugation – Basic principle,typesofrotorsincentrifuges-Fixedanglerotor,Vertical rotor,Swingoutrotor,Zonalrotors.Typesofcentrifuges–UltraandAnalyticalcentrifuges, PreparativeandDensitygradientcentrifugations, Densitygradientspreparations–Sucrose, Cesium chloride. **Chromatography-**Basic principle, Modes&Typesofchromatography– Paper, TLC.ColumnChromatography–Gelpermeation,Ionexchange,Affinitychromatography, GLC,HPLC.**Electrophoresis**-Principle, Types, Agarose gels, SDS-PAGE. IEF, PFG, 2-D gelelectrophoresis, Capillary electrophoresis. **Spectroscopy-**Basic concepts ofspectroscopy, Beer- Lambertslaw, Visible&UVSpectroscopy,Fluorescencespectroscopy,Atomic absorption spectrophotometer, Infrared&FT-IR, Mass spectroscopy. **Isotopic techniques-**Auto-radiography–PrinciplesandApplicationsof radioisotopesinbiologicalsciences. Non- isotopic tracertechniques, Immuno-histochemistry, Solid phase peptide synthesis.

Text books:

1. KeithWilson &John Walker, "Principles &Techniques of Biochemistry andMolecularbiology.PracticalBiochemistry.PrinciplesandTechniques". 5th ed. CambridgeUniversitypress(1994).

2. Uppadyay,Uppadyay&Nath ,"BiophysicalChemistry.PrinciplesandTechniques".11th ed. Himalayapublishing house.

ReferenceBooks:

1. Freifelder,"BiophysicalChemistry". Freeman &Co.

BIOANALYTICAL TECHNIQUESLABORATORY

1. Calibration and measurementofpHfordifferentsolutions.
2. Separation of milk proteins by centrifugation
3. Identification of aminoacids by paper chromatography
4. Identification of aminoacids byTLC.
5. Separation of nucleic acids by affinity chromatography.
6. Agarose gel electrophoresis.
7. SDS-PAGE analysis of proteins.
8. Verification of Beer Lamberts Law

9. Quantification of nucleic acids/proteins by visible method
10. Quantification of nucleic acids/proteins by UV method

Text Books:

1. Boyer R, Modern "Experimental Biochemistry"(3rd Edition)-Pearson Education, 2000.

2. SharmaB.K, "Instrumental Methods of Chemical Analysis"(8th Edition), Gel PublishingHouse, (1999).

MOLECULAR BIOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO NO	Course Outcomes	Mapped PO	B T L
CO 1	Understand the genome organization & replication	1	2
CO 2	Compare DNA transcription and translation mechanisms	2	2
CO 3	Analyze gene regulation mechanisms	2	2

Syllabus:

Genome organization & dna structure-Nucleic acid as genetic material, transformation in *pneumococcus*, Hershey-Chase experiment, RNA as genetic material in viruses. Genome of prokaryotes & eukaryotes, C-Value Paradox, structural genes, regulatory genes, overlapping genes, pseudogenes, split genes. **Structure of DNA**-Watson & Crick's model; Types of DNA: A, B and Z-DNA; Denaturation, renaturation of DNA. **DNA replication and repair-** semi conservative replication apparatus, bi-directional & rolling circle replication. **dna damage-** Mutations, Types of Mutations, Effect of UV, Deamination, Alkylation. **Repair Mechanisms-** Direct Repair, Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair**.Mechanism of transcription and translation Prokaryotic & Eukaryotic Transcription –** Initiation, Elongation and Termination; Structure of Promoters; RNA Polymerases of Prokaryotic and Eukaryotic Organisms; gene splicing and Ribozyme. **Post Transcriptional Processes of Eukaryotic RNA–**Processing of t-RNA, r-RNA, m-RNA. **Translation in prokaryotic and Eukaryotes**-Genetic code, Aminoacylation of tRNA – initiation, elongation and termination of translation, Post-translational modifications. **Regulation of gene expressionRegulation of Gene expression in Bacteria–**Operon concept, inducible and repressible operons, positive and negative regulations, Inducer molecules, repressor molecules, co repressor molecules; Induction and catabolic repression of ***lac*** Operon in ***E.Coli***; Repression and attenuation of ***trp*** operon in ***E.Coli***; Absolute control by Antisense RNA's. Regulation in eukaryotes – Control by promoter, enhancer and silencers. Cis-trans elements.

Text Books:

1. David Freifelder ,"Molecular Biology ", Narosa publications house.
2. P.K.Gupta ,"Genetics", Rastogi publications.

Reference Books:

1.Weaver ,"Molecular Biology ";Academic International Publication.
2. Benjamin Lewin ,"Gene IX ", Pearson Publishing.

IMMUNOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Understand the various defense mechanism of body system	**1**	1
CO 2	Compare different types of Ag-Ab reactions	11	2
CO 3	Differentiate the role of B and T cells	1	1
CO 4	Development of ELISA method for Ag-Ab reactions	2	2

Syllabus:

Basicsofimmunology-Typesofimmunity–Innate,acquired,Humoral&cell mediated;Organsoftheimmunesystem:Primarylymphoidorgans–Bursaof fabraceous, Bonemarrow,thymus;Secondary lymphoidorgans–Spleen,lymphnode.Cellsofimmunity–Lymphoid &Myeloid lineage. Antigens–Types, Chemical nature,characteristics of Antigen, Haptenandadjuvant. Cytokines–Types, receptors and functions. **Immunological techniques-** Antigen-Antibody Reactions–Mechanismand types. Agglutination–blood grouping, Widal&VDRL. Precipitation–double immunodiffusion, Radial Immuno Diffusion; Immunoelectrophoresis, Rocket Immunoelectrophoresis,Complementfixationtest.ELISA,Westernblotting,FACS,IHCandRIA . B **Cellontogeny-**B-Cell biology,BCR,Immuneresponse–primary,secondaryand tertiary response's; Theories of immune response. Immunoglobulins– Structure, types, subtypes and functions. Antibody genes and generation of diversity, Production of monoclonalantibodies.Complement System–Classical,alternativeandMBLectin pathway&regulation **TCellontogeny-**T-Cellbiology,TCR;TypesofTcells–T_H,$T_C$andT_S cells.Structure ofMHC–I&II,ProfessionalAntigenPresentingCells,Mechanismof Antigen processing and Antigen presentation. Tcell effector mechanism. **Clinical immunology-** Hypersensitivity: IgE mediated, antibody dependant cell cytotoxicity, immunecomplexmediatedreactionsanddelayedtypeofhypersensitivity;Autoimmunity–systemic&organspecific.Transplantationimmunity–MLRandMCA;Tolerance-Natural&Adaptive. Tumor immunity– Tumor antigens,Vaccinations– basic concept, types.

Textbooks:

1. RichardA.Goldsby,ThomasJ.Kindt&BarbaraA.Osborne,Kuby, "Immunology", John Wileypublishers 6thed.,(2007).

2. Ivan M. Roitt, PeterJ. Delves, "EssentialImmunology",Blackwellpublishers. 10th addition.

References Books:

1.Ian R. Tizard," Immunology– An Introduction",Thomson publishers.

IMMUNOLOGY LABORATORY

1. Total count ofRed blood cells byNeubaur chamber method
2. Total count ofwhite blood cells byNeubaur chamber method
3. Estimation of hemoglobin bySahli's method
4. Widal Test & VDRLTest
5. Blood GroupingTest
6. Quantitative precipitin Assay

7. RadialImmuno Diffusion
8. Immunoelectrophoresis
9. RocketImmunoelectrophoresis
10. ODD forantigen-antibodypatterns
11. ODD forantibodytitration
12. ELISAfor antigencapture
13. ELISAfor antibodycapture
14. Dot-ELISA
15. Electrophoreticanalysisofserum proteins

BIOINFORMATICS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the theoretical basis of bioinformatics	3,12	1
CO2	Understand the access and retrieval of biological information from data bases	3,12	2
CO3	Manipulate the DNA/Protein sequences using standalone PC programs and with the help of World Wide Web	3,12	1,2
CO4	Develop Multiple Sequence Alignment tools to find homologous, analyze sequences, construct and interpret the evolutionary trees	3,12	1,2
CO5	Demonstrate the relationships using retrieved sequences	3,12	1,2

INTRODUCTION TO BIOINFORMATICS & DATABASES: Need of Computers in Biotechnology Research- Biological Information on the web. Introduction to Biological databases – Primary Databases: NCBL, EMBL, DDBJ. Secondary Databases: SwissProt, PIR. Specialized data bases - KEGG and BRENDA. Information retrieval from Databases. Concepts of Data mining, Basics of Sequencing Technologies, Genome projects-human genome project. SEQUENCE COMPARISIONS AND ALIGNMENTS: String similarity-Local, Global alignment; pair wise alignments – Dot plots, Dynamic Programming Methods, Heuristic methods - FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM. MULTIPLE SEQUENCE Methods for Multiple sequence alignments- local and global multiple sequence alignment; Significance and applications of MSA PHYLOGENETIC ANALYSIS Origins of Molecular Phylogenetics; Methods of Phylogenetic analysis- Maximum Parsimony Maximum Likelihood and Distance based methods. STRUCTURAL BIOINFORMATICS: Protein Structure Basics; Peptide Formation; Dihedral Angles; Hierarchy- Secondary Structures, Tertiary Structures, Primary structural analysis and prediction, Secondary structural analysis and prediction, structure alignment; Secondary Fold recognition: Determination of Protein Three-Dimensional Structure; Structural modeling. Introduction to Unix and PERL. Programming:

Text Books:

1. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta& P Rastogi, 2005
2. Bioinformatics: A Machine learning approach – P. Baldi, S. Brunak, MIT press, 1988.

Recommended References:

1. Introduction to Computational Molecular Biology by Joao Carlos Setubal, Joao Meidanis, Jooao Carlos Setubal, 2003
2. Bioinformatics: Sequence and Genome Analysis David W. MountCSHL Press, 2006

BIOINFORMATICS LABORATORY

1. Basic Unix commands
2. Searching Bibliographic databases for relevant information
3. Sequence retrieval from DNA & Protein databases.
4. Sequence file format conversions.
5. Pair wise comparisons using Dotlet.

6. BLAST services.
7. FASTA services.
8. Multiple Sequence Alignment (CLUSTAL W) & Phylogenetic Analysis using Phylip, Phylodraw.
9. Protein Databank retrieval and Exploring protein structure using Rasmol& Spdbv
10. Restriction Mapping
11. Primer Design.
12. PERL Programming

Text Books:

1. P. Baldi, S. Brunak ,"Bioinformatics: A Machine learning approach ", MIT press (1988)

GENETIC ENGINEERING

Mapping of Course outcomes with Program Outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of steps in gene cloning	3,12	1
CO2	Understand the importance of vectors in cloning	3,12	2
CO3	Acquire knowledge on PCR methods	3,12	2
CO4	Compare gene transfer methods	3,12	2
CO5	Construct recombinant molecules	3,12	4

Basics of Genetic Engineering: Basic steps of gene cloning. Isolation & Purification of DNA & RNA. Enzymes used in cloning – Nucleases, Polymerases, Ligases, Transferases, DNases, RNases, Kinase, Phosphatase. Restriction Enzymes – Nomenclature, classification, uses, restriction sites, applications. Special DNA molecules – Linker, Adaptor, Polytailing. **Cloning Vehicles:** Plasmids Vectors – Classification, Properties, pUC 18/19, pBR 322, Blue script vectors. Cosmid Vectors – essential features, strategies to generate genomic library. BAC's & YAC's Its uses in construction of genomic library. Phagemids – M13 derived vectors. Expression vectors – pRT and pET vectors. Vectors for construction of cDNA libraries. **Polymerase Chain Reaction:** PCR – History, Principle, Mechanism, Methodology, Applications, Primers, Designing of mutagenic primers. Identification of PCR products, Cloning of PCR products, Multiplex PCR, Anchored PCR, Asymmetric PCR, Nested PCR, Inverse PCR, fusion PCR, RAPD-PCR, RT-PCR, Hot Start PCR, Touch Down PCR and Real Time PCR. **Genes to Clones:** Gene Transfer Techniques – Microinjection, Electroporation, Transformation, Particle bombardment, Macroinjection, Chemical methods. Screening of clones - Complementation method, genetic methods, Immunological methods, Hybridization methods. **Gene Technology:** Sequencing of DNA by Maxam-Gilbert method and Sanger's method. RNA silencing, Restriction mapping, RAPD, RFLP, AFLP. Invitro mutagenesis - Site directed mutagenesis. Blotting Techniques – Southern, Northern & Western. Probe preparation, labeling and detection techniques (Phosphoimaging and Radioactive labeling). Applications of gene cloning in medicine and agriculture.

Recommended Textbooks:

1. Old R.W and Primrose S.B .1995. Principles of gene manipulation-An introduction to genetic engineering. 5th edition. Blackwell scientific publications. London.
2. Winnaker E.C. 1987. From genes to clones. Introduction to gene technology. VCH Publications.

Reference Books:

1. J.D.Watson Recombinant DNA (A short Course). W.H.Freeman (1983)
2. T.A Brown gene cloning and DNA analysis. Wiley Blackwell- Apr- 2010

GENETIC ENGINEERING LABORATORY

1. Agarose Gel Electrophoresis
2. Isolation & Visualization of plant genomic DNA by CTAB method
3. Isolation & Visualization of blood genomic DNA by silica column method
4. Isolation & Visualization of plasmid DNA by alkali lysis method
5. Isolation of RNA from liver tissue by hot phenol method

6. Extraction of DNA from agarose gels
7. Restriction digestion of DNA
8. Bacterial Transformation
9. Amplification of DNA fragments by PCR

Recommended laboratory manual:

1. Deininger, Prescott. "Molecular cloning: A laboratory manual: Edited by J. Sambrook, EF Fritsch, and T. Maniatis. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1989 (in 3 volumes)." (1990): 182-183.

FERMENTATION TECHNOLOGY

Mapping of Course outcomes with Program Outcomes:

CO No	COURSE OUTCOME	MAPPED PO	BTL
CO1	Acquire the knowledge of fermentation process basics	1,5	1
CO2	Understand the knowledge of medium optimization	1,5	2
CO3	Acquire the knowledge of medium sterilization.	1,5	1
CO4	Understand the principles of aeration and agitation	1,5	2
CO5	Demonstrate fermentation processes to produce value added proteins and other biological substances for human, animal therapeutic use, food production processing and bio fuels.	1,5	4

Introduction to Fermentation: Different range of fermentation processes; Chronologicaldevelopmentoffermentationindustry;Generalrequirementsoffermentation processes;anoverviewofaerobicandanaerobic fermentationprocess,Monitoring and control of fermentation process. Ancillaryfittings forreactors(samplingport);Aseptictransferof sporesuspension. **Medium Requirements and Optimization:** Medium requirements for fermentation processes -Carbon,Nitrogen,Minerals,VitaminsandOtherComplexnutrients, Oxygenrequirement.Introductiontomediumoptimization;Methodsofmediaoptimization (Onefactormethodand Plackett-Burmandesign). **FermentationProcesses&Sterilization Techniques:**Classificationoffermentationsystem(Batch,fed-batch,Continuous);Solid state fermentation, Submerged fermentation. Dualand multiple fermentations; Concept of Chemostat; Turbidostat,Kinds of sterilization techniques; Thermal death kinetics of microorganisms, Batch and Continuous sterilization of liquid media, Filter sterilization. **Aeration andAgitation:**Typesofmixing mechanisms- bubble aeration & mechanical agitation; mixing equipment; Types of spargers and impellersinfermenters;Significanceofoxygentransferinfermentations;Factorsaffecting oxygentransferrates. Scaleupoffermentationprocess; Principles; Theoretical considerations and techniques used; Scale down methods; Industrial fermentation products- Penicillin, Alcohol production.

Textbooks:

1. PeterFStanbury, Principles of Fermentation Technology, Elsevier, 2009
2. Bailey&Ollis, Biochemical Engineeringfundamentals Mcgraw Hill Higher Education (1988)

ReferenceBooks:

1. F.C. Web BiochemicalEngineering, BS publications, 1997
2. HarveyWBlanch,Biochemical Engineering.Taylor&Francis /b S Publication (Feb 1997).

FERMENTATION TECHNOLOGY LABORATORY

1. Formulation ofsimple and complexmedia for fermentation
2. Medium optimization using plackett burmann design
3. Studyof thermal death kinetics and estimation ofdelta factor forbacterial culture

4. Comparison of growth curve forbacterial and fungalculture
5. Determination ofK_S forbatchgrowth of microorganism
6. Bioreactor instrumentation and control
7. Fermentative production of bioethanol
8. Cellimmobilization anddegradation kinetics ofsubstrate
9. Microbial production andquantification of finechemicals
10. Production ofXylanasesusing *P.feniculosum*.
11. Production ofCellulaseusingSolid State Fermentor.

Text Book:

1. PeterFStanbury, Principles of Fermentation Technology.Elsevier(2009).

BIOCHEMICAL REACTION ENGINEERING

Mapping of Course outcomes with Program Outcomes:

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of reaction engineering basics and batch reaction system.	1,5	1
CO2	Understand different bioreactor systems to analyze microbial growth and product formation.	1,5	2
CO3	Compare various multiphase bioreactors	1,5	3
CO4	Analyze biochemical processes for various biochemical parameters on microbial growth.	1,5	4
CO5	Demonstrate processes to produce value added proteins and other biological substances for human, animal therapeutic use, food production processing and bio fuels.	1,5	3

Syllabus:

Over View of Biochemical Reaction Engineering- Over view of biochemical reaction Engineering; Classification of reactions; Reaction rate; Kinetics of homogenous reactions; Single and multiple reactions; Elementary and Non elementary reactions; Molecularity and order of reactions; rate constant; Kinetic models of non-elementary reactions; Temperature dependency of rate equation. Interpretation of Batch Reactor Data-Constant volume batch reactor; Analysis of total pressure data; The conversion; Integral method of analysis of data; Irreversible uni-molecular, bimolecular reactions; Zero order reactions. Half life of a reaction; Varying volume batch reactor; differential method of analysis; Integral method of analysis; Zero order; First order & second order reactions; Temperature & reaction rate.: Bioreactor Systems- Definitions; Differences and similarities between chemical and bioreactors; Classification of bioreactors; Reactor configurations;Description of a conventional bioreactor with all aspects; Design and construction criteria of a bioreactor; Concept of ideal and nonideal reactors; Residence time distribution; stimulus response techinique; Models of non ideal reactors; Imperfect mixing. Designing Of Bioreactors-Design equations for enzyme reactors; batch growth of microorganism; Design equation of a plug flow reactor; Design of CSTR with wash out concept; Stirred tank reactors with recycle of biomass; Continuous stirred tank fermentors in series with out and with recycle of biomass; Estimation of kinetic parameters. Multiphase Bioreactors-Different types of reactors: Cell lift reactor; Multipurpose tower reactor; Liquid impelled loop reactor; Pumped tower loop reactor; Fluidized-bed reactor; Packed bed reactor; bubble column reactors, Airlift reactors Gas inducing reactors. Animal & plant cell reactor technology-Environmental requirements for animal cell cultivation; Reactors for large scale production using animal cells, plant cell cultivation

Text Books:

1. Octave Levenspiel, “Chemical Reaction Engineering,” Third edition, Wiley India pvt. Ltd (2006)
2. D.G.Rao,” Biochemical Engineering”, McGraw Hill) (2008).

Reference textbooks:

1. Bailey and Ollis, Fundamentals of Biochemical Engineering, Mcgraw Hill HiEducation (1998)
2. Atkinson and Mavituna, Biotechnology and Biochemical Engineering Springer (Mar1973)

BIOCHEMICAL REACTION ENGINEERING LABORATORY

1. Determination of Volumetric mass transfer coefficient in Fermentor (sodium sulphite technique, Static method)
2. Determination of gas holdup in sparged reactor
3. Determination of mixing time in bioreactor
4. Determination of circulation time using flow follower method
5. Estimation of Reynolds number for a given flow in pipes
6. Residence time distribution experiment in CSTR
7. Estimation of power number for stirrer in Fermentor
8. Estimation of conversion of a substrate in plug flow reactor
9. Kinetic studies in fluidized bed bioreactor
10. Scale up and Determination of KLA

Text Books:

1. Bailey and Ollis, Fundamentals of Biochemical Engineering, Mcgraw Hill HiEducation (1988)

PLANT BIOTECHNOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire knowledge plant tissue culture and cryo preservation	1,8	1,2
CO2	Understand homozygous plants & protoplast technology	1,8	2
CO3	Apply the Genetic engineering in plants	1,8	3
CO4	Apply the Metabolic engineering for enhance fatty acids, plant secondary metabolite production	1,8	3
CO5	Develop *In vitro* culture plants and cells	1,8	5

Syllabus:

FundamentalsofTissueculture: Introductiontocellandtissueculture, Concept of Totipotency,Nutritionalcomponents ofculturemedia anddifferentplanttissueultureMedias. Regenerationofplantsthroughorganogenesisandsomaticembryogenesis. Synthetic seeds. Somoclonal variations, Cryopreservation. **Homozygousplants&Protoplast technology**: Productionofhomozygousplants through anther and ovule culture. Applications of homozygous plants.Protoplast technology – Isolation, protoplast fusion, identification and characterization of somatic hybrids, culture and plant regeneration. Conceptofcybrids.**Geneticengineeringofplants**;Methodsforproductionoftransgenic plant– vectormediated(Agrobacterium)andVectorlessmethods. Chloroplast transformation, Marker genes; promoters; Biosafety, Bioethics in plant biotechnology. Developmentof transgenic plantswithresistancetodisease,herbicides,droughtandinsects.**Applications of Plant Biotechnology**: Metabolic engineering- manipulation of metabolic pathways for production of fatty acids. Molecular farming; Production of Planti-bodies, viral antigens, Edible vaccines, Peptide hormones and biodegradable plastics in plants. Production of bio active secondary metabolites and strategies for enhancing product yield.

RecommendedTextBooks:

1. Smith, Roberta H. Plant tissue culture: techniques and experiments. Academic Press, 2013.
2. Razdan, Maharaj K. Introduction to plant tissue culture. Science Publishers, 2003.

References Books:

1. HS Chawla. Introduction to plant biotechnology. Science publishers, 2002.
2. Butler, Mike. Cell culture and technology. Taylor & Francis, 2004.

PLANT BIOTECHNOLOGY LABORATORY

1. Preparation of MS media
2. Selection, sterilization and inoculation of explants
3. Callus induction in legumes

4. Plant regeneration from Meristem
5. Embryo culture in Sweet Corn
6. Anther culture in Solanaceous plants
7. Isolation of Protoplasts
8. Agrobacterium mediated gene transformation
9. Cell immobilization in hot pepper
10. Detection of alkaloids through TLC

Reference Book:

1. Trigiano, Robert N., and Dennis J. Gray, eds. Plant tissue culture concepts and laboratory exercises. CRC press, 1999.

DOWNSTREAMPROCESSING

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of unit operations and understand the principle behind the unit operations, their advantages and disadvantages involved in DSP.	1,5,12	1
CO2	Design, develop and optimize processes for purification of products.	1,5,12	1,2
CO3	Application of appropriate technique/unit operation for the process and evolve processes for purification of products with high market value.	1,5,12	1,2
CO4	Design and develop new economical processes in terms of time and energy for quality product development.	1,5,12	1,2
CO5	Demonstrate various downstream process techniques	1,5,12	1,2

Syllabus:

DownStreamProcessinginBiotechnology – Introduction; Bioprocess Case studies; Characterization of Biomolecules, characterizationoffermentationbroth: Morphologyofcells,structureof thecellwall,productconcentrations,Biomassdensity.PrimarySeparationAndRecovery Processes: Recovery of intracellular products; Celldisruption methods-physical methods (osmotic shock, grindingwithabrasives, solidshear, liquidshear) –chemical methods (alkali, detergents)- enzymatic methods. Removal ofsuspendedsolids: filtration, filtrationequipment,centrifugation, centrifugation equipment-tubularbowl,disk-stack, basket centrifuges. Product Enrichment Operations: Adsorption, Aqueoustwo-phaseextractionprocess:Applications of aqueous two-phase extraction, reversedmicellesextractionprinciple, micellestructures, critical micelleconcentration. Proteinsolubilization,limitationofreversedmicelles. Membranebased separations–Classification&characteristicsofmembrane separation,merits& demerits. Microfiltration,ultra-filtration,Reverseosmosis,dialysis &electrodialysis. Membrane modules: Plate&Frame,hollowfiber,spiralwound,shell&tube. Precipitations ofproteins with salts and organic solvents, kinetics of protein aggregation. Product Purification: ChromatographicSeparations:Classificationofchromatographictechniques, Principles &practices of Gel Filtration, Ion Exchange and Affinity chromatography.AlternativeSeparationMethods andProductPolishing;Supercritical extraction: principles of SCE, Flow scheme of a simple SCE system. Polishing: Crystallization, Principles of crystallization and equipment. Principles of dryingand lyophilization, Freezedryer. Formulation strategies:Importanceofformulation, formulation ofbeakersyeast, Enzymes, formulation of pharmaceutical products.

