SEMESTER -I

Subject Code	Subject	Hrs. /Week			Exam Hrs.	Maximum Marks				
		L	T	P		MS1	MS2	IA	Th.	Total
Personality Development Program for First 15th Days										
THEORY										
1D01	English &Communication Skills	2	0	0	3	10	10	20	60	100
1D02	Applied Chemistry-I	3	1	0	3	10	10	20	60	100
1D03	Applied Physics-I	3	1	0	3	10	10	20	60	100
1D04	Applied Mathematics-I	4	1	0	3	10	10	20	60	100
1D05	Computer Fundamental & Information Technology	3	1	0	3	10	10	20	60	100
Code	**Subject**	**Hrs. /Week**			**Exam Hrs.**	**IA (60%)**		**EA (40%)**		**Total**
		L	**T**	**P**		**MP1 (30%)**	**MP2 (30%)**			
1D06	Applied Chemistry Lab-I	0	0	2	2	30	30	40		100
1D07	Applied Physics Lab-I	0	0	2	2	30	30	40		100
1D08	Computer Fundamental & IT Lab I	0	0	2	2	30	30	40		100
1D09	**Engineering Drawing**	0	0	3	3	30	30	40		100
1D10	Workshop Practice – I	0	0	3	3	30	30	40		100
	TOTAL	**15**	**04**	**12**						**1000**

SEMESTER – II

Subject Code	Subject	Hrs. /Week			Exam Hrs.	Maximum Marks				
		L	T	P		MS1	MS2	IA	Th.	Total
THEORY										
2D01	Applied Chemistry-II	3	1	0	3	10	10	20	60	100
2D02	Applied Physics-II	3	1	0	3	10	10	20	60	100
2D03	Applied Mathematics-II	4	1	0	3	10	10	20	60	100
2D04	Electrical & Electronics Technology	3	1	0	3	10	10	20	60	100
2D05	Applied Mechanics	3	1	0	3	10	10	20	60	100
Code	**Subject**	**Hrs. /Week**			**Exam Hrs.**	**IA (60%)**		**EA (40%)**		**Total**
		L	**T**	**P**		**MP1 (30%)**	**MP2 (30%)**			
2D06	Applied Chemistry Lab-II	0	0	2	2	30	30	40		100
2D07	Applied Physics Lab-II	0	0	2	2	30	30	40		100
2D08	Electrical & Electronics Workshop	0	0	2	2	30	30	40		100
2D09	Workshop Practices-II	0	0	2	3	30	30	40		100
2D10	Computer Fundamental & IT Lab-II	0	0	2	2	30	30	40		100
	TOTAL	**16**	**05**	**10**						**1000**

SEMESTER – III

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	IA	Th.	Total
Theory											
3DMOI01	Basic Cell Biology	3	3	1	0	3	10	10	20	60	100
3DMOI02	General Microbiology	3	3	1	0	3	10	10	20	60	100
3DMOI03	Biochemistry	3	3	1	0	3	10	10	20	60	100
3DMOI04	Techniques in Biotechnology	3	3	1	0	3	10	10	20	60	100
3DMOI05	Radiation Biology	3	3	1	0	3	10	10	20	60	100

Practical's & Sectionals

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)	Total
			L	T	P		MP1*30%	MP2*30%	Pr.W40%	
3DMOI06	Basic Cell Biology Lab	2	0	0	2	3	30	30	40	100
3DMOI07	General Microbiology Lab	2	0	0	2	3	30	30	40	100
3DMOI08	Biochemistry Lab	2	0	0	2	3	30	30	40	100
3DMOI09	Techniques in Biotechnology Lab	2	0	0	2	3	30	30	40	100
3DMOI10	Radiation Biology Lab	2	0	0	2	3	30	30	40	100
	GRAND TOTAL	25	15	5	10					1000

SEMESTER – IV

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	IA	Th.	Total
Theory											
4DMOI01	Molecular Genetics	3	3	1	0	3	10	10	20	60	100
4DMOI02	Molecular Immunology	3	3	1	0	3	10	10	20	60	100
4DMOI03	Molecular Plant Breeding	3	3	1	0	3	10	10	20	60	100
4DMOI04	Animal Biotechnology	3	3	1	0	3	10	10	20	60	100
4DMOI05	Bioprocess Engineering and Technology	2	2	1	0	3	10	10	20	60	100
Practical's & Sessionals											
Code	**Subject**	**CR.**	**Hrs. /Week**			**Exam Hrs.**	**IA (60%)**		**EA (40%)**		**Total**
			L	T	P		MP1* 30%	MP2* 30%	Pr. W 40%		
4DMOI06	Molecular Genetics Lab	2	0	0	2	3	30	30	40		100
4DMOI07	Molecular Immunology Lab	2	0	0	2	3	30	30	40		100
4DMOI08	Molecular Plant Breeding Lab	2	0	0	2	3	30	30	40		100
4DMOI09	Animal Biotechnology Lab	2	0	0	2	3	30	30	40		100
4DMOI10	Bioprocess Engineering and Technology Lab	2	0	0	2	3	30	30	40		100
	GRAND TOTAL	24	14	05	10						1000