Recommended Textbooks

1. Butterworthand Heinmann.Product recoveryinbioprocess Technology-Elsevier India(2004),
2. B.Siva Sankar.Bioseparations, Fifth Edition, PHI Learning(2009)

References Books:

1. HarveyBlanch.BiochemicalEngineering,Taylor&Francis/bSPublication(Feb 1997)
2. Christie J.Geankoplis., Transport processes and Unitoperations, PhiLearning(2009)

DOWNSTREAMPROCESSING LABORATORY

1. Extraction of proteins by Two-phase separation (PEG 3000 &Ammonium sulphate orOrganic solvents)
2. Fractionation ofproteinsfrom Egg byAmmonium SulphatePrecipitation.
3. Desaltingof Proteins byDialysis(CuSo4 +protein)
4. Isolation ofMilk protein(Casein) by Iso-electricPrecipitation.
5. CellDisruption bySonication and Enzymatic Reaction
6. Separation ofproteins byGel Filtration
7. Separation of charged biomolecules by Ion ExchangeChromatography
8. Separation ofproteins byNative/SDS Gel Electrophoresis(SDS PAGE)
9. Extraction and isolationofEnzymes from microbial cultures.
10. Separation ofproteins byAffinityChromatography
11. Separation ofBiomolecules byHigh Pressure Liquid Chromatography
12. Separation ofVolatilecompounds byGas Chromatography

Laboratorymanuals:

1. Handbook ofDownstream Processing ByGoldberg, Elliott,Chapman &Hallpublishers

MOLECULAR GENETICS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Genome Organization &Types of Sequences and Recombination	1	1
CO 2	Describe about Gene Expression Regulation	5	2
CO 3	Compare X chromosome & Mt DNA analysis in Forensics	11	3
CO4	Compare Y Chromosome & Mt DNA analysis in Forensics	11	3

Syllabus:

Genome Organization &Types of Sequences-Nomenclature of chromosome, C-value paradox, dosage compensation. Chromosome structure, Genome organization, Chromatin, Euchromatin, Hetero- chromatin, Organization and evolution of nuclear and organelle genomes, Split genes, Essential & Non-essential genes, VNTR, SNP, SINES, LINES, SSR, STR, Mini and Micro Satellites**. Recombination-**Types of recombination: homologous, reciprocal and nonreciprocal, site-specific and illegitimate. Different models of homologous recombination. Molecular mechanisms of recombination: Base pairing, Nick initiation, Homologous recombination, Cross strand exchange, Site specific recombination, Transpositional recombination. **Gene Expression Regulation-**An Overview of Gene Control, DNA-binding Motifs in Gene, Regulatory Proteins, Genetic Switches, Chromatin Structure and the Control of Gene Expression. The Molecular Genetic Mechanisms that create specialized Cell Types, Posttranscriptional Controls.

Text Books:

1. Alberts ,"Molecular Biology of the Cell" , 5th Ed, Garland Science / Taylor & Francis Group (2008)
2. Ralph Rapley ,"Molecular Forensics " John Wiley & Sons, Ltd (2007).

Reference Books:

1. R.M Twyman ,"Advanced Molecular Biology", Springer-verlag (1998)
2. Eberhard Passarge ,"Genetics ",John Wiley & Sons, Ltd (2006).

TRANSGENIC TECHNOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcome	Mapped PO	B T L
CO 1	Acquire the knowledge of vehicles for transgenic technology and transgenic plants	1	1
CO 2	Describe transgenic animals and silencing technology	5	2
CO 3	Develop gene therapy	8	5
CO4	Develop knockouts strategies	8	5

Vehicles for Transgenic Technology- Plasmids, Phagemids, Cosmids, viruses, artificial chromosomes and shuttle vectors. Gene constructs. Principle and applications. Basic strategies of construction and screening of genomic and cDNA libraries. **Transgenic Plants-** Gene transfer methods in plants, Transgenic plants with beneficial traits, Transgenic plant as

bioreactor, Diagnostics in agriculture, Molecular breeding, Molecular markers, Edible vaccines, Bioethics. Case studies on Bt-Cotton and Bt-brinjal.**Transgenic Animals-**Gene transfer methods in animals, Embryonic Stem Cell Method, Pronucleus Method, Random vs. Targeted Gene Insertion, Super ovulation, Transgenic animals, Case studies on Dolly.**Silencing Technology-**RNA silencing, SiRNAs and anti-sense RNAs – their design and applications, ShRNA, micro RNAs, and siRNA libraries. Epigenetic gene silencing, RNA silencing in plants, Case studies on Drosphilla, Mammalian Oocytes and Yeast cells.**Gene Therapy & Knock outs-**Cationic liposomes, Lentiviral vectors, Retroviral vectors, HSV vectors, SCID therapy, Gene Therapy for Cystic Fibrosis: Gene Therapy Approaches, Gene Therapy Approaches to Duchenne Muscular Dystrophy. Knockout Mice, Tissue-Specific Knockout Mice, Knock-in Mice. Ethics of Gene therapy.

Text books:

1.Old and Primrose ,"Principles of Gene Manipulation" , Wiley-blackwell (1994-09-27)
2.Patrick J. Paddison ,"RNAi ", Springer-verlag (Feb 2008)

Reference Books:

1.Anthony Meager ,"Gene therapy Technologies" by, John Wiley & Sons (December 1999)

MOLECULAR EXPRESSION TECHNOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of gene expression and Prokaryotic system-	1	1
CO 2	Describe mammalian system	5	2
CO 3	Develop various strategies of Protein purification system	11	3
CO 4	Develop various strategies of Protein stability	11	3

Gene Expression-Transient *VS* stable expression, RT-PCR and the Standardized Expression Measurement, Monitoring Eukaryotic Gene Expression, Suppression Subtractive Hybridization, Gene Expression Informatics. **Prokaryotic system-**Expression in *E. coli*: *lac* promoter, T7 expression system, pET, pMAL vectors. Induction methods, Case study on Insulin production.**Eukaryotic system-***Saccharomyces cerevisiae: GAL* system, *CUP1* system, *Pichia pastoris:* AOX system,Expression in insect cells, Baculovirus expression, Polyhedrin promoter, Expression in higher-Eukaryotic cells, Tet-on/Tet-off system. Advantages and disadvantages of yeast and insect expression systems. Case study of Interferons & Interleukins production in Pichia and SF9 cells. **Mammalian system-**CHO cell expression system, Vectors and markers for screening, Roller bottles, Fermentors used, Secretory proteins and Non-secretory proteins, Secretory pathway and signal peptides, Post translation modifications – Glycosylation. Case study of Erythropoietin production in CHO cells. **Protein purification system-**Purification of expressed proteins from E.coli, purification of soluble recombinant proteins, Purification of inclusion bodies, Invitro refolding of proteins, verifying protein integrity. Techniques for measuring protein stability. His-tag, GST-tag, MBP-tag. Factor X, Enterokinase signal cleavage.

Text Books:

1. Shimkets ,"Gene Expression Profiling and Methods", Humana Press (Feb 2004)
2. Reece ,"Analysis of genes and genomes ",John Wiley & Sons (January 2004)

Reference Books:

1. Simon Roe ,"Protein purification applications", Oxford University Press (2001)
2. David R ,"Pichia Protocols" . Higgins Humana Press (1998-06-15)

sGENOMICS AND PROTEOMICS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Genomes	1	1
CO 2	Compare micro array analysis	5	3
CO3	Develop protein networks	8	5
CO 4	Develop mapping strategies	8	5

Genomes and Genome analysis-Organization and structure of genomes, Genome Mapping: Construction of genomic libraries, mapping strategies and techniques. Human Genome Project, Genomes of other organisms. Principles of gene expression; Global analysis of gene expression, Peptide nucleic acid technology. **Comparitive and Functional genomics-** Comparative genomics: protein evolution from exon shuffling, Protein structural genomics, Gene function by sequence comparison. Functional Genomics, Pharmacogenomics, Genomics in relation to molecular Diagnosis, Role of genomics in Drug discovery and development.**Microarrays-**Whole genome analysis of mRNA and protein expression, microarray analysis, types of micro arrays and applications in cancer diagnosis. Protein Biochips, Protein arrays.**Proteomics-**Principles of separation of Bio-molecules, 2D-Gel Electrophoresis, MALDI-TOF, Protein-protein interaction networks:Topology, Network motifs, Protein Expression profiling and applications.**Protein Networks and mapping-**Yeast two hybrid, Co-Precipitation, Phage Display, Phylogenetic Profile, Domain fusion, Gene Neighborhood, Gene Cluster, Mirror Tree, Analysis of genome wide Protein-Protein Interactions in yeast, Genome wide yeast two hybrid analysis of other organisms, Protein fragment complementation assays.

Texts Books:

1. S.Sahai, “Genomics and Proteomics, Functional and Computational Aspects “, Pienum Publications (1999).

2. Moody P C E and A J Wilkinson,”Protein Engineering”. IRL Press. (2004)

Reference Books:

1.Creighton T E, “Proteins”. Freeman W H. Second edition (1993).

MOLECULAR MARKERS AND DIAGNOSTICS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the Diagnosis of Viral & Bacterial diseases analysis	1,6	1
CO2	Understand Biochemical Disorders	1,6	1
CO3	Understand Immunodiagnostics and applications	1,6	1,2
CO4	Apply DNA based Diagnostics	1,6	1,2

Diagnosis of Viral & Bacterial diseases: Host pathogen interactions in disease process; Protective immune response in Bacterial, Viral and Parasitic diseases; Cancer; Inappropriate Immune response; Disease pathology and clinical spectrum; Clinical diagnosis of diseases; Molecular Genetics of the host and the pathogen. **Biochemical Disorders:** Biochemical disorders; Immune, Genetic and Neurological disorders; Molecular techniques for analysis of these disorders; Assays for the Diagnosis of inherited diseases; Bioinformatics tools for molecular diagnosis. **Immunodiagnostics:** Antibody based diagnosis; Monoclonal antibodies as diagnostic reagents; Production of monoclonal antibodies with potential for diagnosis; Diagnosis of bacterial, viral and parasitic diseases by using; ELISA and Western blot. **DNA based Diagnostics:** Isolation of DNA; purification and analysis; DNA sequencing and diagnosis; PCR and Array based techniques in diagnosis; Single nucleotide polymorphism and disease association; Two dimensional gene scanning. **Bioanalytical Techniques for Diagnosis:** Isolation of proteins and other molecules associated with disease; Process and their profiling for diagnosis; 2D analysis of such proteins by sequencing individual spots by Mass Spectrometry; Protein Micro array; Present methods for diagnosis of Specific diseases like Tuberculosis, Malaria and AIDS; Ethics in Molecular Diagnosis.

Texts Books

1. Campbell, M.A and Heyer L.J., Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition, CSHL Press, Pearson/Benzamin Cummings San Francisco, USA, 2007.
2. Andrew Read and Dian Donnai, New Clinical Genetics, Scion Publishing Ltd, Oxfordshire, UK, 2007.

Reference Books

1. James W Goding, Monoclonal antibodies: Principles and Practice, 3rd Edition, Academic Press, 1996.
2. George Patrinos and Wilhelm Ansorage, Molecular Diagnostics, 1st Edition, Academic Press, 2005.

GENE AND THE ENVIRONMENT

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of genes and its impact on environment	1	1
CO 2	Describe about environmental factors that damage DNA	5	2
CO 3	Compare detoxification and antioxidant defenses	11	3
CO4	Compare stress genes from organisms	11	3

Genes and the Impact of Environment: Genes, Genotypes and Phenotypes, Gene activity and the Environment, Genes and the tolerance of environmental stress, DNA stability and the Environment. **Environmental factors that damage DNA**: Synthetic chemicals, nuclear radiation, Ultraviolet radiation, Atmospheric pollutants, Food components, Therapeutic drugs, Microbial and viral pathogens **Possible Oxidative damage from cellular free radicals:** Neutrophils, macrophages and the oxidative burst, superoxide generation and release from non phagocytic mammalian cells. Other cellular sources of superoxide or Hydrogen, singlet oxygen nitric oxide, The potential for superoxide, hydrogen peroxide and nitric oxide to cause DNA damage.The Extent of Oxidative Damage to DNA. **DETOXIFICATION AND ANTIOXIDANT DEFENCES** Systems for the Detoxification of Environmental Chemicals Cellular Antioxidant Defence System **GENE ACTIVATION AND ENVIRONMENTAL STRESS** High-temperature Stress Low-temperature Stress Water Stress Toxic Metal Stress Oxidative Stress Hypoxic and Anoxic Stress Sunlight and Ultraviolet Radiation Stress Toxic Chemical Stress Nutrient Stress Pathogen and Wounding Stress **STRESS GENES AND BIOTECHNOLOGY** Genetic Engineering for Stress Tolerance Biomarkers of Environmental Stress Genes from Organisms Living in Extreme Environments Bioremediation

Text Books

1) Burdon, Roy H. Genes and the Environment. CRC Press, 2014.

2) Costa, Lucio G., and David L. Eaton, eds. Gene-Environment Interactions: Fundamentals of Ecogenetics. John Wiley & Sons, 2005.

Reference Books:

1) Boomsma, Dorret I., and Nicholas G. Martin. "Gene–environment interactions." Biological psychiatry (2002): 181-187.

MICROBIAL GENETICS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcome	Mapped PO	B T L
CO 1	Acquire the knowledge of Genome Organization &Types of Sequences and Recombination	1	1
CO 2	Describe about Gene Expression Regulation	5	2
CO 3	Compare X chromosome & Mt DNA analysis in Forensics	11	3
CO4	Compare Y Chromosome & Mt DNA analysis in Forensics	11	3

DNA REPLICATION AND REPAIR MECHANISMS. Molecular mechanisms of DNA Replication – bidirectional and rolling circle replication. Plasmids – types, structure and replication. DNA repair – mechanism of excision repair, SOS repair and mismatch repair. Plasmids and types, plasmid replication and segregation, plasmid maintenance by host killing-role of ccd genes, conjugation, cis-trans complementation tests DNA RECOMBINATION AND MUTATION. DNA recombination and models – general recombination, site specific recombination, restriction and modification systems, insertion sequences and transposable elements and examples, mutations and types. GENETICS OF BACTERIOPHAGE General characteristics of bacteriophages, phage T4 – structure, gene expression and genome organization, λphage – replication, lytic and lysogenic cycles, transcription of phage genes, mechanisms of repressor synthesis and its control. TRANSCRIPTION AND TRANSLATION. Process of transcription – initiation, elongation – termination. Synthesis of mRNA in prokaryotes and eukaryotes. Synthesis of rRNA and tRNA. RNA processing – capping and polyadenylation. Genetic code, process of translation – initiation, elongation and termination. Signal sequences and protein transport. STRAIN CONSTRUCTION. Construction of bacterial strains – isolation of sugar utilization mutants and thymine requiring mutants, selection for autotrophic deletion mutants, strain construction using existing strains, isolating transposon insertions in genes, using transposon insertions near genes, localized mutagenesis, production of phage mutants, isolation of λ lambda mutants, use of phage to isolate operon and gene fusions.

Text Books

1. Moat and Foster, “Microbial Physiology”, Wiley Liss publishers, 4th edition, 2002
2. Jeremy W. Dale and Simon F Park, “Molecular Genetics of Bacteria”, John Wiley and Sons, 4th edition, 2004.

Reference Books

1. Manuck, Stephen B., and Jeanne M. McCaffery. "Gene-environment interaction." Annual review of psychology 65 (2014): 41-70.

DNA FORENSICS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Genome Organization &Types of Sequences and Recombination	1	1
CO 2	Describe about Gene Expression Regulation	5	2
CO 3	Compare X chromosome & Mt DNA analysis in Forensics	11	3
CO 4	Compare Y Chromosome & Mt DNA analysis in Forensics	11	3

Genome Organization &Types of Sequences-Nomenclature of chromosome, C-value paradox, dosage compensation. Chromosome structure, Genome organization, Chromatin, Euchromatin, Hetero- chromatin, Organization and evolution of nuclear and organelle genomes, Split genes, Essential & Non-essential genes, VNTR, SNP, SINES, LINES, SSR, STR, Mini and Micro Satellites**. X chromosome in Forensics-**History of forensic utilization of the X chromosome, X-chromosomal STR's and markers in trace analysis and kinship analysis. Mapping and haplotype analysis, Population haplotype distribution, Ethical considerations in X Chromosomal marker testing.**Y Chromosome & Mt DNA analysis in Forensics** Y-Chromosomal Markers in Forensic: Introduction, Identification of the male sex and lineage, Identification of a male's paternity and geographical origin. Mitochondrial DNA (mtDNA) biology, Identification of individuals (mtDNA typing).

Text Books:

1. Alberts ,"Molecular Biology of the Cell" , 5th Ed, Garland Science / Taylor & Francis Group (2008)
2. Ralph Rapley ,"Molecular Forensics " John Wiley & Sons, Ltd (2007).

Reference Books:

1. R.M Twyman ,"Advanced Molecular Biology", Springer-verlag (1998)
2. Eberhard Passarge ,"Genetics ", (2006).

MICROBIAL TECHNOLOGY

Mapping of Course out comes with program out comes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of microbial technology	1	1
CO 2	Screen out medium and strain development	5	2
CO 3	Develop various strategies to produce Primary and secondary metabolites	11	3
CO 4	Design various strategies to produce Enzymes, recombinant Proteins, and other special bio products.	11	3

Introduction to basics of biotechnology - A historical overview on scope and development of biotechnology and their products; Biotechnology as an interdisciplinary enterprise; A brief survey of organisms, processes, products and market economics relating to modern industrial biotechnology; Concepts of tools and techniques used in biotechnology; Out line and integrated bioprocesses and various unit operations (upstream and downstream) involved in the bioprocesses. Generalized process flow sheets. **Media, Screening and Strain improvement -** Medium requirements for fermentation process- carbon, nitrogen, minerals, vitamins and other nutrients- examples of simple and complex media; Industrial substrates. Primary and Secondary screening. Strain improvement by Physical, Chemical and Molecular techniques. **Production of Primary Metabolites -** A brief outline of processes for the production of some commercially important Organic acids (e.g., Citric acid, Lactic acid , Acetic acid, Gluconic acid); Amino acids (Glutamic Acid, Lysine, Aspartic Acid and Phenylalanine); and Alcohols (Ethanol, 2,3-butanediol) **Secondary Metabolites-** Study of production processes and flow sheets for various classes of low molecular weight secondary metabolites: Antibiotics-beta- lactams (Penicillin's), aminoglycosides (Streptomycin), Macrolids (Erythromycin), Quinines and aromatics. Vitamin B12 and steroids, Dual or multiple fermentation. **Enzymes, Recombinant Proteins, Special bioproducts-** Enzymes- Protease,; Concept of SSF, Advantages and disadvantages,Production of Recombinant Proteins- Insulin and Special Bioproducts- Biopesticides; Biofertilizers Natural Biopreservatives (Nisin); Biopolymers (Xanthan Gum); Single cell protein, High Fructose Corn Syrup; process ofbioleaching

Text books:

1. Stanbury, Peter F., Allan Whitaker, and Stephen J. Hall. Principles of fermentation technology. Elsevier, 2013.
2. Prescott, Samuel Cate, and Cecil Gordon Dunn. "Industrial microbiology." Industrial microbiology. (1949).

Reference Books:

1. Glazer AN, Nikaido H ,"Microbial Biotechnology", WH Freeman and Company,(1995).
2. JE Baily & DF Ollis ,"Biochemical Engineering Fundamentals"(2nd ed), , McGraw Hill Book Co. NewYork.(1986).

PHARMACEUTICAL BIOTECHNOLOGY

Mapping of course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Fundamentals ofpharmaceutical practice	3	3
CO 2	Asses the drug metabolism and pharmacokinetics and formulate pharmaceutical dosage & blood, plasma products	4	2
CO 3	Compare various Pharmaceutical products	4	2
CO 4	Develop various strategies of manufacturing processes	11	3

Fundamentals of pharmaceutical practice-Pharmaceutical biotechnology: An introduction; Origin & definition; Scope &Importance of Biotechnology; their applications; Microbes in Pharmaceutical industry; Methods of Gene transfer; Biotechnology; Production of Secondary Metabolites; Drug Interactions; Surgical supplies. D**rug metabolism and pharmacokinetics-** ADME-properties-Mechanism of Drug Absorption; Distribution of drugs; Drug metabolism(Biotransformation of drugs);Excretion of drugs; Pharmacokinetics; Basic considerations; Controlled Release Medication; Design of Controlled drug delivery systems; Drug release patterns; Oral parental; Trans-dermal ; Ophthalmic ; Intra-vaginal and Intrauterine Drug Delivery systems. P**harmaceutical dosage & blood, plasma products-** Materials & Formulations; Manufacture of Tablets; Capsules; Sustained Release dosage forms; Parental solutions; Oral liquids; Emulsions; Ointments; Suppositories, Aerosols; Topical applications; Collection; Processing and storage of whole human blood; Concentrated human RBC Control of Blood products; Transfusion products. P**harmaceutical products-**Fundamentals of Therapeutic categories such as Analgesics, Anesthetics, Antipyretic; Anti-inflammatory drugs; Antacids; Alkaloids; Glycosides; Hormone & Hormone antagonists; Antineoplastics and Immuno active drugs; Biologicals (Immunizing agents and allergenic extracts).D**rug manufacturing processes-** Good manufacturing practices; Manufacturing facilities; Sources of Biopharmaceuticals; Production & analysis of Biopharmaceuticals.

Texts Books:

1. LeonLachman,"The Theory andPracticeof Industrial Pharmacy", CBS Publishers & Distributor Pvt. Ltd. (pur)(2009).
2. Remington ,"The Science and Practice of Pharmacy" (Vol.1&11), Lww(2007)

Reference Books

1. SS Purohit,H N Kakarani &AK Saluja ,"Pharmaceutical Biotechnology", Program Edition (2010).

METABOLIC ENGINEERING

Mapping of Course out comes with program out comes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Introduction of Metabolic Engineering	1	1
CO 2	Acquire the knowledge of Genetic improvement of strains	1	1
CO 3	Analyze metabolic pathways	5	2
CO 4	Develop experimental determination strategies of of Flux	8	3

Syllabus:

Introduction of Metabolic Engineering, Identification of metabolic regulation is a key point in metabolic engineering. Synthesis of Primary Metabolites, Metabolic Engineering for Bioproduction , Metaboliic Pathway(MP)Modeling and Obserbability of MP, Metabolic Flux Analysis(Cell Capability Analysis), Metabolic Flux Analysis(Genome Scale Flux Analysis) , Metabolic Control Analysis Molecular Metabolic Engineering, 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, Feedback repression, Catabolite, Repression, optimization and control of metabolic activities. The modification of existing - or the introduction of entirely new - metabolic pathways. Experimental Determintion Method of Flux Distribution with Isotope Labeling, Metabolic Engineering with Bioinformatics. Application in pharmaceuticals, chemical bioprocess, food technology, agriculture, environmental bioremediation and biomassconversion.

Text Books:

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 sons1980.
2. Stanbury P.F., and Whitaker A., Principles of Fermentation Technology, Pergamon Press, 1984.

BIORESOURCE TECHNOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	COURSE OUTCOME	MAPPED PO	BTL
CO1	Acquire the knowledge of Bioresources	1,5	1
CO2	Understand the knowledge of Biogas production	1,5	1
CO3	Describe the methods for Bioethanol and Biobutanol production	1,5	1,2
CO4	Describe the methods for Biodiesel production	1,5	1,2

Syllabus:

Renewable energy source: Hydropower, geothermal power, solar power, wind power – Biofuel -Biomass - Feed stocks (agricultural crops, bioenergy crops, agricultural waste residues, wood residues, waste stream) **Fuel technology and bioconversion:** History - Definition of biofuel, applications of biofuel (transport, direct electricity generation, home use and energy content of biofuel) - Bioconversion of lignocellulosics, cellulose saccharification, pretreatment technologies (air separation process, mechanical size reduction, autohydrolysis) - Pulping and bleaching – Enzymatic deinking. **Biogas:** Biogas plant, feed stock materials, biogas production, factors affecting methane formation - Role of methanogens – Biohydrogen production - Oxygen sensitivity problems in hydrogenenases **Bio ethanol and butanol:** Advantages of ethanol over fossil fuels, production of ethanol from cellulosic materials, ethanol recovery - Biobutanol production, energy content and effects on fuel economy - Octane rating, air fuel ratio, specific energy, viscosity, heat of vaporization -Butanol fuel mixtures **Biodiesel:** Production of biodiesel, oil extraction from algae by chemical solvents, enzymatic, expeller press - Osmotic shock and ultrasonic assisted extraction - Applications of biodiesel, environmental benefits and concerns

Text books

1. Alain A.V., Biomass to biofuels strategies for global Industries, John Wiley & sons ltd, 1st Edition, 2010.
2. Twidell., J & Weir., T., Renewable energy resources, Taylor & Francis 2nd Edition, 2006.

Reference books:

1. Luque, R., Camp, J., Hand book of biofuel production processes and technologies, Woodhead publishing ltd., 1st Edition, 2011.

BIOPROCESS ECONOMICS AND PLANT DESIGN

Mapping of Course out comes with program out comes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Understand basics of economic evaluation	2	2
CO 2	Acquire the knowledge of Bioprocess Economics	2	2
CO 3	Develop various strategies of process design	3	2
CO 4	Design various strategies of Basic considerations in equipment design and Basic Design Problems	5	2

Syllabus

Economic evaluation Capital cost of a project. Interest calculations, nominal and effective interest rates. Basic concepts in tax and depreciation. Measures of economic performance, rate of return, payout time. Cash flow diagrams; Cost accounting-balance sheet and profit loss account. Break even and minimum cost analysis. **Bioprocess Economics** Introduction, elements of total production cost, outline of the total capital investment, equipment sizing, capital cost estimates large-scale equipment and utilities. Manufacturing cost estimates – Operating costs-Raw materials, utilities, fixed costs and overhead costs, case studies of antibiotics, recombinant products, single cell protein. **Introduction to process design** Schematic representation of unit operations, design information and flow diagrams, material and energy balances, formulation of the design problem, the Hierarchy of chemical process design and integration, optimization, Health and safety Hazards, Environment protection, plant location and lay out. **Basic considerations in equipment design** General design procedure, equipment classification, materials of construction-Mechanical properties-strength, elasticity, ductility, resilience, toughness, hardness, creep, fatigue. Metals-ferrous metals, types of iron & steels, nonferrous metals and Non-metals. Corrosion: Forms of corrosion and their presentation. Choice of materials. Design conventions. **Basic Design Problems** Design examples on continuous fermentation, aeration and agitation. Design calculation of filter for air sterilization. Design of batch and continuous sterilizers. Design calculations for immobilized enzyme kinetics. Practical considerations in designing of Bioreactor/Fermentor construction. Introduction to different types of valves, pumps, steam traps, spargers and impellers used in fermentation industries. Design exercise on trickle flow fermenter. Problems associated with design equations.

Recommended Text Books:

1. Peters & Timmerhaus, Plant design and Economics for Chemical Engineers McGraw Hill Higher Education (2004).
2. M V Joshi & V .V. Mahajani, Process equipment design, 3rd Ed. Macmillan India Limited (2000)

Reference books:

1. Harvey W Blanch, Biochemical Engineering, 2nd Ed,Taylor &Francis. 2009

ENZYME ENGINEERING

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	COURSE OUTCOMES	Mapped PO	BTL
CO1	Acquire the knowledge of terminology and classification of enzymes.	1,5,12	1,2
CO2	Understand the mechanisms of enzyme catalysis and action.	1,5,12	1,2
CO3	Evaluate the kinetics of enzyme parameters.	1,5,12	1,2,3
CO4	Understand the various industrial enzymes and their applications.	1,5,12	1,2

Syllabus:

Introduction to Enzymes: Nomenclature and Classification. Criteria of purity of enzymes-Specific activity. Enzyme units-Katal and IU. Enzyme activity, Non-protein enzymes-Ribozymes and DNAzymes. Metalloenzymes and metal activated enzymes. Coenzymes and Cofactors- Prosthetic group, coenzymes involved in different metabolic pathways. Classification of coenzymes. **Enzyme Catalysis and Inhibition:** Lock and key, Induced fit and Transition state Hypotheses. Mechanism of enzyme catalysis. Mechanism of Serine proteases-Chymotryspin, Lysozyme, Carboxypeptidase A and Ribonuclease. Proenzymes (Zymogens). **Reversible Inhibition:** Competitive, Non-Competitive, Uncompetitive, Mixed, Substrate, Allosteric and Product Inhibition. Irreversible Inhibition- Suicide inhibition. Examples and Mechanism of various Inhibitions like Penicillin, Iodoacetamide and DIPF. **Enzyme Kinetics:** Factors affecting the enzyme activity. Kinetics of a single-substrate enzyme catalysed reaction, Michealis-Menten kinetics, Estimation of kinetic parameters, Turnover number, Kinetics of Enzyme Inhibition, Kinetics Allosteric enzymes. **Enzyme Regulation:** Feedback Regulation, Allosteric Regulation, Reversible Covalent Modification and Proteolytic Activation. Organisation of enzymes in the cell. Enzymes in the cell, localization, compartmentation of metabolic pathways, enzymes in membranes, concentrations. Mechanisms of enzyme degradation, lysosomal and nonlysosomal pathways, examples. **Applied Enzymology:** Industrial Enzymes, enzymes used in various fermentation processes, Clinical enzymes, Isoenzymes; Immobilization of enzymes, ELISA. Biosensors. Enzyme Engineering and site directed mutagenesis, Designer enzymes.

Text Books:

1. Enzymes: Biochemistry, Biotechnology and Clinical Chemistry- Trevor Palmer, 2nd edition, Woodhead Publishing, UK.
2. Fundamentals of Enzymology: Nicholas C. Price & Lewis Stevens, Oxford University Press, UK.

Reference Books:

1. Biochemistry: Lubert Stryer, Worth Publishers Inc., 1999.
2. Biochemistry:Donald Voet, Judith G. Voet, 4th Edition, John Wiley & Sons, 2001
3. Lehninger Principles of Biochemistry: David L. Nelson, Michael Cox, Macmillan Learning International Edition, 2005

BIOPROCESS VALIDATION AND cGMP

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of terminology and classification of enzymes.	1,5,12	1,2
CO2	Understand the mechanisms of enzyme catalysis and action.	1,5,12	1,2
CO3	Evaluate the kinetics of enzyme parameters.	1,5,12	1,2,3
CO4	Understand the various industrial enzymes and their applications.	1,5,12	1,2

Bioprocess Validations Validations – Methods of validation. Prerequisites, process design & testing process characterization, Process optimization, Validation options, Prospective process validation, retrospective validations, Concurrent validations, Revalidation, Organizing Revalidation studies, Analytical method validations, Cleaning validation, Prevalidation verification, Documentation, Control of cleaning materials & ancillary tools, Frequency of cleaning, Development of validation protocol. Quality Assurance Quality Assurance, Quality control, Quality management, Responsibilities of quality management in laboratories, Development of quality records, Deviations of quality product process, Good laboratory practices, Responsibilities in GLP, Computational processes in GLP.Standard Operating Procedures. Standard operating procedures, SOP of immunological industries, SOP of tissue culture, Deviations of SOP, Revision occurrence in SOP, Authorized control of SOP, Guidelines and regulation of FDA and ICH for GLP. Good Manufacturing Practices Quality control of a product, Good manufacturing practices, cGMP, GMP of industries, Sanitation & Hygiene, Control of finished products, Maintenance of materials in laboratories, Zero contamination, Documentation of GMP, Compliance of GMP.Clinical Practices Of GMP Clinical practices in laboratories, Clinical practices in vaccine production, Clean room, Class A, B (USFDA), Bacterial counts in clean room, Waste disposal in laboratories, Health & hygiene of persons involved in clinical laboratories. ICH guidelines for clinical laboratories.

Recommended Textbooks:

1. Sharma, P. P. "How to practice GMPs." vandana publication (6) (2001): 58-62.
2. Swartz, Michael E., and Ira S. Krull. Handbook of analytical validation. CRC Press, 2012.

Reference textbook:

1. Seiler, Jürg P. Good Laboratory Practice: The why and the how. Springer Science & Business Media, 2006.

FOOD TECHNOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	COURSE OUTCOME	Mapped PO	BTL
CO1	Acquire the knowledge of food associated microbes	2,3	1
CO2	Describe food processing	2,3	1,2
CO3	Develop various strategies involved in preservation and storage	2,3	1,2
CO4	Conclude various principles involved in food microbiology	2,3	1,2

Food associated Microbes: History of microorganisms in food, historical developments. Biotechnology in relation to the food industry, nutritive value of food, types of microorganism's associated with food, its sources, types and behaviour in foods. Role and significance of microorganisms in food. Intrinsic and extrinsic parameters of foods that affect microbial growth.Food processing: Bioprocessing of meat, fisheries, vegetables, diary product, enzymes and chemicals used in food processing, biochemical engineering for flavor and food productions. Emerging processing and preservation technologies for milk and dairy products. Food preservation: Food preservation using irradiation, Characteristics of Radiations of interest in food preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation. Application of radiation, Radappertization, Radicidation, and Radurization of foods. Legal status of food irradiation. Effect of irradiation of food constituents. Storage of foods: Stability of food preservation with low temperatures, high temperatures, drying. Indicator and food borne pathogens. Food borne illness, quality control, HFCS (High Fructose Corn Syrup) and mycoproteins. Air sampling, metabolically injured organisms, enumeration and detection of food-borne organisms. Food microbiology. Utilization of microorganisms in food industries, genetic manipulations. Thermophiles and Radiation-resistant microorganisms, characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorganisms. Rheology of food production.

Text Books:

1. Lidsay, Willis Biotechnology, Challenges for the flavour and food industries, Elsevier Applied Science. 1988.
2. Food Science and Food Biotechnology by F.F.G. Lopez & G.V. B. Canovas (2003), CRC Press, Florida, USA.

Reference Books:

1. George J.B. Basic Food Microbiology, CBS Publishers & Distributors, 1987.

PERL AND BIOPERL PROGRAMMING

Mapping of Course out comes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of an Introduction to Perl & Variables and Data Types	4	3
CO 2	Acquire the knowledge of Arrays and Hashes	3	2
CO 3	Describe Control Structures & String Manipulation and Input and Output- Program Parameters	4	3
CO 4	Develop various strategies involved inBioperl	11	3

Syllabus:

An Introduction to Perl & Variables and Data Types-The Perl Interpreter - Perl Variables - Scalar Values-Variable Definition -Special Variables **Arrays and Hashes-** Arrays-Array Manipulation -Push and Pop, Shift and Unshift –Splice-Other Useful Array Functions-List and Scalar Context -Hashes -Maintaining a Hash **Control Structures & String Manipulation-** Comparisons Choices- If - Boolean Operators- Else-Loops-For Loops -For each Loops 52. Indeterminate Loops -While -Repeat Until -Loop Exits -Last -Next and Continue -Array-Based Character Manipulation -Regular Expressions –Match-Substitute – Translate. **Input and Output-** Program Parameters -File I/O -File handles-Working with Files -Built-in File Handles - File Safety - The Input Operator –Binary-Interprocess Communications – Processes- Process Pipes-Creating Processes - Monitoring Processes. **Bioperl-** Sequences -SeqFeature – Annotation- Sequence - Example BioperlPrograms

Text books:

1. James Tisdall ,"Beginning Perl for Bioinformatics",ReillyPublishers, 2012
2. Jamison D."Perl Programming for Biologists",Wileypublishers, 2011

Referencebooks:

1. Peter Norton,"Introduction to computers", Tata Mc Graw Hillpublishers, 2006

BIOMEDICAL INFORMATICS

Mapping of Course out comes with program out comes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of web programming with Javascript	2	1
CO 2	Understand genomics role in informatics	2	1
CO 3	Analyze biochemical pathways	5	4
CO 4	Develop virtual Physiological Human; geometric models of proteins	11	5

Web programming with Javascript Why JavaScript? Environment setup: Chrome, Git, GitHub. Control flow, functions, closures; objects, built-in objects; prototype, inheritance; coding style guide, the Javascript ecosystem, Coffeescript. Biomolecules and life Outline of genomics: DNA and genetic code, RNA, mapping of genes and proteins. Outline of proteomics: primary, secondary, tertiary and quaternary structures. Biochemical pathways. Nervous system, neurons, neuro-muscular interface. Biomedical records, data and images Electronic Medical Record (EMR) environments. Laboratory data, anatomic data, biomedical imaging, PACS systems, DICOM images. PDB (Protein Data Bank), European Bioinformatics Institute (EBI) services. Symbolic biomedical knowledge Web 3.0. Ontologies as formal and explicit specification of objects, properties and relations in organizing biomedical data. The University of Washington FMA anatomic model (Digital Anatomist-Foundational Model of Anatomy); Biomedical modeling and simulation Physiological models. Virtual Physiological Human; geometric models of proteins, cells, tissues and systems. Geometric models of neurons, axons and dendrites. Models of the neuro-muscularinterface.

Text Books:

1. J. Kalet, Principles of Biomedical Informatics, Elsevier,2009.

Reference Books:

1. Swartz, Michael E., and Ira S. Krull. Biomedical Informatics. CRC Press, 2012.

MOLECULAR MODELING AND DRUG DESIGN

Mapping of Course out comes with program out comes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Introduction to Molecular Modeling	3	3
CO 2	Describe the Basic concepts of Protein Modeling and Protein structure Determination	2	2
CO 3	Develop Molecular Dynamics and Simulations	11	3
CO 4	Design and constructMolecularmodeling strategies inDrug designing	11	3

Introduction to Molecular Modeling- History of molecular modeling, physical and computer models, different representations of computer models, Generation of 3D coordinates–using x-ray crystallographic databases, compilation of fragment libraries with standard geometrics, drawing of 2D structures using sketch. **Basic concepts of Protein Modeling -**Concepts of Force Fields, Quantum and Molecular mechanical force fields, Generation of potential energy surfaces, Geometry Optimization, Energy-Minimizing Procedure, and Use of Charges. Salvation Effects, Methods, Ab initio Methods, Semi-empirical Molecular Orbital Methods, Conformational Analysis. **Protein structure Determination-** Comparative Modeling of Proteins, Ab initio modeling and fold recognition Transmembrane Protein Models Based on High-Throughput Molecular Dynamics Simulations with Experimental Constraints, Nuclear Magnetic Resonance- Based Modeling and Refinement of Protein Three-Dimensional Structures and Their Complexes. **Molecular Dynamics and Simulations-** Molecular Dynamics Simulations, Monte Carlo Simulations, Hybrid Quantum and Classical Methods for Computing, Kinetic Isotope Effects of Chemical Reactions in Solutions and in Enzymes, Normal Modes and Essential Dynamics.

Molecular modeling applications in Drug designing- Identifying Putative Drug Targets and Potential Drug Leads: Starting Points for Virtual Screening and Docking Receptor Flexibility for Large-Scale In Silico Ligand Screens: Chances and Challenges, Molecular Docking

Textbooks:

1. Hans-Dieter Holtje and Gerd Folkers ,"Mol**ecu**lar modeling basic principles and applications", Wiley(2003).
2. Andreas Kukol, "Molecular modeling of Proteins-edited ", Humana Press. (Apr2008)

Reference books:

1. AR Leach," Molecular Modeling Principles and Applications", Longman (1996).

STRUCTURAL BIOLOGY

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Structural biology of Nucleic acids	3	3
CO 2	Describe the Protein dynamics	3	3
CO 3	Compare various techniques for structural biology	4	2
CO 4	Conclude the principles involved in structure predictions and structural elucidation	11	3

Structural biology of Nucleic acids-Types of Double helices; Structural and Geometrical parameters of each and their comparison. Dynamics and types of interactions of DNA with proteins, and small molecules. RNA – Secondary structures, Tertiary structures, t-RNA tertiary structure. **Protein dynamics-**Protein Purification &Crystallization methods, Principles of X-ray Diffraction, Brags Law. Phase Determination, Calculation of Electron Density Map, Interpretation of the electron density map, Refinement of the Structures. **Techniques for structural biology-**Principle of NMR Spectroscopy, Magnetic properties of nuclei, Energy Levels of proton during spin, Chemical Shift, Coupling Constants, Shielding, Determination of secondary structure NOSEY, COSY. **Structure predictions-**Basic principles of secondary structure prediction methods, Algorithms of Chou Fasman, GOR, PHD, PSI-PRED, Stereo- chemical method of Lim and Neural network method, concepts in measuring the accuracy of predictions. **Structural elucidation-**Steps involved in Homology Modeling. Fold Recognition andab-initiomethods, Derivation and significance of Ramachandran Plot, Root Mean Square Deviation (RMSD), Energy Plot based on Potential of mean force, Packaging Quality, Helical Wheel, Hydrophobicity profiles, Amphiphilicity detection, Transmembrane prediction methods. Concepts in 3D structure comparison, purpose of structure comparison, Algorithms for structure comparison (FSSP, VAST & DALI), Structure-function relation, Function inference from structure.

Recommended Textbooks:

1. Arthur M. Lesk, “Introduction to Protein Science” Oxford UniversityPress (2004).
2. Arthur M. Lesk, “Introduction to Protein Architecture”, Oxford UniversityPress (2001).

Reference textbooks:

1. McPherson, “Introduction to Macromolecular Crystallography” John Wiley Publication (2003) 2.Philip E. Bourne, Helge Weissig, “Structural Bioinformatics”.

SYSTEMS BIOLOGY

CO No	Course Outcomes	Mapped PO	B T L
CO1	Understand the network properties	1,5	1
CO2	Analyze regulatory network throughsystems biology software	1,5	1,2
CO3	Analyze Algorithms for biochemical network construction	1,5	1,2
CO4	Analyze Microarrays	1,5	1,2

Syllabus:

INTRODUCING COMPUTATIONAL SYSTEMS BIOLOGY: basic concepts of systems biology, enabling information and integration for systems biology, databases for systems biology, natural language processing and ontology-enhanced biomedical literature mining for systems biology. FOUNDATION OF BIOCHEMICAL NETWORK ANALYSIS AND MODELING; Introduction to computational models of biochemical reaction networks, Biological foundation of signal transduction and the systems biology perspective, Reconstruction of metabolic Network from Genome Information and Its Structural and Functional Analysis.metabolic flux analysis and gepasi, gopher. COMPUTER SIMULATIONS OF DYNAMIC NETWORKS. Discrete Approach to Network Modeling, Gene Networks: Estimation, Modeling and Simulation, Computational models for circadian rhythms: Deterministic versus stochastic approaches, Multi-Scale Representations of Cells and Emerging Phenotypes; Spatio-Temporal Systems Biology, Cytomics-from cell states to predictive medicine, THE IUPS PHYSIOME PROJECT: Progress, E-cell concept. Genesis tool and its applications. Applications and perspectives of systems biology; development and trends of systems biology, long and medium term goals of systems biology, microarray analysis and gene networks, BRB Array tool.

Text books:

1. Computational systems biology. By Andres Krite, Ronald Eils. Published by academic press, 2005.
2. Systems Biology: Applications and perspectives. By Peter Bringmann, Published by springers, 2007.

Reference Books

1. Systems biology: principles, Methods, and Concepts. By Andrzej K. Konopka. Published by CRC Press, 2007.
2. Systems biology: Definitions and Perspectives. By Lilia Alberghina, Hans V. Westerhoff, Published by Birkhauser. 2005.

APPLIED BIOINFORMATICS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of genomics	3	3
CO 2	Describe the Protein dynamics	3	3
CO 3	Compare various techniques for applied bioinformatics	4	2
CO 4	Conclude the applications of system biology	11	3

Syllabus:

Comparative Genomics. Genetic mapping, Physical mapping, SNPs, ESTs, GSS, Gene prediction methods, Gene prediction tools, Gene annotation, Molecular Predictions with DNA sequence, Human Genome Project. Protein Structure Prediction and Evaluation methods Structure of Protein – PDB, MMDB; Ramachandran Plots; Structure visualization – Rasmol; Methods of Structure prediction – Homology modeling - SPDBV, Threading, Ab-initio method; Structure Evaluation – DSSP, ProCheck, Verify 3D; Structure comparison. Protein Identification And Interactions Proteomics approaches for protein analysis; Protein identification Programs – Mascot, GFS; Comparative Proteomics methods; Protein interactions; Protein Interaction dbs – GRID, MINT; Network Mapping; Biological Pathway dbs – EcoCyc, KEGG; Pathway prediction; Metabolic pathway reconstruction. Gene Expression Analysis Introduction; Serial Analysis of Gene Expression; Microarray, Types of Microarrays, Microarray Fabrication, Microarray hybridization and detection, Microarray Image Processing and analysis, Expression ratios, Transformations of the Expression ratio, Data Normalization. System Biology Foundations of System Biology- Objectives of System Biology-Strategies relating to In Silico Modeling of biological processes- Metabolic Networks- Signal Transduction pathways, Gene Expression patterns – Applications of System Biology Markup Language (SBML), E-cell, V-cell simulations and Applications

Recommended Textbooks:

1. G. Gibson and SV Muse, A Primer of Genome Science, Second Edition - Sinauer Associates, Inc., 2008
2. CW Sensen, Essentials of genomics and Bioinformatics, Wiley-VCH publication, 2013

Reference textbooks:

1. Speed T. (ed.) Statistical analysis of gene expression microarray data (CRC, 2003)

PYTHON AND R PROGRAMMING

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Understand the basics of Python and R programming	1,5	1
CO2	Analyze Biological sequence analysis with python	1,5	1,2
CO3	Analyze biological data statistics	1,5	1,2
CO4	Analyze gene expression with R	1,5	1,2

Python fundamentals: installing python; basic usage, running programs, basic elements & syntax, strings, lists and tuples, dictionaries, loops, comparisons, definitions & functions, classes, randomization & permutation, types and operations, functions, modules, classes, exceptions-object oriented programming, modules object oriented programming, threads, process, synchronization, databases and persistence, image manipulation, modules. **Introducing r:** the big picture,the benefits of using r, installation, r editor and r-gui, r environment, simple mathematics and vectors,the fundamentals of r, arguments,putting the argument in a function,history,structuring the code, comments, packages and r packages control statements, if-else statements, switching looping,for loop, debugging the code, errors and warning. **Biological sequence analysis** using python and r; biopython: parsing dna data files, sequence alignment, dynamic programming, hidden markov model, genetic algorithms, multiple sequence alignment, gapped alignment. Advanced statistical analysis techniques-trees, text mining, clustering, self organizing map, principal component analysis, fourier transforms, numerical sequence alignment. Gene expression array analysis, spot finding and measurement, spreadsheet ,arrays and data displays, applications with expression arrays. Using r programming for gene expression analysis

Text Books

1. Jason kinser, "python for bioinformatics", Jones & Bartlett publishers, 2008.
2. Mark lutz, "learning python", 3rd edition, o'reilly, 2007.

References:

1. Alex Martelli, David Ascher, "Python cookbook", O'Reilly, 2002.
2. R for dummies;andrie de vries and joris meys 2ndedition wiley publishers,2015

DATABASE MANAGEMENT SYSTEMS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire knowledge on database systems	3	2
CO 2	Apply SQL in relational model	3	3
CO 3	Compare data storage devices	4	3
CO 4	Analyze current trends in data types	11	4

Introduction and conceptual modelling: Introduction to File and Database systems- Database system structure – Data Models – Introduction to Network and Hierarchical Models – ER model – Relational Model – Relational Algebra and Calculus. **Relational model**: SQL – Data definition- Queries in SQL- Updates- Views – Integrity and Security – Relational Database design – Functional dependences and Normalization for Relational Databases (up to BCNF). **Data storage and query processing:** Record storage and Primary file organization- Secondary storage Devices- Operations on Files- Heap File- Sorted Files- Hashing Techniques – Index Structure for files –Different types of Indexes- B-Tree - B+Tree – Query Processing. **Transaction management**: Transaction Processing – Introduction- Need for Concurrency control- Desirable properties of Transaction- Schedule and Recoverability- Serializability and Schedules – Concurrency Control – Types of Locks- Two Phases locking- Deadlock- Time stamp-based concurrency control – Recovery Techniques – Concepts- Immediate Update- Deferred Update - Shadow Paging. **Current trends**: Object Oriented Databases – Need for Complex Data types – OO data Model- Nested relations - Complex Types- Inheritance Reference Types - Distributed databases. Homogenous and Heterogenous- Distributed data Storage – XML – Structure of XML. DataXML Document- Schema- Querying and Transformation. – Data Mining and Data Warehousing.

Text books:

1. Abraham Silberschatz, Henry F., Korth and Sudarshan, S., Database System Concepts, McGraw-Hill, 4th Edition, 2002.

Reference Books:

1. Ramez Elmasri and Shamkant B. Navathe, Fundamental Database Systems, Pearson Education, 3rd Edition, 2003.
2. Raghu Ramakrishnan, Database Management System, Tata McGraw-Hill Publishing Company, 2003.
3. Hector Garcia–Molina., Jeffrey D.Ullman and Jennifer Widom., Database System Implementation- Pearson Education, 2000.