SEMESTER – V

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	IA	Th.	Total
Theory											
5DMOI01	Genetic Engineering	3	3	1	0	3	10	10	20	60	100
5DMOI02	Marine Biotechnology	3	3	1	0	3	10	10	20	60	100
5DMOI03	Plant Biotechnology	3	3	1	0	3	10	10	20	60	100
5DMOI04	Medical Biotechnology	3	3	1	0	3	10	10	20	60	100
5DMOI05	Microbial Biotechnology	3	3	1	0	3	10	10	20	60	100

Practical's & Sessionals

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	IA (60%)		EA (40%)	
			L	T	P		MP1*30%	MP2*30%	Pr. W 40%	Total
5DMOI06	Genetic Engineering Lab	2	0	0	2	3	30	30	40	100
5DMOI07	Marine Biotechnology Lab	2	0	0	2	3	30	30	40	100
5DMOI08	Medical Biotechnology Lab	2	0	0	2	3	30	30	40	100
5DMOI09	Microbial Biotechnology Lab	2	0	0	2	3	30	30	40	100
5DMOI10	Immunotechnology Lab	2	0	0	2	3	30	30	40	100
	GRAND TOTAL	20	15	05	10					1000

SEMESTER – VI

Code	Subject	CR.	Hrs. /Week			Exam Hrs.	Maximum Marks				
			L	T	P		MS1	MS2	TA	Th.	Total
Theory											
6DMOI01	Pharmaceutical Biotechnology	3	3	1	0	3	10	10	20	60	100
6DMOI02	Nanobiotechnology	3	3	1	0	3	10	10	20	60	100
6DMOI03	Biosafety, Bioethics and Bioentrepreneurship	3	3	1	0	3	10	10	20	60	100
6DMOI04	Applied Microbiology	3	3	1	0	3	10	10	20	60	100
6DMOI05	Proteomics and Genomics	3	1	1	0	3	10	10	20	60	100
Practical's & Sessional											
Code	**Subject**	**CR.**	**Hrs. /Week**			**Exam Hrs.**	**IA (60%)**		**EA (40%)**		**Total**
			L	T	P		MP1*30%	MP2* 30%	Pr. W 40%		
6DMOI06	Nanobiotechnology Lab	2	0	0	2	3	30	30	40		100
6DMOI07	Pharmaceutical Biotechnology Lab	2	0	0	2	3	30	30	40		100
5DMOI08	Seminar	2	0	0	2	3	30	30	40		100
5DMOI09	Project	4	0	0	0	0					200
	GRAND TOTAL	24	12	04	04						1000