STEM CELL TECHNOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of stem cell technology	2	2
CO 2	Describe stem cell characterization and tissue engineering	8	1
CO 3	Develop various strategies involved in biopharming and regulation ethics.	11	5
CO 4	Conclude various principles involved in biopharming and regulation ethics.	11	4

Syllabus:

Introduction-What are stem cells,types, origin and nature of stem cells? Characteristic features, pluripotent stem cells and its types, Molecular basis of pluripotency. Cell surface markers of stem cells. Embryonic stem cells, factors requirements for maintain stem cells. Differences between human and mouse stem cells. Development of epithelial stem cell concept. Stem cell niches.**Stem cell characterization-**Cell cycle regulation in stem cell. Mechanism of stem cell renewal, Changes of phenotypic characters, Characterization of human embryonic stem cells, Isolation and maintenance of Stem cell. Genetic manipulation of Embryonic Stem cell, homologous recombination of stem cells. Surface antigenic markers, lineage marking, Genomic reprogramming. Microarray analysis of stem cells & differentiation. Zebra fish and Stem cell research. **Tissue engineering-**Neural stem cells and applications in neurodegenerative diseases, Treatment of heart diseases, diabetes, burns & skin ulcers, muscular dystrophy, regeneration of epidermis, orthopedic applications. Embryonic applications in tissue engineering. Novel sources of multipotent stem cells. Adult stem cells, Stem cell gene therapy.**Biopharming-**What is biopharming? Applications of stem cell technology in animal biotechnology. Production of artificial organs using stem cell technology. Artificial pancreas, kidney, heart, liver etc. **Regulations and Ethics-**Ethics of human cell research-immortal cells and moral selves, Ethical considerations, stem cell based therapies. FDA products and preclinical regulatory considerations. Patent advocacy, Science policies, ethics in stem cell research, primordial germ cells and germ cell development epigenetics and reprogramming in stem cell biology, norms in cleanroom.

Text books:

1. Rober Lanza, "Essentials of Stem cell biology", Elsevier academic press(2009).
2. Joseph D, "Bronzino Tissue engineering and artificial organs, Biomedical engineering hand book'. volume -2, 3rd edition, CRC press, Taylor & Francispublications(2006).

Reference book:

1.Daniel R. Marshak, "Stem Cell Biology, *Johns Hopkins University and Cambrex Corp.;* Richard L. Gardner, *University of Oxford;* David Gottlieb, *Washington University, St. Louis*(2001).

HEALTHCARE BIOTECHNOLOGY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of simple proteins and therapeutic agents	1,5	2
CO2	Acquire the knowledge of Human diseases	1,5	2
CO3	Describe the various vaccines used	1,5	2
CO4	Understand the applications of genetic engineering in healthcare	1,5	2

Syllabus:

Simple proteins and therapeutic agents: Proteins as therapeutic agents - Choice of expression systems and optimizing gene expression - Applications, delivery and targeting of therapeutic proteins - Engineering human interferons and human growth hormones - Regulatory aspects of therapeutic proteins - Enzymes as therapeutic agents - Use of genetically engineered DNase I and alginate lyase for treatment of Cystic Fibrosis **Monoclonal antibodies as therapeutic agents**: Production of monoclonal antibodies - Human monoclonal antibodies, its scope and limitations - Hybrid human - Mouse antibodies - Production of antibodies in E. coli - Approaches for producing HIV therapeutic agents **Human diseases**: Viral and bacterial diseases - Diseases caused by protozoan and parasitic worms (helminths) - Emerging infectious diseases - Active and passive immunity – Autoimmunity- Rational of immunization - Diseases controllable by vaccination – Vaccines, designing vaccines adjuvants - Whole organisms vaccines - Attenuated viruses and bacteria - Inactivation of pathogenic organisms by heat and chemical treatment **Vaccines**: Bacterial polysaccharides, proteins and toxins as vaccines - Recombinant vaccines- subunit, attenuated and vector vaccines - Multivalent vaccine development against AIDS - Commercial and regulatory aspects of vaccine production and its distribution **Application of genetic engineering in health care:** Production of Recombinant Proteins having therapeutic and diagnostic applications, recombinant vaccine

Text book:

1. Glick, B. R., Pasternak, J. J., Molecular Biotechnology, Principles and Application of Recombinant DNA, ASM press, Washington, 2nd Edition, 1998

Reference Books:

1. Ratledge, C., Kristiansen, B., Basic Biotechnology, Cambridge University Press, USA, 2nd Edition, 2001

2. David, E., Technology and Future of health care, Preparing for the Next 30 years, Jhon Wiley, Singapore, 2nd Edition, 2000

CANCER BIOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of cancer	2	1
CO 2	Understand about various agents in carcinogenesis	2	1
CO 3	Apply molecular biology in various cancer cells	5	2
CO 4	Apply the role of immune cells in Cancer	6	3

Syllabus:

Cancer Biology: Phenotypic characteristics of cancer cells. Basic feature of normal cell & tissues. Characteristic features of tumour cells. Control of growth in normal cells, Factors influencing the development of cancers, Nomenclature of tumour cells, Effect of cell receptors, Different phases of cell cycle. Cell cycle regulation, Different types of cancer, Role of Diet in cancer. **CARCINOGENESIS:** Chemical carcinogenesis – History, Metabolism & Targets. Physical carcinogenesis – History, Metabolism & Targets. Viral carcinogenesis – History, Retroviruses, SV40, Adenovirus, Papilloma viruses. **MOLECULAR BIOLOGY OF CANCER:** Tumour suppressor genes, Role and regulatory mechanism of tumor suppressor genes-Retinoblastoma (Rb), p53. Mechanism leading to tumour suppressor function loss. Oncogenes - Detection of oncogenes, proto-oncogenes, Proto-oncogene activity. Growth factors, EGF family, Receptor activation, Heterodimerization, Tyrosine phosphorylation, VEGF family, gene silencing and switching off the signal pathways in cancer. **CANCER METASTASIS:** Cancer Metastasis – The spread of cancer, Pathogenesis of the process, Loss of cell-cell cohesion, Mechanism of tumour invasion, Dissemination of tumour cells in blood stream, Patterns of metastatic spread. Role of inflammation in cancer. **CANCER IMMUNOLOGY:** B & T cell biology, Tumour antigens, Monoclonal antibodies, Cytokines in cancer, Complement proteins in cancer, Antigen processing & presentation, Factors influencing the incidence of cancer, Mechanism of immune response to cancer, Immunotherapy.

BoS Approved Text books:

1. The biology of Cancer. Robert A. Weinberg (Garland Science), 2014
2. Cancer Biology – Roger.G.B. Prentice Hall (May 2006).
3. Margaret A Knowles and Peter. J. Shelly, Introduction to Molecular and Cellular Biology of Cancer. 4th Edition. Elsevier publications, 2012

Reference Books:

1. Introduction to modern virology – Dimmock N.J., Blackwell scientific Publications. Oxford, 2011
2. An Introduction to Cellular and Molecular Biology of Cancer – Oxford Medical Publications, 2011
3. Janeway's Immunobiology,7th Edition, Garland Science Taylor &Francis Group

NEURO BIOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Understand the basic concepts of neuroscience	1	2
CO 2	Understand Neurotransmitters and Receptors	1	2
CO 3	Compare and contrast vestibular system	5	3
CO 4	Develop various strategies of nervous system andits Neuronal modulation	8	5

Syllabus:

Neuroscience Overview, Resting Potential and Active Conductance, Excitable membranes – Action potentials, Channels and Transporters, Synaptic Transmission, Neurotransmitters and Receptors, Synaptic Plasticity, Survey of Human Neuroanatomy, Construction of Neural Circuits Modification of Brain Circuits, The Somatic Sensory system, The Somatic Sensory System Auditory System, The Vestibular system, Chemical senses, The Eye, Sleep, Association Cortex and Cognition, Pain, Neuroscience in the News: Chronic Pain, Sex, Sexuality, and the Brain, Gender traits and pathways, Central nervous system, Peripheral nervous system, Sensory organs and their functions, Development of the nervous system, Neuronal modulation, Learning and memory, Repair and Regeneration in the Nervous System, Stroke, Epilepsy & Neurodegenerative diseases, Neurobiology ofdiseases.

Text Books:

1. Gordon M. Shepherd, Neurobiology, Oxford University Press, 1979
2. Fundamentals of Neuroscience by Dana Park, Elsevier publishers, 1999

BIOELECTRONICS AND BIOSENSORS

Mapping of Course outcomes with program outcomes:

CO No	Course Outcome	Mapped PO	B T L
CO 1	Understand concepts of biosensors	3	2
CO 2	Compare transducers in biosensors	3	3
CO 3	Apply bioelectronics in imaging process	6	3
CO 4	Develop various strategies for design for biophotonic computer	8	5

Syllabus:

Biosensors- Advantages and limitations, various components of biosensors Biocatalysis based biosensors, Bioaffinity based biosensors & Microorganisms based biosensors, Biologically active material and analyte. Types of membranes used in biosensor constructions. **TRANSDUCERS IN BIOSENSORS:** Various types of transducers; principles and applications - Calorimetric, Optical, Potentiometric / Amperometric, Conductometric / Resistometric, Piezoelectric, Semiconductor, Impedimetric, Chemiluminiscene - based Biosensors. **APPLICATION AND USES OF BIOSENSORS:** Biosensors in clinical chemistry, medicine and health care, biosensors for veterinary, agriculture and food Low cost - biosensor for industrial processes for online monitoring; biosensors for environmental monitoring. Application of enzymes in analysis; design of enzyme electrodes and their application as biosensors in industry, healthcare, food and environment. **BIOELECTRONICS:** Potential advantages & Developments towards a biomolecular computer, development of molecular arrays as memory stores; molecular wires and switches; mechanisms of unit assembly. **DESIGN FOR A BIOMOLECULAR PHOTONIC COMPUTER:** Assembly of photonic biomolecular memory store; Information processing; commercial prospects for biomolecular computing systems.

TEXT BOOKS:

1. Brian R Eggins - Biosensors an Introduction , First edition, John Wiley & Sons Publishers, 1996.
2. Loic J Blum, Pierre R Coulet - Biosensors Principles and Applications, First edition, Marcel Dekker,Inc, 1991.
3. Donald G. Buerk - Biosensors Theory and Applications, First Edition Technomic Publishing. Co, Inc, 1993.

REFERENCE BOOKS:

1. Elizabeth A Hall - Biosensors, First Edition, Open University, Milton Keynes, 1990.
2. Graham Ramsay - Commercial Biosensors, First edition, John Wiley & Sons, Inc. 1998.

TISSUE ENGINEERING

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of Tissue Engineering and Cell-Based Therapies	3	1
CO 2	Acquire the knowledge of tissue culture basics	3	1
CO 3	Analyze 3D organization and angiogenesis	6	4
CO 4	Develop Stem Cell Therapies with case studies.	8	5

Syllabus:

Introduction: Tissue Engineering and Cell-Based Therapies, Biomaterials. metals, ceramics,polymers (synthetic and natural). Biodegradable materials, native matrix, Tissue culture basics:primary cells vs. cell lines, sterile techniques, plastics, enzymes, reactors and cryopreservation.Principals of self assembly. cell migration, 3D organization and angiogenesis. TissueMorphogenesis, Stem Cells and Lineages, Cell Isolation and Culture, Cell-Cell Communication, ECM and Natural Scaffold Materials, Synthetic Biomaterial Scaffolds, Scaffold Fabrication &Tailoring,Graft Rejection/Material Biocompatibility, Cell Migration, Engineered Disease Models, Stem Cell Therapies with case studies. Liver tissue engineering. bioartificial liver (BAL) assist device, shear forces , oxygen transport, plasma effects. Cardiovascular tissue engineering. blood vessels structure, vascular grafts. Skin tissue engineering, scar vs. regeneration, split skin graft,apligraft.

Text Books:

1. Principles of Tissue Engineering, 4th Edition 4th Edition by Robert Lanza, Academic Press, 2011.
2. Cells and Biomaterials in Regenerative Medicine by Daniel Eberli, Springer, 2009

Reference Books:

1. Jiawei Han and M Kamber, “Data Mining Concepts and techniques”, Third Edition, Elsevier Publications, (2011).
2. P.-N. Tan, M. Steinbach, V. Kumar ,”Introduction to Data Mining”, Addison- Wesley (2005).

VIROLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge of viruses	3	3
CO 2	Acquire the knowledge of techniques in virology	3	3
CO 3	Analyze structure of viruses	6	2
CO 4	Compare plant and animal viruses	6	3

Syllabus:

BASICS OF VIROLOGY Historical introduction, Brief outline of discovery of viruses, Scientific investigation, Diseases and filterable agents, Properties of viruses, Morphology of viruses – Structure, Capsid, Architecture, Envelopes & Peplomers. Chemistry of viruses – Viral proteins, Genomes structure, types, study of sub-viral agents. Brief account on diseases caused by viriods – PSTV, Cadang Cadang, Satellite viruses. TECHNIQUES IN VIROLOGY Cultivation of viruses – Animal viruses, Plant viruses. Isolation & purification of viruses – Plant viruses & Animal viruses. Criteria of purity, Maintenance of Viruses – Electromicroscopy, X-ray crystallography, Sedimentation Analysis, Chemical Determination. Enumeration of viruses – Electro microscopy, Plaque assay, Acid End point method, Haemagglutinin Assay. Detection of viruses – Serological characterization, viral antigens, viral nucleic acid. Ultra structure & life cycles of Bacteriophage – M13, Mu, T3, T4 & lambda. PHYSIOLOGY OF VIRUSES Role of components – Nucleic acids, Proteins, Lipids, Carbohydrates & other constituents. Reconstitution of viruses, Multiplication of viruses, Replication of viruses – Lytic cycle of coliphage, Lysogeny, Replication of Pi X 184, Replication of RNA Phages. Replication of plant viruses, Replication of Animal viruses, Artificial synthesis of viruses. PLANT VIRUSES Taxonomy, Symptoms of diseases caused by plant viruses (Morphological, Physiological and Histological), Ultra structure & life cycle of TMV & CaMV, Transmission of plant viruses – Mechanical and biological (vector and non-vector), Basic control measures of plant diseases – vector and chemical control. HUMAN VIRUSES Taxonomy, Ultra structure and brief account on life cycle of RNA viruses – Polio viruses, Influenza viruses, Measles, Rota viruses & HIV. Ultra structure and brief account on life cycles of DNA viruses – Vaccina virus, HSV, Adeno virus, SV40 & Hepatitis virus. Viral Vaccines – Types and preparation of conventional vaccines.

Texts Books:

1. Introduction to modern virology – Dimmock N. J, Blackwell Publications, Sixth Edition, 2012
2. An Introduction to Viruses – S B Biswas & Amita Biswas, Third Edition, 2014

Reference Book:

1. Function of plant virology – Mathews, Academic press, Fourth Edition, 2013

NANO BIOTECHNOLOGY

Mapping of Course outcomes with program outcomes:

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Understand concepts of nanotechnology	2	2
CO 2	Compare biopolymer and Lipo polymer strategies	6	3
CO 3	Develop various strategies of nucleic acid based nanomaterial's	8	5
CO 4	Conclude various principles involved in Biocompatible nanomaterial's	8	5

Syllabus:

Introduction to Nanotechnology – definition and scope, nanobiotechnology- recent development and applications, Biocompatability and cytotoxicity studies of Nanomaterials, carbon nanotubes, Bioconjugation mediated drug delivery. General medicine is changing into personalized nanomedicine. **Biopolymer**- polymer nanofibers - electrospinning method and their biomedical applications, polymer nanocomposite- bone and dental restorations, polymer controlled drug delivery for the treatment of cancer and other diseases. Biodegradable polymer derived from amino acid. **Liposphere** in drug target and delivery Liposome - liposomes in sensor technology, polymeric Micelles – Production of Lipospheres for Bioactive compound delivery – Melt dispersion technique, Solvent evaporation technique and InVitro drug release - Polymericbiodegradablelipospherefor vaccinedelivery.**Nucleicacidbasednanomaterials**:Nucleic acid engineered nanomateials and their applications. Protein patterning for applications in biomaterials. DNA lipoplexes – Lipofection efficiency In Vitro and In Vivo, Polymer controlled delivery of therapeutic nucleic acid. **Biocompatible nanometerials**: PLA and PLGA Based nanoparticulate delivery system. Metal Microbes interaction, Biological metal nanoparticle synthesis and biomedical application – Dendrimers, quantum dots, Biodegradable optical nanoparticles for tumor diagnosis and treatment.

Text books:

1. Challa S.S.R. Kumar (Ed). Biological and pharmaceutical nanomaterials. Wiley-VCH Verlag Gmbh & Co.,KgaA (2006.).
2. K.K. Jain ," Nanobiotechnology in Molecular Diagnostics: Current Techniques and Application Horizon Biosciences" (2006)..

Reference Books:

1. Ian H.witten, Eibe frank , Mark.A.Hall , "Data Mining: Practical machine learning tools and techniques", 3rd edition, elsevier, (2011).
2. Daniel T. Larose," Data mining methods and models", Wiley,(2006).

OPEN ELECTIVES

IPR & PATENT LAWS

Mapping of Course out comes with student out comes:

CO No	Course Outcomes	Mapped SO	B T L
CO 1	Acquire the knowledge of intellectual property rights	a	1
CO 2	Describe the principles and regulatory affairs	e	2
CO 3	Develop documentation ,Protocols and Case Studies on Patents	k	3
CO 4	Compare various Case Studies on Patents	k	3

SYLLABUS:

Intellectual Property Rights Patents and intellectual property rights (IPR): Definition, History of intellectual property; Types of intellectual property rights, copy rights, trade marks, geographical indication, Industrial design rights, patents. Sources of patent information, patent application procedures. Principles, Scope and Functions Of GATT&WTO GATT-Historical perspective, objectives and fundamental principles, impact on developing countries. WTO- Objectives, scope, functions, structure, status, membership and withdrawal, dispute settlement, impact on globalization, India-tasks and challenges. Regulatory Affairs Indian contest-requirements and guidelines of GMP, understanding of Drugs and cosmetic act 1940 and rules 1945 with reference schedule M,U & Y. Related quality systems-objectives and guidelines of USFDA,WHO & ICH; Introduction to ISO series. Documentation and Protocols Documentation: Types related to pharmaceuticals industry, protocols, harmonizing formulation development for global fillings, NDA, ANDA, CTD, Dealing with post approval changes-SUPAC, handling and maintenance including electronic documentation. Case Studies on Patents. Case Studies on - Patents (Basumati rice, turmeric, Neem, and related medicinal plants and byproducts)

Textbooks:

1. S. H. Willig, Good manufacturing practices for Pharmaceuticals, Informa Healthcare (Oct 2000).

Reference books:

1. Industrial Property Rights: Vol. III-4, Kogan Pate, Kogan Pate, Kogan Page (May 1998)

ENVIRONMENTAL POLLUTION CONTROL METHODS

SYLLABUS :

Air pollution: Sources, Types, and effects and Fate of air pollutants. Meteorological factors and their impacts on pollutants dispersal. Sampling and measurement of air pollutants. Air quality standards. Air pollution control methods for particulates and gaseous pollutants. Emission Control equipments for particulate and gaseous matter. **Water pollution:** Sources, Types and Effects of Water pollutants. Measurement of pollution loads: DO, BOD, COD, TOC - Water quality and Effluent discharge standards. Role of Microorganisms in wastewater treatment. Bacterial population dynamics- growth kinetics. Pretreatment, primary treatment, secondary and tertiary treatment of wastewater. Low cost treatment unit processes. **Solid waste:** Sources and types of Solid wastes – Disposal methods: Land filling - Composting - Incineration – Pyrolysis. Reclamation of polluted and degraded soil by Bioremediation- Phyto-remediation. Human acoustics, Sound and its general features- Noise and its measurement - Noise pollution hazards -Control methods.

Text Books:

1. Environmental Pollution Control Engineering by C.S.Rao (2006), New Age International (P)Limited Publishers, New Delhi.
2. Environmental Engineering by Howard S. Peavy, Donald R. Rowe and George Tchobanoglous(1985), Mc Graw-Hill International Editions, NewYork.

ReferenceBooks:

1. Sewage Disposal And Air pollution Engineering by S.K. Garg, Khanna publishers, New Delhi, 2010.

2. Waste water Engineering by M.N Rao and A.K Dutta, Oxford & IBH Publishing Co.Ltd, 2000.

3. Air Pollution by M.N Rao and H.V.N Rao, Tata McGraw- Hill Publishing Company Limited,

New Delhi, 2000.

4. Environmental Engineering by Davis Cornvel, McGraw Hill Book Co., New York, 2000.

5. Waste Water Engineering by Met Calf &Eddy, McGraw Hill Book Co., New York, 2006.

SOLID AND HAZARDOUS WASTE MANAGEMENT

Syllabus:

Solid wastes: Sources, Types, reasons for increase in generation, composition and properties of solid waste, Collection and on-site handling, Separation and processing. Solid waste disposal methods, Land filling, methods of land filling, Design of Landfills, gas production, Leachate and its control.

Conversion and recovery:Incineration, Pyrolysis, Composting methods, merits and demerits, Energy recovery, Bio methanation, use of refuse derived fuels (RDF).

Hazardous Waste, Definition, Sources, Classification, Hazardous wastes rules, and Nuclear waste, Biomedical wastes, Chemical wastes, disposal methods, Waste minimization. Treatment methods, Physico-chemical processes, Biological methods, Stabilization and Solidification, Thermal methods, Disposal methods Land disposal. Remedial technologies.

Text Books:

1. Solid waste Engineering by P.AarneVesilind , William Worrell & Debra Reinhart, Cengage Learning India Pvt. Ltd, New Delhi
2. Environmental pollution control Engineering by C. S. Rao; New age International Publishers, New Delhi.

Reference Books:

1. Venkatappa Rao. G and Sasidhar. R.S.(2009), Solid waste management and Engineered Landfills, Sai Master Geoenvironmental Services Pvt.Ltd, Hyderabad
2. World Health Organization, *Global Water Supply and Sanitation Assessment 2000* (Geneva2000).
3. Environment and Pollution Laws: Universal, Universal Law Publishing Co. Pvt.Ltd, Ed 2011.
4. Solid and hazardous waste management by M.N.Rao and Razia Sultana, BS Publications, Hyderabad.

REMOTE SENSING AND GIS

Syllabus:

Remote sensing basic definition and process, Passive and active remote sensing. Electromagnetic Spectrum, Resolution, Characteristics of Various sensors and satellites, Fundamentals of Image Processing. Map as a model, Spatial elements and terminology, Map scale, Spatial referencing system, Computers in map production, General software's in map production. Types of data products; Image interpretation strategy, Levels of interpretation keys; Topography, Types of Drainage Pattern and Texture, Erosion, ; Basic elements of image interpretation. Overview on visual image interpretation equipment. -

A brief history of GIS, GIS architecture, Components of a GIS, GIS workflow, Theoretical models of GIS: Functional elements, Fundamental operations, Theoretical framework, GIS categories, Levels/scales of measurement. The data stream, Data input methods: Keyboard entry, Manual digitizing, Scanning and automatic digitizing.Stages of GIS data modeling; Raster and Vector data representation, Spatial data models; Data editing, Detecting and correcting errors, Data reduction and generalization Edge matching and Rubber sheeting, Components of data quality, Sources of error in GIS.

Land use /Land cover studies, slope mapping, preparation of structures map, Ground water prospects mapping, Watershed management and Action plan, Water quality modeling, Salt Water intrusion models, pipeline alignment studies, Solid and hazardous waste disposal site selection, Landslides mapping, Urban planning and Management, GPS applications.

TEXT BOOKS:

1. Remote Sensing and Image Interpretation- 5th Edition by Lillesand, Kiefer and Chipman, Published byJohn Wiley and Sons, Inc, New York, 2007**2.**

2. Text book of Remote sensing and GIS – 3rd Edition by M. Anji Reddy, BS Publications, Hyderabad, 2010.

Reference Books:

1.Geoinformatics for Environmental management" by M. Anji Reddy, B.S Publications, Hyderabad

2. Remote Sensing and GIS- by B. Bhatia Published by Oxford University Press, 2009

DISASTER MANAGEMENT

Syllabus:

Introduction and Concept of disasters and hazards related to Earthquakes, Tsunami, Volcanic eruption, Cyclones, Floods, Drought, Landslides, Forest fires, Avalanches and Pest infestation. Prediction and perception of hazards and adjustments to hazardous activities; Rates of natural cycles and residence time. Landslide: causes, prevention and correction. Landslide hazard mitigation. Earthquakes: intensity and magnitude of earthquakes; geographic distribution of earthquake zones; precursors to the earthquakes, seismic waves, travel-time and location of epicentre; nature of destruction; ground subsidence; protection from earthquake hazards; do's and don'ts during earthquake; Tsunamis causes and consequences. Floods: Causes, nature and frequency of flooding: nature and extent of flood hazard; urban floods, environmental effects of flooding; flood mitigation methods. Tropical cyclone- formation and consequences. Coastal erosion; sea level changes and its impact on coastal areas. Drought: Nature and effect on plant and animal systems. Study of pattern and mitigation of forest fires. Geological and environmental investigations for the construction of dams, bridges, highways and tunnels. Impact of major geotechnical projects on the environment. Disaster Management: Capability- Vulnerability- risk- preparedness and mitigation- Disaster management cycle; Disaster Risk Reduction and Resilience; Disaster Management Act and Policy. Disaster Management case studies.

Text books:

1. Environmental Hazards by Smith, K., Routledge, London,1992.
2. Geological Hazards by Bell, F.G., Routledge, London,1999.

Reference books:

1. Principles of Engineering Geology by Krynine, D.S. and Judd, W.R., CBS, New Delhi, 1998.
2. Natural Hazards by Bryant, E., Cambridge University Press. London, 1985.
3. Landslide Disaster – Assessment and Monitoring Nagarajan, R., Anmol Publications, New Delhi, 2001.
4. Environmental risks and hazards by Cutter, Susan L., Prentice Hall of India, New Delhi.1999.
5. Bill Mc Juire, Ian Mason and C. Killburn (2002) Natural hazards and Environmental change, Oxford University Press, New York.
6. Gupta, Harsh K. (2003) Disaster Management, Universities Press (India) Pvt. Ltd
7. Coppola, Damon P. (2006) Introduction to International Disaster Management, Butterworth -Heinemann
8. Jha, Madan Kumar (2010) Natural and Anthropogenic Disasters: Vulnerability, Preparedness and Mitigation, Springer.
9. Glade, Thomas, Malcolm G. Anderson, Michael J. Crozier (2005) Landslide Hazard and Risk, edited Springer
10. Singh, Surendra, LeszekStarkel, Hiambok Jones Syiemlieh (2008) Environmental Changesand Geomorphic Hazards, Bookwell.

FUNDAMENTALS OF DBMS

Syllabus:

Database Fundamentals: DBMS Characteristics & Advantages, Database Environment, Database Users, Database Architecture, Data Independence, Languages, Tools and Interface in DBMS, DBMS types, **Data Modeling:** ER Model, Notation used in ER Diagram, Constraint, Types, Relationships in ER Model and other considerations in designing ER diagram. **SQL:** Data Definition and other languages in SQL, Creating tables and Data types, Constraints, DML statements, Functions and writing SQL statements using nested sub queries, complex queries, joining relations, Embedded SQL- Writing functions and procedures with PL/SQL, Relational Model, Relational Algebra, Operators in relational algebra. **Normalization:** Guidelines for good database design, Normalization- Normal Forms, First, Second, Third Normal Forms, BCNF, Multi value and join dependencies, 4^{th} and 5^{th} normal forms. File storage, Index structures, Indexing and hashing (Basics) Query Processing: Issues in query processing **Transaction Processing:** Transaction processing issues, Transaction states, problems during multiple transactions processing, ACID properties, system log, Concurrency control techniques: binary locks**,** exclusive locks, Lock based techniques, Timestamp based techniques,.

Text Book:

1.Elmasri and Navathe, 'Fundamentals of Database Systems', 2008, 4^{th} edition, Pearson Education. '

Reference Books:

1.Silberschatz, Henry F Korth, S. Sudarshan, "Database System Concepts:, 2003, Fifth Edition, Tata MCGraw-Hill.
2.Raghu Ramakrishnan, Johannes Gehrke, "Database Management Systems", 2004, second Edition, Tata MCGraw Hill.

FUNDAMENTALS OF SOFTWARE ENGINEERING

Syllabus:

Software and Software Engineering: Nature of software, software application domains, unique nature of web applications, software engineering, software process, software engineering practice, software myths. Process Models: Generic process model, prescriptive process models, specialized process models, unified process, personal and team process models, product and process. Agile development: Agility, agile process, extreme programming. Design issues : Software architecture, architectural styles, architectural design.Use cases, Classes, Relationships, common Mechanisms and their diagrams. Interfaces, Modeling techniques for Class & Object Diagrams. Behavioral Modeling :Interaction diagrams. Activity Diagrams.Software testing: A strategic approach to software testing, strategic issues, test strategies for conventional software, Black-Box and White-Box testing, validation testing, system testing. Software Process Improvement, SPI, The SPI process, The CMMI.

Text Books:

1. Roger S.Pressman ,"Software Enginering – A Practitioner's Approach 7th Edition, Mc Graw Hill,(2010).
2. Ian Sommerville, 'Software Engineering', Sixth Edition,Pearson Education,(2001).
3. Jim Arlow, Ila Neustadt, "UML 2 and the Unified Process: Practical Object-Oriented Analysis and Design", 2nd Edition, Pearson, (2005).

Reference Books:

1. Craig Larman, "Applying UML and Patterns: An introduction to OOAD and design and interface deployment", Pearson, (2002).
2. Alan Dix, Janet Finlay, Gregory d Abowd, Russel Bealel,"Human Computer Interaction", 3rd edition, Pearson education, (2008).
3. Stephen R.Schach, "Software Engineering", Tata McGraw-Hill Publishing Company Limited,(2007).

FUNDAMENTALS OF INFORMATION TECHNOLOGY

Syllabus:

Fundamentals of Computers: Introduction, Architecture, organization of a small computer, center Processing Unit, Execution cycle, Instruction categories, measures of CPU performance, Memory, Input/output devices, BUS-addressing modes. **System Software:** Assemblers, Loaders and linkers, compilers and interpreters. **Operating System:** introduction, memory management schemes, Process management, scheduling, threads. **Programming Fundamentals:** Problem solving with algorithms, Programming styles, coding Standards and Best practices, Introduction to C Programming, Testing and Debugging. Code reviews. **System Development Methodologies:** Software development Models. **User Interface Design:** introduction, the process, Elements of UI design & reports. **RDBMS:** Introduction, Data processing, the database technology, Data models **ER Modeling:** Concept, Notations, Extended ER features, Logical database design **Normalization:** Functional Dependency, Normal Forms. **SQL:** DDL statements, DML statements, DCL statements, writing Simple queries. **SQL tuning techniques:** Embedded SQL, OLTP. **Object oriented concepts:** Object oriented programming, relationship, Inheritance, Abstract classes, polymorphism, UML Diagrams, Object Oriented Design Methodology. **Rational Rose Tool:** Application of OOC using Rational Rose Tool.

Text Books:

1. Andrew S. Tanenbaum, Structured Computer Organization,PHI,3rd ed.,1991
2. **S**iberschatz and Galvin, Operating System Concepts, 4th ed., Addision-Wesley,1995
3. Dromey R.G., How to solve it by Computers PHI,1994
4. Kernighan, Ritchie, ANSI C language PHI,1992
5. Wilbert o.Galitz essential Guide to user interface design john,wiley,1997
6. Alex Berson, Client server Architecture, McGrew Hill International,1994
7. Rojer Pressman,Softer Engineering-A Practitioners approach, McGraw Hill 5th ed., 2001
8. Alfred V Aho,EHoproft, Jeffrey D Ullman, Design and Analysis or computer algorithms, Addison Wesley publishing Co..;1998
9. Henny F korth , Abraham Silbefrschatz, Database System concept, 2nd . McGraw- Hill international editions,1991
10. Elmasri and Navathe, Fundamentals of Database systems, 4th edition, admisonWesely, Person Eductaion

IMAGE PROCESSING

Syllabus:

INTRODUCTION: Origin of Digital Image Processing, Fields that uses Digital Image Processing, Fundamental steps in Digital Image Processing, Components of an Image Processing System**.**

DIGITAL IMAGE FUNDAMENTLS: Elements of Visual perception, Image sampling and Quantization, Basic relationships between Pixels, Linear and Non-linear operations.

DIGITAL IMAGE TRANSFORMS: Image Transforms – The Discrete Fourier Transform, The FFT, Walsh, Hadamard, Discrete Cosine Transform, The Haar Transform, And The Slant Transform,

IMAGE ENHANCEMENT IN SPATIAL DOMAIN: Some basic Grey level transformations, histogram processing, enhancement using Arithmetic/Logic operations, Smoothing Spatial Filters, Sharpening Spatial Filters.

IMAGE ENHANCEMENT IN FREQUENCY DOMAIN: Introduction to Fourier Transform and the Frequency Domain, Smoothing Frequency Domain Filters, Sharpening Frequency Domain Filters.

IMAGE RESTORATION: Noise models, Restoration in the presence of Noise, only Spatial Filtering, Periodic Noise reduction by Frequency Domain Filtering, Linear, Position-Invariant Degradations, Inverse Filtering, Wiener Filtering, Least mean square Filtering.

IMAGE COMPRESSION: Fundamentals – Image Compression models – Error Free Compression, Lossy Compression.

IMAGE SEGMENTATION: Detection of discontinuities, Thresholding, Edge based Segmentation and Region based Segmentation.

IMAGE REPRESENTATIONS AND DESCRIPTION : Representation schemes, Boundary Descriptors, Regional Descriptors

Text books:

1. Rafael C Gonzalez, Richard E Woods," Digital Image Processing", Second Edition, Pearson Education Asia, 2002. (Chapter 1, 3, 4, 5, 6, 7, 8, 9)
2. Jorg Arndt, " DSP Algorithms for Programmers"(Chapter 3)
3. Gonzalez. R & Woods B.E.," Digital Image Processing", Addison Wesley Longman Pearson Education, 2000.

REFERENCE BOOKS

1. MilanSonka, Vaclav Hlavac and Roger Boyle, Image Processing Analysis and Machine Vision, Thomson learning, SecondEdition, 2001.
2. William J Prati, "Digital Image Processing", John Wiley & sons
3. Tinku Acharya, Ajoy K Ray, "Image Processing Principles and Applications Principles and Applications", Wiley- Inter science.

LINUX PROGRAMMING

Syllabus:

Linux Utilities-File handling utilities, Security by file permissions, Process utilities ,Disk utilities Text processing utilities, and Backup utilities Sed- scripts, operation, addresses, commands, applications, Awk execution, field and records , scripts, operation, patterns, actions functions using system commands in awk.
Working with Bourne again Shell (bash) responsibilities, here documents , running shell script, Shell as a programming language, shell meta characters, Control structures, arithmetic in shell, examples Interrupt processing, functions, debugging shell scripts.
Files : file Concept , File System Structure, I nodes, File Attributes, File types Library functions ,standard and formatted I/O in C, stream errors Kernel support for files ,System calls, file descriptors, low level file access File structure related system calls (FILE APIS), file and record locking File and directory management-Directory file APIS, Symbolic links and hard links
Process concept, Kernel support for process, process attributes, process creation , waiting for a process, Process termination ,Zombie process, orphan process, Process APIs Introduction to signals, signal generation and handling ,Kernel support for signals, signal function, unreliable signals , reliable signals Kill ,raise, alarm, pause, abort, sleep functions
Introduction to IPC , pipes, FIFOs- Introduction to three types of IPC-message queues, semaphores and shared memory -Kernel support for messages, Unix system V APIs for messages- Client /Server example

Text Books:

1. Unix and Shell Programming , B. A. Forouzan and R.F Gilberg, Cengage learning
2. Unix Concept and Applications, 4th edn. SumitabhadasTMH
3. Beginning Linux programming 4th edn. N. Matthew , R stones Wrox Wiley India edn.

Reference Books:

1. Linux system Programming , Robot Love, O;Reilly, SPD
2. Unix Network Programming , W.R. Stevens , PHI
3. Unix Internals , U Vahalia , Pearson Educaiton
4. UnixandshellProgramming,S.G.KochanandP.Word3rd edn.PearsoEdn.

E-COMMERCE

SYLLABUS

Electronic Commerce: Revolution. E-Commerce Business models and concepts: The Internet and World Wide Web: E-commerce infrastructure. Building an E-commerce web site, online Security and payment systems, E-Commerce Marketing concepts, , Ethical, Social and Political issues in E-Commerce, Retailing on the Web, Online Service industries, B2B E-Commerce: Supply chain management and collaborative commerce. E-Commerce Marketing communications, Internet Resources for Commerce: Technologies for Web Servers, Internet Applications for commerce, Internet Charges, Internet Access and Architecture, Searching the Internet

Text Books:

1. Kenneth C.Laudon, Carol G.Traver , E-Commerce, (Pearson Education)

Reference Books:

1. Daniel Minoli,EmmaMinoli,'Web Commerce Technology Handbook',(TMG)

2. Elias M.Awad'Electronic Commerce'(PHI)

RENEWABLE ENERGY RESOURCES

SYLLABUS

Extraterrestrial solar radiation, terrestrial solar radiation, solar thermal conversion,flat plate and concentrated solar thermal collectors, solar ponds, solar heating/cooling technique, solar distillation, photovoltaic energy conversion, solar cells – 4 models.

Planetary and local winds, vertical axis and horizontal axis wind mills, principles of wind power, maximum power, actual power, wind turbine operation, yaw control, pitch control and stall control mechanisms, derivation of power coefficient.

Ocean temperature differences, principles of OTEC plant operations, wave energy, devices for energy extraction, tides, simple single pool tidal system.

Origin and types, Bio fuels, classification, direct combustion for heat and electricity generator, anaerobic digestion for biogas, biogas digester, power generation.

Biomass energy conversion technologies, Biogas generation – classification of Biogas plants. Micro hydro electric systems- different types of turbines.

Text books*:*

1. Godfrey Boyle “Renewable Energy”, Oxford Publications, Second edition.

2. G. D. Rai, “Non-Conventional Energy Sources”, Khanna Publishers, First edition.

Reference books*:*

1. Roger H.Charlier, Charles W. “Ocean Energy- Tide and Tidal Power”ISBN: Library of Congress Control Number: 2008929624_c Springer-Verlag Brerlin Heidelberg 2009.

2. John Twidell& Toney Weir: E&F.N. Spon, “Renewable Energy Sources”, Taylor & Francis New York, 2nd edition.

3. John F.Walker&N.Jenkins, “Wind Energy Technology”, John Willey and Sons Chichester, U.K – 1997

ROBOTICS

SYLLABUS

Introduction to Robotics, Major components of a Robot, Robotic like devices, Classification of Robots – Classification by coordinate system and by control method, Specifications of Robots, Fixed versus flexible automation, economic analysis.

ROBOT END EFFECTORS: Introduction, End effectors, interfacing, types of End effectors, grippers and tools, considerations in the selection and design of remote centered devices.

ROBOTIC SENSORY DEVICES: Objective, Non-Optical position sensors – Potentiometers, Synchros, inductosyn, optical position sensors – opto interrupters, Optical encoders (absolute & incremental).

PROXIMITY SENSORS: Contact type, non-contact type – reflected light scanning laser sensors.

TOUCH & SLIP SENSORS: Touch sensors – proximity Rod & Photodetector sensors, Slip sensors – Forced oscillation slip sensor, interrupted type slip sensors, force and torque sensors.

TRANSFORMATIONS AND KINEMATICS: Objectives, homogeneous coordinates, basic transformation operations, forward solution – DenavitHartenberg procedure, Simple problems involving planar manipulators, inverse or backward solution – problems involved, techniques.

Introduction to Trajectory Planning, the manipulator jacobian.

ROBOT APPLICATIONS: Industrial Applications – Material Transfer, material handling, Loading and unloading, processing, spot and continuous arc welding, spray painting, grinding, Assembly and Inspection and Non-Industrial Applications.

ROBOT LANGUAGES: Introduction, AL, AML, VAL, RAIL

TEXT BOOK

1. Robotic engineering by Richard D. Klafter, Prentice Hall India
2. Industrial robotics by MikellP.Groover, Mcgraw Hill Publications

REFERENCE BOOKS

1. Robotics – K.S. Fu, Gonzalez & Lee, Mcgraw Hill Publications
2. Robotics For Engineers by YoramKkoren, Mcgraw Hill Publications
3. Introduction to Robot Technology, - P.Coiffet and M.Chairenze / Kogam Page Ltd. 1983 London.

MECHATRONICS

SYLLABUS

INTRODUCTION TO MECHATRONICS: Introduction, Elements of Mechatronic system, Applications.
SENSORS AND TRASDUCERS: Introduction, Classification of Sensors, selection of sensors. Classification of transducers - strain gauges, displacement transducers, capacitive and inductive transducers, LVDT, oscillation transducer, piezoelectric, potentiometric, velocity transducers, temperature transducers, optical transducers.

SIGNAL CONDITIONING: Introduction, data acquisition –Quantizing theory, Analog to Digital conversion, Digital to Analog conversion.

DATA PRESENTATION SYSTEMS: Data presentation elements, Data acquisition systems, systems measurement, Testing and calibration.

ACTATION SYSTEMS: Pneumatic and hydraulic actuation systems, Stepper and Servo Motors
SYSTEM MODELS: Modeling of one and two degrees of freedom Mechanical, Electrical, fluid and thermal systems. Block diagram representations for these systems.

SYSTEM RESPONSE: Introduction, Transfer function, Time response and Frequency response analysis mechanical systems and electrical systems.

CLOSED LOOP CONTROLERS: Continuous and discrete processes, control modes, Two-step, proportional, Derivative, integral, PID controllers.
DIGITAL LOGIC: Logic gates, Boolean algebra, Karnaugh maps**.**
PLC: Introduction, basic structure, I/P ,O/P processing, programming, ladder diagrams, Timers, Internal relays and counters ,data handling, Analogue Input and Output, selection of a PLC**.**
DESIGN: Mechatronics system Design, possible design solutions.
CASE STUDY: pick and place Robot, CNC Machine.

TEXT BOOKS:

1. W.Bolton, ”Mechatronics: Electronic Control Systems in Mechanical and Electrical Engineering” , 3rd Edition, Pearson education,2007.
2. David G. Alciatore, Michael B. Histand ,” Introduction to mechatronics and measurement systems”, 2nd Edition, McGraw-Hill Professional, 2002.

REFERENCE BOOKS:

1. A.K.Sawhney, "A course in Electrical and Electronic Measurement and Instrumentation"- Dhanpat Rai & Sons - 1991.
2. NitaigourPremchandMahalik, “Mechatronics”, Tata McGraw-Hill, 2003.
3. HMT Limited, “Mechatronics”, McGraw-Hill Education (India) Pvt Ltd, 2000.

4. T.G. Beckwith &N.L.Buck, "Mechanical Measurements", 3rd Edition, Addison-Wesley Pub. Co., 1969.

OPERATIONS RESEARCH

SYLLABUS

Introduction to Operation Research: Introduction, Modeling in Operations Research, Phases of OR study, Scope and application of OR. Linear Programming and its Applications: Linear Programming Problem – Graphical solution of LP Problem. Simplex method, Big M method, two phase method, multiple solution, infeasible solution, unbounded solution, degeneracy, Dual Simplex method. Transportation: Introduction – Methods of basic feasible solution, Optimality test, Degeneracy in transportation problem, unbalanced transportation Problem, Assignment Problems: Hungarian method for assignment problem, Traveling salesman problem. Theory of Games: Introduction, to solve the rectangular two person zero sum games, solution of rectangular games in terms of mixed strategies, solution of 2x2 games without saddle point, solution of a two person zero sum 2Xn game, Graphical method for 2Xn and nX2 games.

Inventory Control: Introduction – EOQ with uniform rate of demand, Economic lot size with finite rate of replenishment, Quantity discounts, Deterministic model with Shortages, ABC analysis of inventory. Dynamic Programming: Introduction, Bellman's principle of optimality, application to shortest route problem, linear programming, tabular method. Queuing Theory: Introduction, single channel, Poisson arrival, exponential service time with finite population and infinite population, Simulation: Introduction, Monte-Carlo Simulation, Application to Inventory Control. Project Management by PERT/CPM: Introduction, simple network techniques, construction rules of drawing, Fulkerson's rule, Critical path method (CPM)- floats, critical path, project duration, PERT: Introduction, different Time estimates, expected time, variance, expected project duration and probability of completion. Crashing: Introduction, crashing of network, problem

Text Books:

1. Operations Research - Hamdy Taha
2. Operations Research – Hiller &Liberman.

Reference Books:

1. Quantitative Techniques – A.P. Natarajan

2. Operations Research – S.D. Sarma

NANO MATERIALS AND TECHNOLOGY

SYLLABUS

Introduction : Evolution of science and technology, Introduction to Nanotechnology, Nanotechnology-Definition, Difference between Nanoscience and Nanotechnology, Feynman predictions on Nanotechnology, Moore's law, Bottom up and top down approaches, challenges in Nanotechnology .

Nano materials : History of materials, Nanomaterials-Definition, Classification of Nanostructured materials, causes of interest in nanomaterials, some present and future applications of nanomaterials, Bio-Medical Applications-Drugs, Drug Delivery, Photodynamic therapy, Molecular motors, Neuro-Electronic Interfaces, Protein Engineering, Nanoluminescent tags.

Synthesis and processing of nanoparticles, thin films : Nanoparticles: Processes for producing ultrafine powders-mechanical milling, wet chemical synthesis, gas condensation process, chemical vapour condensation, laser ablation.

Thin Films: Synthesis techniques- Physical Vapor Deposition: Evaporation, Molecular beam epitaxy, Sputtering. Comparision of evaporation and sputtering.

Special nanomaterials, characterization and tools : Carbon nanotubes, nano composites, carbon fullerenes-An overview over preparation, properties, applications. Electron Microscopy Techniques: Scanning Electron Microscopy, Transmission Electron Microscopy, Scanning Tunneling Microscopy, Atomic Force Microscopy, Scanning Probe Microscopy– X ray Diffraction. MEMS: – Introduction, types of MEMS:- Mechanical, Thermal, Magnetic MEMS; Fabrication of MEMS.

TEXT BOOKS

1.Nano structures & Nano materials by Guozhongcao, Imperial college press.

2.Micro manufacturing and Nano Technology by N.P.Mahalik.

REFERENCE BOOKS

1. Nano Technology by Mark Ratner &Danier Ratner, Prentice Hall
2. Nano materials by A S Edelstein& R C Cammarata, Institute of physics publishing, Bristol and Philadelphia.

SUBSEA ENGINEERING

SYLLABUS

Overview of subsea engineering, subsea field development, distribution systems, subsea surveying positioning and foundation, installation of subsea equipment, subsea control, power supply, subsea hydraulics, subsea corrosion and scale, subsea connections and jumpers, subsea well heads and X-trees, subsea drilling risers, subsea production risers, subsea pipelines, subsea risk and reliability.

REFERENCE BOOKS

1. Yong Bai, Qiang Bai, “Subsea engineering handbook”, Gulf publishers, (2010)
2. Yong Bai, Qiang Bai, “Subsea pipeline and risers”, Gulf publishers, (2005)
3. Boyun Guo, Shanhong Song, Jacob Chacko, Ali Ghalambor, “Offshore Pipeline”, Gulf publishers, (2005)

OIL AND GAS MANAGEMENT

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course outcomes	Mapped PO	BTL
CO 1	Understand the global oil and gas market	1	1
CO 2	Understand the E&P activities, marketing and transportation of oil and gas	1	1
CO 3	Understand the refining activities, estimating the future of oil and gas industry	1	1

SYLLABUS

Global Oil and Gas: Value Chain and Geopolitics of Oil

The Upstream: Exploration, Development, and Production

The Midstream: Markets and Transportation

The Downstream: Refining and Marketing

The Future Oil and Gas Industry

REFERENCE BOOKS

1. Adedeji B. Badiru Samuel O. Osisanya, "Project Management for the Oil and Gas Industry", CRC Press, 2013.
2. Use Internet sources for present trends.

SELF DEVELOPMENT

SYLLABUS

Orientation, Discussion on Values : Understanding Values, Behavior and Attitudes, Application of Values and Universal Values, **Philosophy of Yoga :** God, Self and Ultimate goal of yoga, Brief Introduction to various types of yoga and Integration of values in Yoga, **Study of major Religions :** Identify commonality, condition of its origin or intention vs. current state, **Art of Meditation :** Observation, Introspection, Contemplation, Meditation and Concentration, Schools of Meditation, **Systematic Practice of Meditation:** Theories of life, Need for Meditation, Natural Path, Integration **Personal Responsibility:** Stress Management, Tips for Self-Management, Choices we make, Excellence.

TEXT BOOK

1. Self development modules from Heartfulness Institute (www.heartfulness.org)

REFERENCE BOOKS

1. Complete works of Swami Vivekananda
2. Jonathan –Livingston - Seagull
3. The Monk Who Sold His Ferrari_Robin S. Sharma
4. You can win by shiv khera
5. Many lives Many Masters
6. The road less travelled – Scott Peck
7. As a man thinketh
8. Journey of the Soul
9. The Bhagavad-Gita
10. King James version of the Holy Bible
11. Holy-Quran

EMOTIONALINTELLIGENCE

SYLLABUS

Course Objective: The main objective of the course is to enable the students understand meaning and importance of emotional intelligence.