Semester-I

1D01: English Communication & Skills-I		
Objective: English communication encompasses written, oral, visual and digital communication within a workplace context. This discipline blends together pedagogical principles of rhetoric, technology, and software to improve communication in a variety of settings ranging from technical writing to usability and digital media design.		
Unit	**Topic**	**35hrs**
Unit – I	Narration, Voice, Basic Sentence Patterns. (Nine basic sentence patterns)Tenses, Common errors (Noun, Pronoun, Articles, Adverb, Punctuation, Preposition etc.)Transformation of Sentences, Determiners, Preposition	**5**
Unit – II	Modals in Conversational Usage, Prefix, Suffix, Idioms & Phrasal verbs: Modals Can, Could, Should, Will, Would, May, Might, Must, Need not, Dare not, Ought to, Used to. **Phrase** At all; Instead of; In Spite of; As well as; Set up; Upset; Look up; Call off; Call out; Come across; Set right; Look other. **Idioms** Work up (excite); Break down; Stand up for; Turn down; Pass away; Pass on; Back up; Back out; Carry out; Done for (ruined); Bring about; Go through; Ran over; Look up (improve); Pick out (selected).	**8**
Unit – III	Composition - . Unseen Passage, Précis Writing Letter Writing: Letter to the editor of a magazine, newspaper, business letters, letters to relatives, friends, government officers. Report Writing Paragraph Writing, Essay Writing - Essays on general and local topics related to environmental problems.	**6**
Unit – IV	**Listening:** For improving listening skills the following steps are recommended, Listen to Prerecorded Tapes, Reproduce Vocally what has been heard, Reproduce in Written form. Summaries the text heard, Suggest Substitution of Words and Sentences, Answer Questions related to the taped text, Summaries in Writing **Vocabulary:** Synonyms. Homonyms. Antonyms and Homophones**,** Words often confused, as for example, I-me; your-yours; its-it's; comprehensible-comprehensive; complement-compliment] Context-based meanings of the words, for example, man[N] man [vb]; step[|N| ,step [vb] conflict Israel Palestinian conflict Emotional conflict, Ideas conflict learn. learn at this school I learnt from the morning news **Group Discussion :** Developing skill to initiate a discussion [How to open] Snatching initiative from others [Watch for weak points, etc.]	**8**
Unit – V	**Speaking:** Introducing English consonant-sounds and vowel-sounds**.,** Remedial exercises where necessary**,** Knowing Word stress**,** Shifting word stress in poly-syllabic words [For pronunciation practice read aloud a Para or page regularly while others monitor]**Delivering Short Discourses:** About one self Describing a Place, Person, Object Describing a Picture, Photo. **Expand a topic-sentence into 4-5 sentence narrative. Note :**1. The Medium of teaching and examination will be English.2. The Question on Essay Writing (Unit-7) will be compulsory. The student will have to attempt one essay out of two, touching the given points on general/local topic related to environmental problems.3. At least on question will be set from each unit.4. No theory question will be set from syllabus of practicals.	**8**

	Text Books: Intermediate English Grammar Raymond Murphy, Pub: Foundation Books, New Delhi2. Eng. Grammar, usage & Composition Tickoo & Subramanian Pub: Scand and Co.3. Living Eng. Structure Standard Alien. Pub: Longman4. A Practical Eng. Grammar Thomson and Martinet. (and its Exercise Books) Pub : ELBS5. High School English Grammar Wren & Martin. and Composition **Reference Book :**1. Communicative Skills for Engineers and Scientists by Sangita Sharma and Binod Sharma, New Delhi : Pearson.2. English for Engineers by Abidi & Ritu, New Delhi : Cengage Learning.	

1D02: Applied Chemistry-I

Objective	**Chemistry** is the science of matter, especially its chemical reactions, but also its composition, structure and properties. Chemistry is concerned with atoms and their interactions with other atoms, and particularly with the properties of chemical bonds.	
	Topic	**38 Hours**
Unit – I	**Atomic Structure**: Constituents of the Atom, Bohr's Model of the Atom, Quantum Number and Electronic Energy Levels , Aufbau's Principle, Pauli's Exclusion Principle, Hand's Rule + *l* Rule ,Electronic Configuration of Elements (s,p,d Block Elements)**Development of Periodic Table:** Modern Periodic Law, Long form of Periodic Table. Study of Periodicity in Physical and Chemical Properties with, special reference to Atomic and Ionic Radii, Ionizations, Potential. Electron Affinity. Electro negativity. Variation of Effective Nuclear Charge in a Period. Metallic Character.	**8**
Unit – II	**Electro Chemistry:** Ionization, Degree of Ionization, Factors which Influence Degree of Ionization .Hydrolysis – Degree of Hydrolysis, Hydrolysis Constant., pH Value, Buffer Solution Electrolysis, Faraday's Laws of Electrolysis	**8**
Unit – III	**Kinetic Theory of Gases:** Postulates of kinetic Theory**,** Ideal Gas Equation, Pressure and Volume Corrections, Vender**.** Walls Equations**,** Liquefaction of Gases, Critical Pressure and Critical Temperature**,** for Liquefaction.**,** Liquefaction of Gases by Joule – Thomson Effect, Claude's Method and Linde's Method **Carbon Chemistry:** Definition of Organic Chemistry. Difference between Organic and Inorganic Compounds. Classification and Nomenclature - Open Chain and Closed Chain Compounds, IUPAC System of Nomenclature. (up to C5).	**8**
Unit – IV	**Metals and Alloys:** General Principles and Terms listed in Metallurgy, Metallurgy of Iron and Steel, Different forms of Iron, Effect of Impurities on Iron and Steel6.5 Effect of Alloying Elements in Steel **Pollution:** Water Pollution, Causes and Effects, Treatment of Industrial Water Discharges -Screening, Skimming and Sedimentation Tanks, Coagulation, Reductions, Chlorination, Biological Methods. Air Pollution Causes and Effects Control Methods – Electrostatic Precipitator, Scrubbers, Gravitational Setting Methods, by Plants. Awareness on	**8**
Unit – V	**Water:** Sources of Water**,** Hardness of Water.**,** Degree of Hardness, Estimation of Hardness by EDTA method, Problems on Calculation of Hardness**,** Disadvantages of	**6**

	Hardness**,** Softening Methods**,** Lime-Soda Method**,** Permutite Method**,** Ion -Exchange Method Problems on Softening of Water**,** Drinking Water, its Requisites, Purification and Sterilization of Water.	
	Text Books: 1. Engineering Chemistry II (Hindi) Mathur and Agarwal2. Chemistry of Engineering Materials C.V. Agarwal3. Engineering Chemistry P.C. Jain and Monika4. Chemistry M.M. Uppal5.Applied Chemistry (Hndi) V.P.Mehta Jain Bros. Jodhpur **Reference Books:** Instrumental methods of Chemical analysis, MERITT & WILLARD (EAST – WEST press) Physical Chemistry , P.W Atkin (ELBS, OXFORD Press) 3 Physical Chemistry W.J.Moore (Orient Longman)	

1D03: Applied Physics-I		
Objective: physics employs mathematical models and abstractions of physics to rationalize, explain and predict natural phenomena. This is in contrast to experimental physics, which uses experimental tools to probe these phenomena.		
Unit	**Topic**	**36 Hours**
Unit – I	**Units and Dimensions :** Idea of various systems of units, SI units Basic, Supplementary and Derived Units, Prefixes & Symbols, Dimensions and Dimensional Formulae**,** Principle of Homogeneity of Dimensions**,** Dimensional Analysis**,** Applications and Limitations **Elasticity :** Elasticity**,** Stress and Strain**,** Elastic Limit & Hooke's law**,** Young's Modulus, Bulk Modules & Modulus of Rigidity, Poisson's Ratio	**8**
Unit – II	**Properties of Liquids:** Surface Tension & Surface Energy**,** Cohesive & Adhesive Force, Angle of Contact**,** Capillarity & Expression for Surface Tension **,** Streamline & Turbulent Flow**,** Reynolds Number, Viscosity & Coefficient of Viscosity. Stokes's law & Terminal Velocity	**8**
Unit – III	**Sound Waves:** Velocity of Sound Waves: Newton's Formula , Laplace Correction ,Factors affecting Velocity of Sound Waves Propagation of Progressive Wave, Displacement, Velocity and ,Acceleration of a particle during propagation of wave Superposition of Waves: Stationary Waves (without mathematical analysis) Resonance tube	**8**
Unit – IV	**Gravitation & Satellites:** Newton's law of Gravitation, Acceleration due to Gravity Kepler's laws of Planetary Motion (statement only), Artificial Satellite (simple idea), Geo-Stationary Satellites, Escape Velocity. Velocity & Time Period of an Artificial Satellite. **Transfer of Heat:** Modes of Transmission of Heat - Idea of Conduction, Convection & Radiation, Thermal Conductivity & Coefficient of Thermal Conductivity Black Body, Kirchoff's Laws & Stefan Boltzmann Law (statement only), Newton's Law of Cooling & its Derivation from Stefan's Law	**6**
Unit – V	**Electrostatics:** Coulomb's Law**,** Intensity of Electric Field, Intensity due to a Point Charge**,** Electric Lines of Forces & Electric Flux**,** Electric Potential, Electric Potential due to a Point Charge **D.C. Circuits :** Resistivity, Effect of Temperature on Resistance , Ohm's Law, Resistance in Series and Parallel and their Combination Kirchoff's Law Wheatstone Bridge Meter Bridge Principle of Potentiometer	**6**
	Suggested Text Books: 1.Engineering Physics Gaur & Gupta (hindi)2. Applied Physics Vol.-I Hari Harlal, NITTTR3. Applied Physics Vol.-II Hari Harlal, NITTTR4,Modern Engineering Physics – A.S. Vasudeva (S. Chand)5,Solid State Physics : Kittel**Suggested Reference Book:**Solid State Physics: S. O. Pillai, Wiley Eastern Ltd. **2.**Physics Vol-I & II – Resnick & Halliday (Wiley Eastern) 3.A Text Book of Optics – Brij Lal & Subramanyam	
1D04: Applied Mathematics-I		
Objective: We can use of abstraction and logical reasoning, mathematics developed from counting, calculation, measurement, and the systematic study of the shapes and motions of physical objects. Practical mathematics has been a human activity for as far back as written records exist.		
Unit	**Topic**	**35 Hours**
Unit – I	**Matrices and Determinants:** Definition and Properties of Determinants**,** Definition and Types of Matrix**,** Transpose of a Matrix, Symmetric, Skew Symmetric Matrices,	6