Emotional Intelligence: The Concept, dimensions of emotions; Theories of Multiple intelligences; importance of emotions; emotions and the brain; The Role of Emotions in Organizations; Self-Awareness and Self-Control; Empathy; Social Expertness; Personal Influence.

Emotional Intelligence and Personality: relationship between EQ and IQ; human mind; consequences of low and high EQ; EQ development; Emotional Skills; emotional factors: Emotional Competency, Emotional Maturity, and Emotional Sensitivity**.**

Levels of EI: Models of Emotional Intelligence; emotional intelligence competencies; emotional intelligence and leadership behavior; emotional intelligence and stress management; art of influencing people.

The Role of Emotional Intelligence in Professional Success: Emotional Intelligence and the Complexity of Work; Emotional Intelligence and High IQ Professions; Emotional Intelligence and Leadership; manage emotional upsets; Emotional 'Winner'**.**

EQ in the Indian Perspective; EQ and Managerial Effectiveness; the soft art of being a tough leader.

Recommended Textbook(s):

1.Dalip Singh - Emotional Intelligence at Work: A Professional Guide – Response Books – 2006.

Reference Books:

1. Daniel Goleman, Emotional Intelligence, Bantam Books, 2006.
2. Moshe Zeidner, Gerald Matthews, and Richard D. Roberts, What We Know About Emotional Intelligence – How It Affects Learning, Work, Relationships, and Our Mental Health, The MIT Press, 2009.
3. James Bradford Terrell and Marcia Hughes , A Coach's Guide to Emotional Intelligence: Strategies for Developing Successful Leaders , Wiley, 2008.
4. Dr. Jeanne Segal , The Language of Emotional Intelligence, McGraw-Hill, 2008.

BEHAVIORALSCIENCES

SYLLABUS

Introduction to Behavioural Science;Foundations of Individual Behavior: Personality-Personality determinants; Personality traits: The Big Five Model, Major personality attributes influencing OB; Theories of personality; Values – Types of Values.
Learning- **Theories of learning**; Principles of learning; Attitudes – Source of attitudes; Types of Attitudes, Attitudes and consistency – Cognitive Dissonance theory.
Perception- Perceptual process; Factors influencing **Perception;** perceptual distortion; Linkage between perception and individual decision making; Motivation – Theories of Motivation – Hierarchy Needs Theory – Two-Factor Theory – Expectancy Theory; Applications of Motivation.
Foundations of Group Behavior: Groups – Nature of groups; Types of groups; Stages of Group Development; Group Cohesiveness; Teams vs Groups
Leadership – Nature; Leadership Styles; Theories of leadership: Trait Theories, Behavioral Theories and Contingency Theories.
Recommended Text Book(s):

1. Aswathappa, **Organizational Behaviour**, Himalaya Publishing House, 2010.

Reference books:

1. Robbins, Stephen, Timothy, A &Sanghi, S. **Organizational Behavior**, 13thEdn, Pearson Education. 2009.
2. Fred Luthans, **Organizational Behaviour**, Prentice Hall, 2007.
3. UdaiPareek, **Organizational Behavior**, Oxford Publishers, New Delhi, 2008.

PHOTOGRAPHY

Syllabus:

History of Photography –Cameras. Film Speed – Shutter Speed – Aperture – Figuring Focus – Depth Definitions – Camera: Types, Structure & Features. Specialized of Field – Exposure Types of Lenses – Normal lens, Wide angle, Telephoto, Fish eye & Close up lenses, Macro and Zoom Lens – Focal Length - Angle of View.

Photographic equipment and types of photography,Digital and film photography.,Digital images and their characteristics,Pixels and resolutions,Digital Camera and their types, Storage and memory issues of digital images, Scanners and their applications.

Basic Lightings – Outdoor Lightings- Indoor Portrait Lighting - Flashbulbs – Electronic Flash units – Flash Techniques - B/W & Color Filters – Filter Factor Composing Effective Photographs: Picture Purpose – Centre of Interest , Rule of Third, Backgrounds, Angles – Framing – Varying Format, Focus for Effect – Good Timing – Color Consideration – Imagination. Photography under Special Conditions.

Different types of photography, Introduction to Digital Photography & Its Fundamentals. – Digital Image Sensor – Resolution - Storage Medium – File Formats – Digital Printing Technology.

Reference:

1. Tom Grimm, *The Basic book of Photography*, New York, Plume, 1979
2. George Haines, *learning photography*, Hamlyn Publishing Group, London 1992
3. Michael Langford , *Basic photography* , focus press London 1986
4. JhonHedgeco, *New Book of photography* , Dorling Kindersley book Lonon1994
5. Leslie D Stroebel,and Richard D Zakia, *Basic photography materials and process*-
6. John Hedgecoe, *The Photography's Handbook*,-1992
7. Chris George, *Mastering Digital Flash Photography*-2008.

MANAGEMENT ELECTIVES

PARADIGMS IN MANAGEMENT THOUGHT

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the basic management concepts along with an insight into levels of management.	9
CO 2	Understand the key contributions of classical approach to Management	12
CO 3	Understand and apply Quantitative methods to improve Management performance.	9
CO 4	Understand the key contributions ofBehavioural and contemporary approaches to Management.	9,12

Syllabus:

Management Introduction - Early management thought - Management Concept – Nature - Management as art, science, profession - Scope and functions of Management - Levels of Management - Importance of management.**Classical Approach to Management: (a) Scientific Management-** The advent of Scientific Management – Frederick W Taylor's contributions, - Contribution by Henry L Gantt - Contribution by Frank, Lillian Gilberth.**General Administrative Approach**: Henry Fayol's contributions towards general management – Max Weber's Bureaucracy Approach.**Quantitative Approach:** Important contributions – TQM – implications in today's management – Six sigma.

Behavioral Approach: Organizational Behaviour – Contributions of Elton Mayo's – .Hawthorne studies – contributions of Mary Parker Follett – Chester Bernard.

Contemporary Approach: Systems Theory – Contingency Theory – Chao's Theory -Peter F Drucker Contributions – C K Prahlad's Contribution – Porter's theory – Worker Management – Employee Engagement – People Capability Maturity Model.

Recommended Text Book(s):

1. Management by Stephen P Robbins, Mary Coulter, Neeharika Vohra – Pearson – 10th edition

Reference Books:

1. Management by Stoner, Freeman, Gilbert – PHI – 7th edition.
2. Management A Global & Entrepreneurial Perspective – Weihrich, Cannice, Koontz – Mc Graw Hill – 13th Edition.
3. The evolution of management thought by Daniel A Wren, Arther G Bedeian : john wiley& sons

INDIAN ECONOMY

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the structure of Indian Economy	7
CO 2	Understand the structural problems encountered by India	7
CO 3	Develop a perspective approaches to economicplanning and development in India	7
CO 4	Understand the role of the Indian Economy in the global context	7,12

SYLLABUS:

Economy: Meaning, types, problems and functions – Features of Indian Economy: Circular flow of economic activity: two sector, three sector and four sector models. Sectoral distribution of the economy. Nature and features of Indian Economy; Sectoral contribution of National Income-Share of Public and Private Sectors in GDP.Agricultural Sector of India: importance and general problems; Land Reforms, Agricultural marketing problems and remedies. Industrial Sector of India: Types, Importance and general problems: Small Scale Sector: Importance and general problems. Tertiary Sector in India- Importance – Infrastructure Development – Transport – Roadways, Railways – Banking and Insurance – Communication – Science and Technology – Software. Personal Income distribution and causes of inequality - Unemployment causes and remedial measures; Poverty in India-Poverty Line – antipoverty programs. Human development: concept and measurement - Human Development Index.Economic Planning in India: Role of Planning Commission - Over all Objectives and achievements of various Five Year Plans. 12th Five Year Plan; Economic Liberalisation: LPG strategy-General Agreement on Tariffs and Trade (GATT) - Objectives of GATT and Evolution of WTO – WTO and the Indian Economy, NABARD and World Bank.

Recommended Text Book(s):

1. G.Dutt and K.P.M.Sundaram: Indian Economy (2011), S.Chand&Co., New Delhi.
2. S.K.Mishra and V.K.Puri: Indian Economy, 30th ed., Himalaya Publishing House, New Delhi.
3. M.L.Jingan: Macro Economics, 6th ed., Konark Publishing House.

Reference Books:

1. P.K.Dhar, Indian Economy-Its growing dimension, Kalyani Publishers.
2. Alok Ghosh, Indian Economy, Its Nature and Problem, World Press.
3. A.N.Agarawal, Indian Economy- Problems of Development and Planning, New Age

MANAGING PERSONAL FINANCES

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the need for effective financial planning	12
CO 2	Analyze the basic concepts of money management, tax planning, consumer credit, housing and other consumer decisions, insurance, investments, retirement planning etc.	12
CO 3	Evaluate various financial tax saving schemes to save money to get tax benefits.	12
CO 4	Design savings and investment plans.	12

SYLLABUS

Financial planning process: Introduction-Importance of Financial Planning- Process of financial planning -The planning environment-Determinants of personal income- Financial statements and plans-Concept of Time value of money - Preparing a personal balance sheet - Preparing the income and expense statement-Using personal financial statements - Ratio Analysis.**Managing Taxes:** Introduction-Importance of tax planning-Basic concepts of income tax - Personal taxation -Income tax benefits on certain long term investments -Tax planning-Ethical consideration in tax planning. **Making decisions regarding houses and automobiles:-** Meeting housing needs-The rental option - The home buying process - Financing the housing transaction - Housing finance institutions in India - Housing schemes in India- Automobile purchase planning.**Planning for Investments:-** Types of investment vehicles-Factors considered in the choice of investments- Developing the investment strategy-Investing in Equities- Investment Process- Investing in Fixed Income Securities-Bond Market-Bond Investing Strategies-Types of Bonds-Bond Returns- Risks from Investing in Bonds. **Insurance & Mutual Funds**:-Insurance planning - Buying a life insurance - Life insurance products in India- Health Insurance-Need-Types and Sources of health care plans-Providers of Health care-Long term care insurance-Disability income insurance-Health Insurance in India; Mutual funds – Types of mutual fund products – Objectives of investing in Mutual funds.

Recommended Text Book(s):

1. Jack R Kapoor, “Personal Finance” Mc Graw Hill Publications, New Delhi, 2008.
2. KC Mishra and Steward Doss, “Basics of Personal Financial Planning” Cengage Learning, First Edition 2009.

Reference books:

1. Joehnk, Billingsley and Gitman “Planning Your Personal Finances” Cengage Learning India Private Limited, Delhi, 2012.

2. Mark Hirschey and John Nofsinger “Investments Analysis” and Behavior” Mc Graw Hill Publications, New Delhi, 2008.

BASICS OF MARKETING FOR ENGINEERS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the basic concepts of marketing management	12
CO 2	Analyze the markets and consumers, the changing environmental factors with special focus on technology products	12
CO 3	Understand the basics of marketing mix	12
CO 4	Create an appropriate strategy for the marketing of high tech products and services	12

SYLLABUS:

Introduction and Nature of Marketing: Evolution of Marketing Concept - Core concepts of marketing - Scope and Importance of Marketing. -Difference between Selling and Marketing - Marketing Myopia - Consumer Marketing Vs. Industrial Marketing.Understanding Consumer Behaviour: nature, scope and importance of consumer behavior – Factors influencing Consumer Behavior - Buying decision making process - Market Segmentation, Targeting and Positioning (STP).Marketing mix - Product definition, levels of product, product classification, difference between goods and services, Product Life Cycle, New Product Development – Technology and Product Management - Concept of Pricing – Factors influencing the pricing policy – Pricing strategies - Pricing Considerations in High-Tech Markets.Promotion mix - Marketing Communication Tools for High-Tech Markets - Channels of distribution - Supply Chain Management in High-Tech Markets - Technology Marketing, Green Marketing, Introduction to market study.

Text Books:

1. Philip Kotler and Gary Armstrong- Principles of Marketing- 18/e, Pearson Education.
2. Jakki J Mohr, Sanjit Sengupta and Stanley Slater, Marketing of High-Technology Products and Innovations, 3/e Pearson India

Reference Books:

V.S. Ramaswamy and S.Namakumari – Marketing Management, 4/e, Mc Millan Publications, New Delhi.

1. RajanSaxena, Marketing Management- 3/e, TMH, New Delhi.

ORGANIZATION MANAGEMENT

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the theories and approaches of organizational management	9
CO 2	Understand the basics of organization structure	9
CO 3	Understand the methods for motivating in competitive business environment.	9
CO 4	Understand the basic modes of maintaining good industrial relations	9

SYLLABUS: Development of Management thought – Introduction, Various theories; Functional approach, scientific management approach, human relations approach, latest management thoughts, organisation theory-classical organisation, neo-classical organisation theory, modern organisation theory.Organization Structure--Principles of organisation, organizational theories, departmentalism, authority, power, organizing, organizational effectiveness, structuring the organisation, organizational change, organisation charts; types of organisations—line , functional and line and staff relations, Organisational manuals.Motivation, Morale and behavioral science—Motivation: Characteristics, importance, Kinds of motivation. Thoughts of motivational philosophy: Gouglass Mc Gregore—X and Y theory; Herzberg's theory. Human needs, Incentive as motivators, Managing dissatisfaction and frustration. Morale, Absenteeism, Behavioral science, Group dynamics, Group behavior. Leadership—Meaning, importance, styles, theories, leaders Vs managers. Management concept—Management, Administration, Organisation, Difference and Relationship between Management, Administration and Organisation, Importance of Management, Characteristics of management, Managerial Skills, Managerial Objectives, Harmonization of Objectives, Hirechy of Objectives.Industrial Relations, Trade Union And Collective Bargaining—Industrial relations, Industrial Psychology, Industrial disputes, Conflict management, Views about conflict, Labor Policy. Workers grievances, Suggestion system. Trade Unions. Collective Bargainning, Negotiations, Industrial Safety—working conditions, Accidents, Preventive measures, Safety training.

Text Books

1. Stephen P. Robins, Organizational behavior, PHI / Pearson education, 11^{t} edition , 2008.
2. Koontz &Wehrich., Essentials of Management, 12th edition, Tata Mc Grawhill, 2007.

Reference Books:

1. Banga&Sarma , Industrial Engineering Management including Productionmanagement, 11th edition, 2010.
2. O.P. Khanna , Industrial engineering management, Khanna publications, 2006.

RESOURCE, SAFETY AND QUALITY MANAGEMENT

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand the management of materials	12
CO 2	Understand the management of machinery	12
CO 3	Understand the basics of safety management	12
CO 4	Understand the process of quality management	12

Syllabus:

Resource Management (Man Power, Materials & Machinery): Introduction; Resource smoothing; Resource Leveling, Establishing workers productivity; Objectives of material management;Functions of material management department; ABC classification of materials; Inventory of materials; Material procurement; Storage management;Classification of construction equipment; Earth moving equipment; Excavation equipment; Hauling equipment; Earth compaction equipment; Hoisting equipment; Concrete plant and equipment; Time and motion study; Selection of equipment – Task consideration, cost consideration; Factors affecting the selection; Factors affecting cost owning and operating the equipment; Equipment maintenance.**Safety and Quality Management:**Accident prevention program; Immediate attention in case of accident; Approaches to improve safety in construction; Safety benefits to employees, employees and customers; Prevention of fire in construction industries; Fault tree analysis; Safety information system; Safety budgeting;Importance of quality; Elements of quality; Organization for quality control; Quality assurance techniques; Documentation; Quality control circles; Total quality management; ISO 9000 – 2008.

Text Books:

1. Construction Engineering and Management by S.Seetharaman; Umesh Publications, NaiSarakl, Delhi.
2. Fundamentals of PERT/CPM and Project Management by S.K.Bhattacharjee; Khanna Publishers, NaiSarak; Delhi.

Reference Books:

1. Construction Management and Planning by B.Sengupta and H.Guha; Tata Mc.Graw-Hill Publishing Co. Ltd., New Delhi.
2. Construction Planning, Equipment and Methods by Peurifoy R.L; MC Graw-Hill International Book Company.

ECONOMICS FOR ENGINEERS

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No.	Course Outcomes	Mapped PO
CO 1	Understand basic concepts of engineering economics	5, 12
CO 2	Apply the methods of value engineering	5,12
CO 3	Apply the methods of cash flow	5,12
CO 4	Analyze the methods of depreciation	5,12

Syllabus:

Introduction to Engineering Economics: Introduction to Economics- Flow in an economy, Law of supply and demand, Concept of Engineering Economics – Engineering efficiency, Economic efficiency, Scope of engineering economics- Element of costs, Marginal cost, Marginal Revenue, Sunk cost, Opportunity cost, Break-even analysis, Elementary economic Analysis.**Value Engineering:** Make or buy decision, Value engineering – Function, aims, value engineering procedure. Interest formulae and their applications –Time value of money, Single payment compound amount factor, Single payment present worth factor, Equal payment series sinking fund factor, Equal payment series payment Present worth factor-equal payment series capital recovery factor-Uniform gradient series annual equivalent factor, Effective interest rate, Examples in all the methods.**Cash Flow:** Methods of comparison of alternatives – present worth method (Revenue dominated cash flow diagram), Future worth method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), Annual equivalent method (Revenue dominated cash flow diagram, cost dominated cash flow diagram), rate of return method, Examples in all the method. **Replacement and Maintenance Analysis:** Introduction-Types of maintenance –types of replacement Problem-Determination of economic life of an asset-Replacement of existing asset with a new asset.Depreciation- Introduction, Straight line method of depreciation, declining balance method of depreciation-Sum of the years digits method of depreciation, sinking fund method of depreciation/ Annuity method of depreciation, service output method of depreciation-Evaluation of public alternatives- introduction.

Text Books:

1. Dr. K K Patra, DhirajBhattacharjee, Engineering Economics and Costing, S. Chand & Company Ltd, New Delhi, 2013.
2. PanneerSelvam, R., ***Engineering Economics***, Prentice Hall of India Ltd, New Delhi, 2001.

Reference Books:

1. Chan S.Park, **Contemporary Engineering Economics**, Prentice Hall of India, 2002. Donald.G. Newman, Jerome.P.Lavelle, **Engineering Economics and analysis**Engg. Press, Texas, 2002.
2. Degarmo, E.P., Sullivan, W.G and Canada, J.R, **Engineering Economy**, Macmillan, New York, 1984.
3. William G. Sullivan, Elin M Wicks, and James Luxhoj, Engineering Economy, 13th edition (Prentice-Hall)

TECHNICAL SKILL-1 (CODING)

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No:	Course Outcomes	Mapped PO	BTL	PSO
1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	1,2	3	1
2	Build solutions for problems on Numbers and array based problems , functions, recursion	1,2	3	1
3	Solve problems solutions for character/string based problems and pointers	1,2	3	1
4	Build solutions to programs on Data structures concepts.	1,2	3	1

SYLLABUS:

Basic problems, Pattern based problems, Number based problems, Array based problems (one dimensional and two dimensional), character and string based problems, functions and recursion (class and objects for java), pointer based problems, function pointers and array pointers (For C Users), linked lists, queues, stack problems.

TECHNICAL SKILL-2 (CODING)

CO No:	Course Outcomes	Mapped PO	BTL	PSO
1	Apply the concepts of basic programming to solve the basic problems, pattern based problems	1,2	3	1
2	Build solutions for problems on Numbers and array based problems , functions, recursion	1,2	3	1
3	Solve problems solutions for character/string based problems and pointers	1,2	3	1
4	Build solutions to programs on Data structures concepts.	1,2	3	1

SYLLABUS:

Problem solving on Arrays, Array of Structures, Nested Structures, Queues: DE Queue, Circular Queue and Priority Queues, Lists: Operations on Single Linked List, Double Linked List - Operations on DLL, Circular Linked List, Problem Solving on Strings, Applications of Stacks and Queues, Implementation of Stacks and Queues using Linked List, Constructing Recursion, Heaps, Sorting: Merge Sort, Quick Sort, Heap Sort, Insertion Sort and Shell Sort, Trees: Binary Tree, Expression Tree, Binary Search Tree: Implementation- Insertion, Deletion, Tree Traversals, AVL Tree and Splay Tree , Hashing: Hash Function, Separate Chaining, Open Addressing, Re-Hashing and Extendible Hashing.

Tools & References:

1. http://hackerrank.com
2. http://codechef.com
3. http://hackerearth.com

SKILLING FOR ENGINEERS -1 (MEDICAL CODING)

Mapping of course outcome with program out comes:

CO.No	Course outcome	Mapped PO	BTL
CO-1	Apply reference manager in CPT	3	3
CO-2	Analyze ICD codes	5	4
CO-3	Develop diagnostic tests for clinical research	8	5
CO-4	Analyze applications of biostatistics in clinical trial management	8	5

Mendeley: Introduction, methods to build library online and offline, organize library, using search functions, share documents, annotate documents, using mendeley to cite.

Introduction to Medical Coding:

Human Anatomy & Physiology

Cardio Vascular System, Blood & Its Components , Integumentary System, Endocrine System, Urology, Male Reproductive System.- Location, Shape, Size, Structure, Physiology, Pathology, Diagnostic Test, Terminologies. Female Reproductive Systems, Nervous System, Gastro Intestinal System, Pulmonology, Urinary System, Orthopedics, Lymphatic System- Location, Shape, Size, Structure, Physiology, Pathology, Diagnostic Test, Terminologies.

Current Procedure Terminology Coding (CPT)

CPT Codes, CPT Description, Medical Record Format, Speciality Listings and its Format, Examples of CPT Speciality Code Practice, HCPCS Coding ers, Surgery.

International Classification of Disease Coding (ICD)

ICD Codes, ICD 9 CM,ICD 10 Transition, Diagnosis Interpretation, Usage of ICD Manuals, Index Listings, Tabular Listings, Software usage, Examples of Dx Code Practice.

Biostatistics:

Applications of Biostatics in clinical Trial Management: Correlation - simple linear regression – multiple regressions – T-test - F-test – Chi square test - ANOVA – One way ANOVA. Biostatistics and database management system.

Textbooks

1. Essent Human Anatom Physi_12 (12th Edition) by Elaine N. Marieb, Suzanne M. Keller, ISBN-13: 978-0134395326

2. ICD-10-CM Code Book ISBN: 978-1-626884-718

3. SPSS for Dummies, Keith McCormick, Jesus Salcedo with Aaron Poh Wiley (3rd edition, 2015)

SKILLING FOR ENGINEERS -2 (INSTRUMENTATION)

Mapping of Course outcomes with program outcomes:

CO No.	Course Outcome	Mapped PO	B T L
1	Analyze spectroscopy in study of biomolecules	3	4,5
2	Analyze microscopy in study of biomolecules	8	4,5
3	Analyze chromatography in study of biomolecules	5	4,5
4	Analyze electrophoresis in study of biomolecules	8	4,5

Spectroscopy study of chemical compounds and bio-molecules, Electromagnetic spectrum. Quantisation of energy, Electronic, vibrational and rotational spectroscopy. Franck–Condon principle, Jablonski diagram, radiative, nonradiative pathways, fluorescence and phosphorescence. Beer Lambert's law, deviation of Beer-Lambert's equation and its limitations. UV-Visible spectroscopy, Fluorescence spectroscopy, Raman spectroscopy, NMR Spectroscopy and Mass spectroscopy. **Microscopy:** Principals, instrumentation and applications of imaging techniques: Dark-field, Phase contrast, Fluorescence, Confocal microscopy, Atomic force microscopy, and Transmission and Scanning electron microscopy. **Chromatography:** band broadening, rate and plate theory factors responsible for separation. GC-MS and LC-MS. **Electrophoretic Techniques:** Principle, equipment and process, horizontal and vertical gel electrophoresis, Isoelectric focusing, capillary electrophoresis and application of electrophoresis in analysing macromolecules.

SKILLING FOR ENGINEERS -3 (DOCKING)

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	COURSE OUTCOME	MAPPED PO	BTL
CO1	Understand concepts of protein biology	1,5	2
CO2	Analyse protein structure prediction methods.	1,5	3
CO3	Construct various Neural Network method	1,5	4
CO4	Demonstrate lead discovery and analog based drug design	1,5	3
CO5	Develop drug design through molecular docking	1,5	5

PROTEIN BIOLOGY: Basics of Protein biology (Classification, Structural Organization, Domains & Motifs). Protein sequence analysis.PROTEIN STRUCTURE PREDICTION METHODS: Protein Structure Prediction Concepts : Secondary & Tertiary Structure Predictions (Chou-Fasman Method, GOR Method, Neural Network method, Homology Modeling, Ab-intio method, Threading methods).LEAD DISCOVERY AND ANALOG BASED DRUG DESIGN: Rational approaches to lead discovery based on traditional medicine, Random screening, Non-random screening, serendipitous drug discovery, lead discovery based on drug metabolism, lead discovery based on clinical observation.MOLECULAR DOCKING: Rigid docking, flexible docking, manual docking, Docking based screening. De novo drug design.

Text books:

1. T Schlick. Molecular Modeling and Simulation: An Interdisciplinary Guide. Springer. 2010.

SKILLING FOR ENGINEERS -4 (IMPORT & EXPORT)

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	COURSE OUTCOME	MAPPED PO	BTL
CO1	Acquire the knowledge of import process	1,5	1
CO2	Understand import management	1,5	1
CO3	Compare the import & export management	1,5	3
CO4	Develop documentation for import and export	1,5	4
CO5	Create filing process for insurance	1,5	3

Import-Export Management: Overview Import Export Management Introduction; Concept Key Feature; Foreign Trade - Institutional Framework and Basics; Trade Policy; Foreign Trade; Simplification of Document; Reduction in Document to Five for Custom Purpose; Exporting; Importing Counter Trade; the Promise and Pitfall of Exporting; Improving Export Performance; Counter Trade. International Marketing: Environmental and Tariff Barrier International Marketing: Definition, Components of International Marketing Management; Trade Barrier Definition: Components of Trade Barrier, Objectives of Trade Barrier. Non Tariff Barrier Non Tariff Barriers; Government Participation in Trade; Quota; Advalorem Duty; Specific Duties and their Differences Export and Import Financing, Procedure, and Primary Consideration Export and Import Financing Procedures; 14 Steps for Conducting Export Transaction; Export Assistance; Export-Import Primary Consideration Import Export Documentation Import and Export Documentation: Introduction, Freight Forwarder's Powers of Attorney, Bill of Lading, Certificates of Origin, Letter of Credit. Processing of Export Order Processing of Export Order; Nature and Format of Export Order; Examination and Confirmation of Export Order; Manufacturing or Procuring Goods; Central Excise Clearance; Pre Shipment Inspection; Appointment of Clearing and Forwarding Agents; Transportation of Goods to Port of Shipment; Port Formalities and Customs Clearance; Dispatch of Documents by Forwarding Agent to the Exporter; Certificate of Origin and Shipment Advice; Presentation of Documents to Bank; Claiming Export Incentives; Excise Rebate; Duty Drawback. Marine Insurance Marine Insurance Introduction and Meaning; Principle of Marine Insurance; Features & Types of Marine Insurance; Insurance Claim Procedure for Filling Marine Insurance; Documents for Claim; ISO-9000

Text books:

Export Import Management Paperback – 28 Oct 2013 by Justin Paul

TECHNICAL PROFICIENCY AND TRAINING – 1 (GENOMICS)

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Apply the role of biomolecules in metabolic process	1,5	3
CO2	Compare and contrast various microorganisms	1,5	3
CO3	Analyse analytical methods for biological samples	1,5	4
CO4	Develop a model for protein-ligand binding process	1,5	5

Biochemistry: Biomolecules-structure and functions; Biological membranes, structure, action potential and transport processes; Enzymes; Basic concepts and designs of metabolism; photosynthesis, respiration and electron transport chain; Bioenergetics. **Microbiology:** Viruses- structure and classification; Microbial classification and diversity; Microbial growth and nutrition; Aerobic and anaerobic respiration; Nitrogen fixation; Microbial diseases and host-pathogen interaction. **Cell Biology:** Prokaryotic and eukaryotic cell structure; Cell cycle and cell growth control; Cell-Cell communication, Cell signalling and signal transduction. **Molecular Biology:** Genes and chromosomes; Mutations and mutagenesis; Replication, Transcription, Translation and their regulatory mechanisms in prokaryotes and eukaryotes; Mendelian inheritance; Gene interaction; RNA interference; DNA damage and repair; Chromosomal variation; Molecular basis of genetic diseases **Analytical Techniques:** Principles of microscopy-light, electron, fluorescent and confocal; Centrifugation- high speed and ultra; Principles of spectroscopy-UV, visible, CD, IR, FTIR, Raman, MS, NMR; Principles of chromatography- ion exchange, gel filtration, hydrophobic interaction, affinity, GC, HPLC, FPLC; Electrophoresis; Microarray. **Immunology:** Innate, humoral and cell mediated immunity; Antigen; Antibody structure and function; Molecular basis of antibody diversity; Synthesis of antibody and secretion; Antigen-antibody reaction; Complement; Primary and secondary lymphoid organ; B and T cells and macrophages; MHC; Antigen processing and presentation; Polyclonal and monoclonal antibody; Regulation of immune response; Immune tolerance; Hypersensitivity; Autoimmunity; Graft versus host reaction. **Bioinformatics:** Major bioinformatic resources and search tools; Sequence and structure databases; Sequence analysis (biomolecular sequence file formats, scoring matrices, sequence alignment, phylogeny); Data mining and analytical tools for genomic and proteomic studies; Molecular dynamics and simulations (basic concepts including force fields, protein-protein, protein-nucleic acid, protein-ligand interaction).

TextBooks:

1) Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of biochemistry: life at the molecular level. No. 577.1 VOE. Hoboken: Wiley, 2013.
2) Darnell, James E., Harvey F. Lodish, and David Baltimore. Molecular cell biology. Vol. 2. New York: Scientific American Books, 1990.
3) Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta& P Rastogi, 2005
4) Kindt, Thomas J., et al. Kuby immunology. Macmillan, 2007.

TECHNICAL PROFICIENCY AND TRAINING – 2 (BIOPROCESSING)

Mapping of Course outcomes (CO) with program outcomes (PO):

CO No	Course Outcomes	Mapped PO	BTL
CO1	Apply the cloning methods for construction of recombinants	1,5	3
CO2	Compare and contrast among various PCR methods	1,5	3
CO3	Design, develop and optimize processes for purification of products.	1,5	5
CO4	Application of appropriate technique/unit operation for the process and evolve processes for purification of products with high market value.	1,5	3

Recombinant DNA Technology: Restriction and modification enzymes; Vectors; plasmid, bacteriophage and other viral vectors, cosmids, Ti plasmid, yeast artificial chromosome; mammalian and plant expression vectors; cDNA and genomic DNA library; Gene isolation, cloning and expression ; Transposons and gene targeting; DNA labelling; DNA sequencing; Polymerase chain reactions; DNA fingerprinting; Southern and northern blotting; In-situ hybridization; RAPD, RFLP; Site-directed mutagenesis; Gene transfer technologies; Gene therapy. **Bioprocess Engineering:** Chemical engineering principles applied to biological system, Principle of reactor design, ideal and non-ideal multiphase bioreactors, mass and heat transfer; Rheology of fermentation fluids, Aeration and agitation; Media formulation and optimization; Kinetics of microbial growth, substrate utilization and product formation; Sterilization of air and media; Batch, fed-batch and continuous processes; Various types of microbial and enzyme reactors; **Process Biotechnology**: Instrumentation control and optimization; Unit operations in solid-liquid separation and liquid-liquid extraction; Process scale-up, economics and feasibility analysis Engineering principle of bioprocessing-Upstream production and downstream; Bioprocess design and development from lab to industrial scale; Microbial, animal and plant cell culture platforms; Production of biomass and primary/secondary metabolites; Biofuels, Bioplastics, industrial enzymes, antibiotics; Large scale production and purification of recombinant proteins; Industrial application of chromatographic and membrane based bioseparation methods; Immobilization of biocatalysts (enzymes and cells) for bioconversion processes; Bioremediation-Aerobic and anaerobic processes for stabilization of solid / liquid wastes.

Textbooks

1. Butterworthand Heinmann.Product recoveryinbioprocess Technology-Elsevier India(2004)
2. Bailey and Ollis, Fundamentals of Biochemical Engineering, Mcgraw Hill HiEducation (1998)
3. Atkinson and Mavituna, Biotechnology and Biochemical Engineering Springer (Mar1973)

HONOURS DEGREE

BIOCHEMISTRY

CO No	Course Outcomes	MAPPED PO	BTL
CO1	Understand the functions and properties of biomolecules in biological systems.	2	2
CO2	Understand the organization and biochemical reactions of biomolecules	4	2
CO3	Understand the importance of various metabolic pathways	2	2
CO4	Apply various biosignaling in biological systems	5	3
CO5	Analyze techniques used in biochemistry to address biochemical problems	2	4

Carbohydrates: Introduction to biomolecules; types of linkages/bonds; importance of biomolecules; Classification, structure and functions of monosaccharides (glyceraldehyde, ribose, glucose, galactose and fructose), disaccharides (maltose, lactose and sucrose); polysaccharides (starch, cellulose, glycogen) and heteropolysaccharides (hyaluronic acid and chondroitin sulfate). **Aminoacids and proteins:** Amino acid structures, three and one letter nomenclature, classification, biological properties of amino acids; physicochemical properties, reactions of amino acids; Importance of proteins in biological systems; primary, secondary, tertiary and quaternary structure and proteins. Synthesis of Peptides (solid phase peptide synthesis); **Lipids** Classification; Structure; physicochemical properties of different classes of lipids. **Nucleic acids:** Structure; properties and biological functions of nucleic acids. Types of DNA and RNA. **Metabolism:** Introduction, IUBN Classification of enzymes, role of vitamins and coenzymes; basic metabolic pathways; glycolysis, Krebs cycle**,** Electron Transport Chain, Beta oxidation of fatty acids. **Enzymes – Nomenclature, IUB classification, specific activity, measurement and expression, enzyme assays.**

TextBooks:

1) Lehninger, A. L., et al. "Principles of Biochemistry (2nd edn)." Trends in Biochemical Sciences-Library Compendium 18 (1993): 354-354.

2) Voet, Donald, Judith G. Voet, and Charlotte W. Pratt. Fundamentals of biochemistry: life at the molecular level. No. 577.1 VOE. Hoboken: Wiley, 2013.

Reference Books:

4) Rodwell, Victor, et al. Harpers illustrated biochemistry 30th edition. McGraw Hill Professional Google Scholar, 2015.
5) Principles of *biochemistry*: By A. *White*, P. Handler, and E. L. *Smith* (5th edition) pp 1296: McGraw-Hill Kogakusha Ltd., 1973,

BIOCHEMISTRY LAB

13. Qualitative analysis of Carbohydrates
14. Qualitative analysis of Amino acids and Proteins
15. Qualitative analysis of Lipids
16. Qualitative analysis of Nucleic acids
17. Estimation of Glucose by Benedict's test
18. Quantitative analysis of Carbohydrates by Anthrone Method
19. Estimation of Aminoacids by Ninhydrin method
20. Estimation of Proteins by Biuret Method
21. Estimation of DNA by Diphenylamine
22. Estimation of RNA by Orcinol method
23. Estimation of Protein by Lowry's Method
24. Isolation of Caesin from Milk

Reference Book:

1. Jayaraman, J. Laboratory manual in biochemistry. Wiley Eastern, 1981.

MICROBIOLOGY

CONo.	Course Outcomes	Mapped PO	B T L
CO 1	Acquire the knowledge about characteristics and diseases of microorganisms	2	1
CO 2	Remember various factors affecting growth	11	2
CO 3	Compare various media, isolation, identification and sterilization methods of microorganisms	5	3
CO 4	Demonstrate various methods of microbiology such as sterilization, isolation, identification and characterization.	2	5

History and classification of microorganisms-Discovery of microorganisms; Theoryof spontaneousgeneration, Germtheoryof disease;Microbialtaxonomy anddiversity: Bacteriaandtheirbroadclassification-Majorcharacteristicsusedintaxonomy. MajorcontributorsinfieldofMicrobiology-Antonyvanleeuwenhoeks;LouisPasteur;Robert Koch;EdwardJenner;JosephLister;Winogradsky;Beijerinck.Microscope-Simple,Compound and Fluorescence. **Morphology &Cell structure of microorganisms-** Ultrastructureofbacteria,cellwall,flagella,pili,capsule,endosporeandcellinclusions.Viruses – Chemistry &Morphology (size, shape and symmetry), replication of viruses,lytic and lysogeniccycles.Yeasts&Molds–Morphology,lifecycle,economicimportanceoffungi(Eg. Aspergillus). Identification based on shape, staining reactions (Differential stain, Acid fast, capsule staining, Endospore staining).**Growth kinetics of microorganisms, Bacterial nutrition-**Nutritional classification of bacteria, Essential Macronutrients, MicronutrientsandGrowthfactors.Microbialgrowth**–**Growthcurveandfactorsaffectingthe growth– solutes,wateractivity,pH,Temperature,Oxygenconcentration,Osmoticpressure, Radiation.Bacterial growth; synchronousgrowthandmethodsofgrowthestimation.Onestep growth curve, Physiology of Archaebacteria–thermophiles, psychrophiles, halophiles and methanogens. **Growthmediaandcontrolofmicroorganisms-** culturemedia-syntheticandcomplexmedia,solidifyingagents,typesofmedia.Isolationofpurecultures-spread,pourandstreakplatemethods;MaintenanceandPreservationofmicroorganisms.Control of microorganisms – Sterilization and disinfection, effects of physical (moist and dryheat, radiationandfiltration)and chemical agents.Antibiotics–classification,modeofactionand resistance.**Medicalmicrobiology-**Diseasereservoirs;Respiratory infectionscausedby bacteriaandviruses,(tuberculosis);Diseasetransmittedby animals(rabies)andinsects(malaria); Food and water-bornediseases (cholera); pathogenicfungi,Viriods& Prions. Microbial Exopolysaccharides: Xanthan, Alginate, Microbial Flavours: Diacetyl, Methyl ketones, Terpenes, Vanillin. Edible Mushrooms: Cultivation of edible and medicinal mushrooms.

Texts books:

1. Pelczar, J. R. "MJ., Chan, ECS, Krieg, NR 1986." Microbiology. USA: McGraw-Hill.

2. Prescott, Samuel Cate, and Cecil Gordon Dunn. "General microbiology." (1949).

ReferenceBooks:

1. Schlegel, Hans G., and Christiane Zaborosch. General microbiology. Cambridge university

press, 1993.

MICROBIOLOGY LABORATORY

1. Calibration ofmicroscope andIdentification ofAnimal, Plant and Bacterial cells

2. Sterilization techniques for preparation of pure culture media for cultivation of microorganisms andvalidation ofproof.

3. Preparationofculturemedianutrientbrothandnutrientmediaandpreparationof slants.

4. Culturingof Microorganismson slants and nutrient broth.

5. Isolation ofBacterialcultureusingstreakand pourplatemethods

6. Identification ofMicroorganisms

(a) SimpleStainingtechnique (b)Differential stainingtesting

7. Microbiological Examination ofwater

8. A qualitative microbiological analysisfordeterminingthe qualityof MILK

9. Characterization ofbacterial strainbyBiochemical tests

10.Determination ofbacterial growth.

11.DeterminationZoneof inhibition of an antibiotic bycup method.

12.Determination ofMIC ofanytwoantibiotics on same bacteria.

ReferencesBooks:

1. Madigan, Michael T., John M. Martinko, and Jack Parker. Brock biology of microorganisms. Vol. 11. Upper Saddle River, NJ: Prentice hall, 1997.

PROCESS ENGINEERING PRINCIPLES

Introduction to Engineering CalculationsPhysical variables; dimensions and Units; Measurement conventions: Density, specific gravity; specific volume, mole, chemical composition, vaporpressures,concentration,Stiochiometry.compositionofmixturesand solutions: molarity, molality, normality, weight fractions, mole fractions ,volumetric compositionlawsofchemicalcombinationIdeal gasesIdealgaslaw,differencesbetween idealandrealgases,applicationofidealgaslaw,Daltonslawofadditivepressures,amagats lawofadditive volumes,volumechangeswithchangein composition,purecomponent volume method,partialpressuremethod,gasesin chemicalreactions. Materialbalances Introductiontosystemandprocess;differencebetweensteadystateandequilibrium,Lawof conservationofmass:Typesofmaterialbalances,Procedure formaterialbalancecalculations with and without chemical reactions, yield, conversion, limiting and excess reactants. EnergybalancesBasicEnergyconcepts:lawofconservationofenergy,standardheatof formation,standardheatofreaction.Latentheatofvaporizationand condensation,specific heat,sensibleheatofformation, heat ofreaction,heatofcombustion, Hess's law,effectof temperature and pressureon heat of reaction, Kirchhoff's law; Materialandenergybalances incellculture. Material balancefor continuous filtration, batch mixing, material balances with recycle, bypass and purgestreams. Energybalanceworked examples without reaction: coolingin downstream processing, continuous waterheater, and fermentation energybalance.

Text Books:

1) Doran, Pauline M. Bioprocess engineering principles. Elsevier, 1995.

Reference books

1) Rao, Dubasi Govardhana. Introduction to biochemical engineering. Tata McGraw-Hill Education, 2010.

BIOANALYTICAL TECHINIQUES

CO NO	Course Outcomes	Mapped PO	B T L
CO1	Understand the basic principles of different bio analytical methods	3	2
CO2	Correlate centrifugation use in biological assays	3	3
CO3	Contrast various chromatographic methods	3	3
CO4	Compare electrophoresis methods	11	3
CO5	Analyze the methods for determination of biological samples	11	4

Centrifugation – Basic principle, typesofrotorsincentrifuges-Fixedanglerotor,Vertical rotor,Swingoutrotor,Zonalrotors.Typesofcentrifuges–UltraandAnalyticalcentrifuges, PreparativeandDensitygradientcentrifugations, Densitygradientspreparations–Sucrose, Cesium chloride. **Chromatography -**Basic principle, Modes&Typesofchromatography– Paper, TLC.ColumnChromatography–Gelpermeation,Ionexchange,Affinitychromatography, GLC,HPLC.**Electrophoresis**-Principle, Types, Agarose gels, SDS-PAGE. IEF, PFG, 2-D gelelectrophoresis, Capillary electrophoresis. **Spectroscopy-**Basic concepts ofspectroscopy, Beer- Lambertslaw, Visible &UVSpectroscopy,Fluorescencespectroscopy, Atomic absorption spectrophotometer, Infrared &FT-IR, Mass spectroscopy. **Isotopic techniques-**Auto- radiography– PrinciplesandApplicationsof radioisotopesinbiologicalsciences. Non- isotopic tracertechniques, Immuno-histochemistry, Solid phase peptide synthesis. Optical Rotatory Dispersion, Circular Dichroism, X-Ray Crystallography, Nuclear Magnetic Resonance.

Text books:

1. Keith Wilson and John Walker, "Principles &Techniques of Biochemistry andMolecularbiology.Fifth Edition. CambridgeUniversitypress, 1994.

2. Uppadyay,UppadyayandNath ,"BiophysicalChemistry.PrinciplesandTechniques".11th ed. Himalayapublishing house, 1998

ReferenceBooks:

1. Freifelder, David. Physical biochemistry: applications to biochemistry and molecular biology. Macmillan, 1982.

BIOANALYTICAL TECHNIQUESLABORATORY

1. Calibration and measurementofpHfordifferentsolutions.
2. Separation of milk proteins by centrifugation
3. Identification of amino acids by paper chromatography
4. Identification of amino acids byTLC.
5. Separation of nucleic acids by affinity chromatography.
6. Agarose gel electrophoresis.

7.SDS-PAGE analysis of proteins.

8. Verification of Beer Lamberts Law

9. Quantification of nucleic acids/proteins by visible method

10. Quantification of nucleic acids/proteins by UV method

11. Immunoassay by electrophoresis

12. Density gradient preparation

Text Book:

1. Boyer, Rodney F., and Rodney Boyer. Modern experimental biochemistry. Reading: Addison-Wesley, 1986.

MOLECULAR BIOLOGY

CO NO	Course Outcomes	Mapped PO	B T L
CO 1	Understand the genome organization & replication	1	1,2
CO 2	Compare DNA transcription mechanisms	5	3,4
CO 3	Compare DNA translation mechanisms	5	3,4
CO 4	Analyse gene regulation mechanisms	8	4

Genome organization & DNA structure-Nucleic acid as genetic material, transformation in *pneumococcus*, Hershey-Chase experiment, RNA as genetic material in viruses. Genome of prokaryotes & eukaryotes, C-Value Paradox, structural genes, regulatory genes, overlapping genes, pseudogenes, split genes. **Structure of DNA**-Watson & Crick's model; Types of DNA: A, B and Z-DNA; Denaturation, renaturation of DNA. **DNA replication and repair-** semi conservative replication apparatus, bi-directional & rolling circle replication. **dna damage-** Mutations, Types of Mutations, Effect of UV, Deamination, Alkylation. **Repair Mechanisms-** Direct Repair, Excision Repair, Mismatch Repair, SOS Repair and Recombination Repair**.Mechanism of transcription and translation Prokaryotic & Eukaryotic Transcription –** Initiation, Elongation and Termination; Structure of Promoters; RNA Polymerases of Prokaryotic and Eukaryotic Organisms; gene splicing and Ribozyme. **Post Transcriptional Processes of Eukaryotic RNA–**Processing of t-RNA, r-RNA, m-RNA. **Translation in prokaryotic and Eukaryotes**-Genetic code, Aminoacylation of tRNA – initiation, elongation and termination of translation, Post-translational modifications. **Regulation of gene expressionRegulation of Gene expression in Bacteria–**Operon concept, inducible and repressible operons, positive and negative regulations, Inducer molecules, repressor molecules, co repressor molecules; Induction and catabolic repression of ***lac*** Operon in ***E.Coli***; Repression and attenuation of ***trp*** operon in ***E.Coli***; Absolute control by Antisense RNA's. Regulation in eukaryotes – Control by promoter, enhancer and silencers. Cis-trans elements. Plasmid Biology: Types, compatibility, replication, segregation, control of copy number and plasmid. Molecular biology of tumor: Control of cell proliferation, oncogene activation, role of tumor, suppressor genes.

Text Books:

1. Freifelder, David. Molecular biology: a comprehensive introduction to prokaryotes and eukaryotes. No. 577.2 FRE. 1983.
2. Becker, Wayne M., et al. The world of the cell. Vol. 4. Menlo Park, CA: Benjamin/Cummings, 1996.

Reference Books:

1. Darnell, James E., Harvey F. Lodish, and David Baltimore. Molecular cell biology. Vol. 2. New York: Scientific American Books, 1990.

IMMUNOLOGY

CO No	Course Outcomes	Mapped PO	B T L
CO 1	Understand the various defence mechanism of body system	1	1
CO 2	Remember different types of Ag-Ab reactions	11	2
CO 3	Differentiate the role of B and T cells	1	3
CO 4	Development of ELISA method for Ag-Ab reactions	2	4
CO 5	Analyze the intereactions between antigen and antibody	5	4

Basicsofimmunology-Typesofimmunity–Innate,acquired,Humoral&cell mediated;Organsoftheimmunesystem:Primarylymphoidorgans–Bursaof fabraceous, Bonemarrow,thymus;Secondary lymphoidorgans–Spleen,lymphnode.Cellsofimmunity–Lymphoid &Myeloid lineage. Antigens–Types, Chemical nature,characteristics of Antigen, Haptenandadjuvant. Cytokines–Types, receptors and functions. **Immunological techniques-** Antigen-Antibody Reactions–Mechanismand types. Agglutination–blood grouping, Widal & VDRL. Precipitation–double immunodiffusion, Radial Immuno Diffusion; Immunoelectrophoresis, Rocket Immuno electrophoresis,Complementfixationtest.ELISA,Westernblotting,FACS,IHCandRIA. B **Cellontogeny-**B-Cell biology,BCR,Immuneresponse–primary,secondaryand tertiary response's; Immunoglobulins– Structure, types, subtypes and functions. Production of monoclonalantibodies.Complement System–Classical,alternativeandMBLectin pathway&regulation. **TCellontogeny-**T-Cellbiology,TCR;TypesofTcells–T_H,$T_C$andT_S cells.Structure ofMHC–I&II,ProfessionalAntigenPresentingCells,Mechanismof Antigen processing and Antigen presentation. **Clinical immunology-**Hypersensitivity: IgE mediated, antibody dependant cell cytotoxicity, immunecomplexmediatedreactionsanddelayedtypeofhypersensitivity;Autoimmunity–systemic&organspecific.Transplantationimmunity–MLRandMCA;Tumor immunity–Tumor antigens,Vaccinations– basic concept, types.

Theories of immune response, Antibody genes and generation of diversity, Tcell effector mechanism, Tolerance – Natural & Adaptive. Immuno suppressive drugs.

Textbooks:

1. Kindt, Thomas J., et al. Kuby immunology. Macmillan, 2007.
2. Delves, Peter J., et al. Essential immunology. John Wiley & Sons, 2017.

References Books:

1. Tizard, Ian R. Immunology: an introduction. Saunders College Pub., 1984..

IMMUNOLOGY LABORATORY

16. Total count ofRed blood cells byNeubaur chamber method
17. Total count ofwhite blood cells byNeubaur chamber method
18. Estimation of hemoglobin bySahli's method
19. Widal Test & VDRLTest
20. Blood GroupingTest
21. Quantitative precipitin Assay
22. RadialImmuno Diffusion
23. Immunoelectrophoresis
24. RocketImmunoelectrophoresis
25. ODD forantigen-antibodypatterns
26. ODD forantibodytitration
27. ELISAfor antigencapture
28. ELISAfor antibodycapture
29. Dot-ELISA
30. Electrophoreticanalysisofserum proteins
31. Immunoprecipitation

Text Books:

1. Delves, Peter J., et al. Essential immunology. John Wiley & Sons, 2017

BIOINFORMATICS

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the theoretical basis of bioinformatics	3,12	1
CO2	Understand the access and retrieval of biological information from data bases	3,12	2
CO3	Manipulate the DNA/Protein sequences using standalone PC programs and with the help of World Wide Web	3,12	4
CO4	Develop Multiple Sequence Alignment tools to find homologous, analyze sequences, construct and interpret the evolutionary trees	3,12	5
CO5	Demonstrate the relationships using retrieved sequences	3,12	4

INTRODUCTION TO BIOINFORMATICS & DATABASES: Need of Computers in Biotechnology Research- Biological Information on the web. Introduction to Biological databases – Primary Databases: NCBL, EMBL, DDBJ. Secondary Databases: SwissProt, PIR. Specialized data bases - KEGG and BRENDA. Information retrieval from Databases. Concepts of Data mining, Basics of Sequencing Technologies, Genome projects-human genome project. SEQUENCE COMPARISIONS AND ALIGNMENTS: String similarity- Local, Global alignment; pair wise alignments – Dot plots, Dynamic Programming Methods, Heuristic methods - FASTA, BLAST; Amino acid substitution matrices- PAM and BLOSUM. MULTIPLE SEQUENCE Methods for Multiple sequence alignments- local and global multiple sequence alignment; Significance and applications of MSA PHYLOGENETIC ANALYSIS Origins of Molecular Phylogenetics; Methods of Phylogenetic analysis- Maximum Parsimony Maximum Likelihood and Distance based methods. STRUCTURAL BIOINFORMATICS: Protein Structure Basics; Peptide Formation; Dihedral Angles; Hierarchy- Secondary Structures, Tertiary Structures, Primary structural analysis and prediction, Secondary structural analysis and prediction, structure alignment; Secondary Fold recognition: Determination of Protein Three-Dimensional Structure; Structural modeling. Introduction to Unix and PERL. Programming: Genomics, proteomics, transcriptomics and metabolomics, high throughput technologies, tools for "omic" sciences-databases, Programming: scalars, arrays, hashes and regular expressions.

Text Books:

3. Bioinformatics: Methods and Applications- SC Rastogi, N Mendiratta& P Rastogi, 2005
4. Bioinformatics: A Machine learning approach – P. Baldi, S. Brunak, MIT press, 1988.

Recommended References:

3. Introduction to Computational Molecular Biology by Joao Carlos Setubal, Joao Meidanis, Jooao Carlos Setubal, 2003
4. Bioinformatics: Sequence and Genome Analysis David W. MountCSHL Press, 2006

BIOINFORMATICS LABORATORY

1. Basic Unix commands

2. Searching Bibliographic databases for relevant information

3. Sequence retrieval from DNA & Protein databases.

4. Sequence file format conversions.

5. Pair wise comparisons using Dotlet.

6. BLAST services.

7. FASTA services.

8. Multiple Sequence Alignment (CLUSTAL W) & Phylogenetic Analysis using Phylip, Phylodraw.

9. Protein Databank retrieval and exploring protein structure using Rasmol& Spdbv

10. Restriction Mapping

11. Primer Design.

12. PERL Programming

13. Dynamic programming method- local and global alignment

14. Gene prediction methods

Text Books:

1. P. Baldi, S. Brunak ,"Bioinformatics: A Machine learning approach ", MIT press (1988)

GENETIC ENGINEERING

CO No	COURSE OUTCOME	MAPPED PO	BTL
CO1	Acquire the knowledge of steps in gene cloning	3,12	1
CO2	Understand the importance of vectors in cloning	3,12	2
CO3	Analayze PCR methods	3,12	4
CO4	Compare gene transfer methods	3,12	3
CO5	Construct recombinant molecules	3,12	4

Basics of Genetic Engineering: Basic steps of gene cloning. Isolation & Purification of DNA & RNA. Enzymes used in cloning – Nucleases, Polymerases, Ligases, Transferases, DNases, RNases, Kinase, Phosphatase. Restriction Enzymes – Nomenclature, classification, uses, restriction sites, applications. Special DNA molecules – Linker, Adaptor, Polytailing. **Cloning Vehicles:** Plasmids Vectors – Classification, Properties, pUC 17/19, pBR 322, Blue script vectors. Cosmid Vectors – essential features, strategies to generate genomic library. BAC's & YAC's Its uses in construction of genomic library. Phagemids – M13 derived vectors. Expression vectors – pRT and pET vectors. Vectors for construction of cDNA libraries. **Polymerase Chain Reaction:** PCR – History, Principle, Mechanism, Methodology, Applications, Primers, Designing of mutagenic primers. Identification of PCR products, Cloning of PCR products, Multiplex PCR, Anchored PCR, Asymmetric PCR, Nested PCR, Inverse PCR, fusion PCR, RAPD-PCR, RT-PCR, Hot Start PCR, Touch Down PCR and Real Time PCR. **Genes to Clones:** Gene Transfer Techniques – Microinjection, Electroporation, Transformation, Particle bombardment, Macroinjection, Chemical methods. Screening of clones - Complementation method, genetic methods, Immunological methods, Hybridization methods. **Gene Technology:** Sequencing of DNA by Maxam-Gilbert method and Sanger's method. RNA silencing, RAPD, RFLP, AFLP. Invitro mutagenesis - Site directed mutagenesis. Blotting Techniques – Southern, Northern & Western. Probe preparation, labelling and detection techniques (Phosphoimaging and Radioactive labelling). Applications of gene cloning in medicine and agriculture.

CRISPR-CAS technology, Viral vectors, Plant vectors, Animal vectors, Restriction mapping, ligation process.

Recommended Textbooks:

3. Old R.W and Primrose S.B .1995. Principles of gene manipulation-An introduction to genetic engineering. 5th edition. Blackwell scientific publications. London.
4. Winnaker E.C. 1987. From genes to clones. Introduction to gene technology. VCH Publications.

Reference Books:

3. J.D.Watson Recombinant DNA (A short Course). W.H.Freeman (1983)
4. T.A Brown gene cloning and DNA analysis. Wiley Blackwell- Apr- 2010

GENETIC ENGINEERING LABORATORY

10. Agarose Gel Electrophoresis
11. Isolation & Visualization of plant genomic DNA by CTAB method
12. Isolation & Visualization of blood genomic DNA by silica column method
13. Isolation & Visualization of plasmid DNA by alkali lysis method
14. Isolation of RNA from liver tissue by hot phenol method
15. Extraction of DNA from agarose gels
16. Restriction digestion of DNA
17. Bacterial Transformation
18. Amplification of DNA fragments by PCR
19. DNA ligation
20. Southern blotting
21. Blue-White screening method

Recommended laboratory manual:

2. Deininger, Prescott. "Molecular cloning: A laboratory manual: Edited by J. Sambrook, EF Fritsch, and T. Maniatis. Cold Spring Harbor Laboratory Press, Cold Spring Harbor, NY, 1989 (in 3 volumes)." (1990): 182-183.

FERMENTATION TECHNOLOGY

CO No	Course Outcomes	MAPPED PO	BTL
CO1	Acquire the knowledge of fermentation process basics	1,5	1
CO2	Understand medium optimization	1,5	2
CO3	Analayze medium sterilization.	1,5	4
CO4	Compare aeration and agitation	1,5	3
CO5	Demonstrate fermentation processes to produce value added proteins and other biological substances for human, animal therapeutic use, food production processing and bio fuels.	1,5	4

Introduction to Fermentation: Different range of fermentation processes; Chronologicaldevelopmentoffermentationindustry;Generalrequirementsoffermentation processes;anoverviewofaerobicandanaerobic fermentationprocess,Monitoring and control of fermentation process. Ancillaryfittings forreactors(samplingport);Aseptictransferof sporesuspension. **Medium Requirements and Optimization:** Medium requirements for fermentation processes -Carbon,Nitrogen,Minerals,VitaminsandOtherComplexnutrients, Oxygenrequirement.Introductiontomediumoptimization;Methodsofmediaoptimization (Onefactormethodand Plackett-Burmandesign). **FermentationProcesses&Sterilization Techniques:**Classificationoffermentationsystem(Batch,fed-batch,Continuous);Solid state fermentation, Submerged fermentation. Dualand multiple fermentations; Concept of Chemostat; Turbidostat,Kinds of sterilization techniques; Thermal death kinetics of microorganisms, Batch and Continuous sterilization of liquid media, Filter sterilization. **Aeration andAgitation:**Typesofmixing mechanisms- bubble aeration & mechanical agitation; mixing equipment; Types of spargers and impellersinfermenters;Significanceofoxygentransferinfermentations;Factorsaffecting oxygentransferrates. Scaleupoffermentationprocess; Principles; Theoretical considerations and techniques used; Scale down methods; Industrial fermentation products- Penicillin, Alcohol production.

Technology of yeast production, Production of organic acids important for food industry, Principles of malt-technology and brewing industry, Separation equipment's in fermentation industry, Production of microbial biomass.

Textbooks:

1. PeterFStanbury, Principles of Fermentation Technology, Elsevier, 2009

2. Bailey&Ollis, Biochemical Engineeringfundamentals Mcgraw Hill Higher Education (1988)

ReferenceBooks:

1. F.C. Web BiochemicalEngineering, BS publications, 1997

2. HarveyWBlanch,Biochemical Engineering.Taylor&Francis /b S Publication (Feb 1997).

FERMENTATION TECHNOLOGY LABORATORY

1. Formulation ofsimple and complexmedia for fermentation
2. Medium optimization using plackett burmann design
3. Studyof thermal death kinetics and estimation ofdelta factor forbacterial culture
4. Comparison of growth curve forbacterial and fungalculture
5. Determination of K_S forbatchgrowth of microorganism
6. Bioreactor instrumentation and control
7. Fermentative production of bioethanol
8. Cellimmobilization anddegradation kinetics ofsubstrate
9. Microbial production andquantification of finechemicals
10. Production ofXylanasesusing *P.feniculosum.*
11. Production ofCellulaseusingSolid State fermentation.
12. Production ofProteaseusingsubmerged fermentation.

Text Book:

1. PeterFStanbury, Principles of Fermentation Technology.Elsevier(2009).

DOWNSTREAMPROCESSING

CO No	Course Outcomes	Mapped PO	BTL
CO1	Acquire the knowledge of unit operations and understand the principle behind the unit operations, their advantages and disadvantages involved in DSP.	1,5,12	1
CO2	Design, develop and optimize processes for purification of products.	1,5,12	4
CO3	Application of appropriate technique/unit operation for the process and evolve processes for purification of products with high market value.	1,5,12	3
CO4	Design and develop new economical processes in terms of time and energy for quality product development.	1,5,12	4
CO5	Demonstrate various down-stream process techniques	1,5,12	4

DownStreamProcessinginBiotechnology – Introduction; Bioprocess Case studies; Characterization of Biomolecules, characterizationoffermentationbroth: Morphologyofcells,structureof thecellwall,productconcentrations,Biomassdensity.PrimarySeparationAndRecovery Processes: Recovery of intracellular products; Celldisruption methods-physical methods (osmotic shock, grindingwithabrasives, solidshear, liquidshear) –chemical methods (alkali, detergents)- enzymatic methods. Removal ofsuspendedsolids: filtration, filtrationequipment,centrifugation, centrifugation equipment-tubularbowl,disk-stack, basket centrifuges. Product Enrichment Operations: Adsorption, Aqueoustwo-phaseextractionprocess:Applications of aqueous two-phase extraction, reversedmicellesextractionprinciple, micellestructures, critical micelleconcentration. Proteinsolubilization,limitationofreversedmicelles. Membranebased separations–Classification&characteristicsofmembrane separation,merits& demerits. Microfiltration,ultra-filtration,Reverseosmosis,dialysis &electrodialysis. Membrane modules: Plate&Frame,hollowfiber,spiralwound,shell&tube. Precipitations ofproteins with salts and organic solvents, kinetics of protein aggregation. Product Purification: ChromatographicSeparations:Classificationofchromatographictechniques, Principles &practices of Gel Filtration, Ion Exchange and Affinity chromatography.AlternativeSeparationMethods andProductPolishing;Supercritical extraction: principles of SCE, Flow scheme of a simple SCE system. Polishing: Crystallization, Principles of crystallization and equipment. Principles of dryingand lyophilization, Freezedryer. Formulation strategies:Importanceofformulation, formulation ofbeakersyeast, Enzymes, formulation of pharmaceutical products.
Stabilization of bioproducts, Utilities (Air, water, steam etc), Problems will relate to design, estimating operating conditions and optimization of the process.

Textbooks

1. Butterworthand Heinmann.Product recoveryinbioprocess Technology-Elsevier India(2004)
2. B.Siva Sankar.Bioseparations, Fifth Edition, PHI Learning(2009)

References Books:

1. HarveyBlanch.BiochemicalEngineering,Taylor&Francis/bSPublication(Feb 1997)
2. Christie J.Geankoplis., Transport processes and Unitoperations, PhiLearning(2009)

DOWNSTREAMPROCESSING LABORATORY

1. Extraction of proteins by Two-phase separation (PEG 3000 &Ammonium sulphate orOrganic solvents)
2. Fractionation ofproteinsfrom Egg byAmmonium SulphatePrecipitation.
3. Desaltingof Proteins byDialysis(CuSo4 +protein)
4. Isolation ofMilk protein(Casein) by Iso-electricPrecipitation.
5. CellDisruption bySonication and Enzymatic Reaction
6. Separation ofproteins byGel Filtration
7. Separation of charged biomolecules by Ion ExchangeChromatography
8. Separation ofproteins byNative/SDS Gel Electrophoresis(SDS PAGE)
9. Extraction and isolationofEnzymes from microbial cultures.
10. Separation ofproteins byAffinityChromatography
11. Separation ofBiomolecules byHigh Pressure Liquid Chromatography
12. Separation ofVolatilecompounds byGas Chromatography

Laboratorymanuals:

1. Handbook ofDownstream Processing ByGoldberg, Elliott,Chapman &Hallpublishers

MINOR DEGREE

BIOANALYTICAL TECHINIQUES

	Competency	POs	BTL
C-1	Understand theimportanceof analytical instrumentation in	PO1-2	1
C-2	Understand the basic principles ofcentrifugationand understand	PO1-3	1
C-3	Determination ofmolecularweight and purityofmacromolecules	PO1-2, PO 4-2	3
C-4	Remember the principleof chromatographic techniques	PO1-2	2
C-5	Apply the modeofoperation and applications of different	PO1-2, PO4-2	4

Syllabus

CENTRIFUGATION Centrifugation – Basic principles (sedimentation, Sedimentation coefficient, Svedbergunits)andtypesofrotorsincentrifuges-Fixedanglerotor,Vertical rotor,Swingoutrotor,Zonalrotors.Typesofcentrifuges–UltraandAnalyticalcentrifuges, PreparativeandDensitygradientcentrifugations, Densitygradientspreparations–Sucrose, Cesium chloride. Determination of molecular weight and purity of macromolecules by centrifuges. **CHROMATOGRAPHY** Basic principle of chromatography - Partition chromatography,CounterCurrentdistribution.Modes&Typesofchromatography–Paper, TLC.ColumnChromatography–Gelpermeation,Ionexchange,Affinitychromatography, GLC,HPLC.**ELECTROPHORESIS**Electrophoresis:Principleofelectrophoresis, Typesof electrophoresis: Free Electrophoresis – Microelectrophoresis, Moving boundary; Zonal Electrophoresis – Paper, Cellulose Acetate, Starch gels, Agarose gels, SDS-PAGE. IEF (Isoelectric focusing), Pusle field gel electrophoresis (PFGE), 2-D gel electrophoresis, Capillary electrophoresis.**SPECTROSCOPY** Basic concepts of spectroscopy, Beer-Lambertslaw,Colorimetry,Visible&UVSpectroscopy,Fluorescencespectroscopy,Flame photometry, Atomic absorption spectrophotometer, Infrared, FT-IR, NMR &Mass spectroscopy.**ISOTOPIC AND ELECTROCHEMICAL TECHNIQUES**Auto- radiography– PrinciplesandApplicationsof radioisotopesinbiologicalsciences. Non- isotopic tracertechniques. Principles andrangeofelectrochemical techniques– pHelectrodes. Ion-selective,gas sensingelectrodesand Oxygenelectrodes,Immuno-histochemistry.

Recommendedtextbooks:

1. KeithWilson &John Walker, Principles &Techniques of Biochemistry and Molecularbiology.PracticalBiochemistry.PrinciplesandTechniques.KeithWilson &John, 1994, 5th ed. CambridgeUniversitypress

2. BiophysicalChemistry.PrinciplesandTechniques.Uppadyay,Uppadyay&Nath11th ed. Himalayapublishing house.

ReferenceBooks:

1. Freifelder,BiophysicalChemistry. Freeman &Co.

BIOINFORMATICS

	Competency	POs	BTL
C1	Understandtheorganization ofcomplex Genomicdata	PO1-2	1
C2	Identifythesimilaritiesin Genomicdatain termsof chemicaland biological significance.	PO1-3	2
C3	Applytheproteinandgenomicdatain termsofpair wise	PO1-2, PO4-2	3
C4	Writeasequencesimilarityand pattern matchingprogram for sequencesusingPERL	PO1-2, PO4-2	4
C5	UseMultiplesequencealignment tocreatephylogenetictree	PO1-2, PO4-2	3

Syllabus:

INTRODUCTIONTOBIOINFORMATICS&DATABASES NeedofComputers inBiotechnologyResearch-BiologicalInformationontheweb.IntroductiontoBiologicaldatabases-theirOrganization andmanagement -Database search-Algorithmsissuesindatabasesearch - Information retrieval from Databases - Concepts of Data mining, data warehousing and Data integration. **SEQUENCECOMPARISIONSANDALIGNMENTS**Stringsimilarity-Local,Global alignment;pairwisealignments–Dot plots,DynamicProgrammingMethods,Heuristicmethods-FASTA,BLAST;Aminoacidsubstitutionmatrices-PAMandBLOSUM.**MULTIPLE SEQUENCE** MethodsforMultiplesequencealignments-localandglobal multiplesequencealignment;Significance andapplicationsofMSA-sequencecomparisons-Profileanalysis,Blockanalysis,patternsearching.
PHYLOGENETICANALYSISOriginsofMolecularPhylogenetics; Methodsof Phylogenetic analysis-MaximumParsimonyMaximumLikelihoodandDistancebasedmethods,TreeEvaluation, ProblemsinPhylogeneticAnalysis,AutomatedToolsforPhylogeneticAnalysis; **PROGRAMING USING PERL** Introductionto PERL. Programmingbasics, scalar,arraysandhashes.Control statements, I/O, Regular expressions, data formats, file handles, file tests. File and directory manipulations.

RecommendedT

exts:

1. Bioinformatics:AMachinelearningapproach–P.Baldi,S.Brunak,MITpress,1988.
2. Bioinformatics:MethodsandApplications-SCRastogi,NMendiratta&PRastogi

Recommended References:

1. Introductionto Computational Molecular BiologybyJoao Carlos Setubal,Joao Meidanis, Jooao Carlos Setubal

FOOD TECHNOLOGY

			BTL
C-1	Studyand understandBiotechnologyin relation to the food industry	PO1-2, PO4-2	1
C-2	Illustrate theimportanceofBio processingof meat,	PO1-2,	2
C-3	Explorethe Principles underlyingthe destructionof	PO1-2,	3
C-4	Predict the Stabilityof food preservation with low	PO1-1, PO -3	3

Sylla bus

Introduction:Foodmicrobiology; historicaldevelopments. Biotechnologyin relation to the foodindustry,typesofmicroorganism'sassociatedwithfood,itssources,typesandbehavior infoods.Roleandsignificanceofmicroorganismsinfood.Intrinsicandextrinsicparameters of foods that affect microbial growth.:Utilization of microorganisms in food industries, geneticmanipulations.ThermophilesandRadiation-resistantmicroorganisms,characteristics and growth of thermophilic microorganisms, Nature of Radiation resistance in microorgani productions. Emerging processing and preservationtechnologiesformilkanddairyproducts.**Foodpreservation** Foodpreservation usingirradiation,CharacteristicsofRadiationsofinterestinfood preservation. Principles underlying the destruction of Microorganisms by irradiation, processing of foods for irradiation. Application ofradiation, Radappertization, Radicidation, and Radurization of foods. Legalstatusoffoodirradiation.Effectofirradiationoffoodconstituents.torageof foods Stability of food preservation with low temperatures, high temperatures, drying. Indicator and food borne pathogens. Food borne illness, quality control, HFCS (High FructoseCornSyrup)andmycoproteins.Airsampling, metabolicallyinjuredorganisms, enumeration and detection of food-borneorganisms.

Recommendedtextboo ks:

1. Lidsay,WillisBiotechnology,Challengesfortheflavourandfoodindustries,Elsevier AppliedScience. 1988.

2. FoodScienceandFoodBiotechnologybyF.F.G.Lopez&G.V.B.Canovas(2003), CRC Press, Florida, USA.

ReferenceBoo
ks:

1. GeorgeJ.B.BasicFood Microbiology, CBSPublishers &Distributors,1987.
Roger,A., Gordan B., and John T. Food Biotechnology, 1989.

ANATOMY AND PHYSIOLOGY

	Competency	POs	BTL
C-1	Identificationoftypes of human body systems	PO1-2	1
C-2	Understand human skeleton system	PO1-2, PO4-2	1
C-3	Studythedevelopment of various physiological systems	PO1-2,PO 4-2	2
C-4	Remember various communicable diseases	PO1-2	2

Introduction to human body and organization of human body. Functional and structural characteristics of cell. Detailed structure of cell membrane and physiology of transport process. Structural and functional characteristics of tissues- epithelial, connective, muscle and nerve. Skeletal system: Structure, composition and functions of skeleton. Classification of joints, types of movements of joints. Muscular system: Anatomy & physiology of skeletal and smooth muscle, energy metabolism, types of muscle contraction, muscle tone. Demography and family planning, medical termination of pregnancy. First aid: Emergency treatment of shock, snake bites, burns, poisoning, fractures and resuscitation methods. Sense organs: Basic anatomy and physiology of the eye (vision), ear (hearing), taste buds, nose (smell), and skin (superficial receptors). Communicable diseases: Brief outline, their causative agents, modes of transmission and prevention (Chicken pox, measles, influenza, diphtheria, whooping cough, tuberculosis

Recommended textbooks:

1. Ed. John R.W. Masters, Human Physiology, 4th Edition, OUP, 2000.

2. Clynes, Basic Physiology, Springer, 1998.

Reference books:

1. Animal Cell Biotechnology. Portner, 2nd Edition, Humana Press, 2007.

BIONANOTECHNOLOGY

	Competency	POs	BTL
C-1	Understand the basic concepts of bionanotechnology	PO1-2	1
C-2	Emphasizes on variousapplications in tissue engineering	PO1-3	2
C-3	Provides knowledgeof interactions between natural and artificial structures	PO1-2, PO 4-2	2
C-4	Understandthe biologynanoparticles	PO1-2	1

Nanostructures in Cancer Research: Examples of nanostructures in Research and Therapy Nanotechnology for Tissue Engineering: Applications in Reg The Science of Nano - What is Nanobiotechnology. **Introduction to Nanostructures:** Carbon Nanotubes (CNT), Fullerenes. Nano Peapods. Introduction to Nanostructures: Quantum Dots and Semiconductor Nanoparticles Metal-based Nanostructures (Iron Oxide Nanoparticles). Introduction to Nanostructures: Nanowires Polymer-based Nanostructures (Dendrimers) Renerative Therapy. Design of Nanostructures for Daily Applications: **Commercial Examples.** Introduction to Nanostructures: Gold Nanostructures: (Nanorods, Nanocages, Nanoshells). Protein-based Nanostructures: Nanomotors: Bacterial (E.coli) and Mammalian (Myosin family) **Nanobiosensors:** Science of Self-assembly - From Natural to Artificial Structures. Nanoparticles in Biological Labeling and **Cellular Imaging:** Science of Nanoparticles Functionalization and its applications in tissue engineering.

Textbooks

1. Cellular and Subcellular Nanotechnology: Methods and Protocols by David S. Goodsell's, John Wiley Publishers
2. Ehud Gazit, An introduction to bionanotechnology. Imperial College Press, 2007

Reference Books

1. Nolting B, "*NANOTECHNOLOGY*". In: "Methods in Modern Biophysics", Springer, 2005