	Orthogonal matrices, Hermitian and Skew Hermitian, Minors and Cofactors, Adjoint and Inverse of a Matrix, Cramer's Rule,Solution of Simultaneous Linear Equations by Inverse Matrix Method., Characteristic Matrix, Characteristic Equation, Eigen Values & Vectors, Cayley Hamilton Theorem (verification only)	
Unit – II	**Trigonometry:** Allied Angle(sin (180±A), sin (90±A) etc., Sum and Difference Formula (without proof) and their Application, Product Formula and C-D Formula, T-Ratios of Multiple and Sub-Multiple Angles (2A, 3A, A/2), Solution of Trigonometric Equations : sin X = 0, tan X = 0,cos X = 0, sin X=A, cos X =A & tan x = A	6
Unit – III	**Introduction to Different Types of Expansion:** Factorial Notation, Meaning of C(n, r), P(n, r), Binomial Theorem for Positive Index, any Index, Exponential Theorem, Logarithm Theorem **Complex Number:** Definition of Complex Number**,** Operations on Complex Number (Add., Sub ,Multiplication, Division)**,** Conjugate Complex Number**,** Modulus and Amplitude of a Complex Number, Polar form of a Complex Number	8
Unit – IV	**Two Dimensional Coordinate Geometry:** General Introduction**,** Distance Formula and Ratio Formula ,Co-ordinate of Centroid, In-Centre, Ortho-Centre and Ex-Centreof a Triangle, Area of Triangle, Straight Line, Slope form, Intercept form, Perpendicular form, One Point Slope form, Two Point form & General form, Angle between Two LinesPerpendicular Distance of a Line from a Point	7
Unit-V	**Conic: Circle :** Definition and Standard Equations**,** Equations of Tangent and Normal at a Point (simple problems)**Parabola :** Definition and Standard Equations**,** Equations of Tangent and Normal at a Point (Simple problems)**Ellipse and Hyperbola :** Definition and Standard Equations**,** Equations of Tangent and Normal at a Point(simple problems)	8
	Text Books:1. Mathematics XI & XII NCERT, New Delhi2. Mathematics XI & XII Rajasthan Board, Ajmer(Hindi)3. Polytechnic Mathematics H. K. Dass4. Text Book on Differential Calculus Chandrika Prasad **Reference Books:**1:Advanced Engineering Mathematics, Erwin Kreyszig, Wiley 9th Edition.2:Higher Engineering Mathematics, B.V.Ramana, Tata McGraw Hill.3: Thomas Calculus, Maurice D. Weir, Joel Hass and others, Pearson, 11th Edition.	
1D05: Computer Fundamental & Information Technology		
Objective: Computer programming (often shortened to programming or coding) is the process of designing, writing, testing, debugging, and maintaining the source code of computer programs. This source code is written in one or more programming languages.		
Unit	**Topic**	**40 Hours**
Unit – I	**Introduction:** Computer: An Introduction**,** Generation of Computers & Types : PC, PC/XT, PC/AT, Main Frame, Super, Lap Top, Pam Top**,** Central Processing Unit (CPU) Memory Unit, Input/ Out Devices : Keyboard, Mouse (Optical), Digitizer, Scanner,Web Camera, Monitor (CRT, TFT) , Printers, Plotters, Bar Code Reader, Secondary Storage Devices : Floppy, Hard Disk, CD, DVD, Flash, Drive, Block Diagram Showing	**8**

	Interconnection of Computer Parts, **Data Representation:** Bit, Nibble, Byte, Word**,** **Number System** : Decimal, Binary, Hexadecimal & their Conversions, Arithmetic Operations (Addition, Subtraction using Binary Number System) 1s , 2s Compliment, Coding Technique : BCD, EBCDIC, ASCII ,Idea of: Hardware ,Software, Firmware, Free ware, Human ware, Computer Languages and Translators Machine, Assembly, High Level Language, Scripting Language, Object Oriented Language, Platform Independent Language, Translators: Assembler, Interpreter, Compiler	
Unit – II	**Operating System :** Definition of Operating System (OS)**,** Types of OS**,** Single user, Multi user**,** Multi Programming**,** Time Sharing**,** Multi Processing ,**Introduction to Windows XP:** Introduction to Windows Environment**,** Parts of Windows Screen**,** Icon, Menu, Start Menu**,** Minimizing , Maximizing , Closing Windows**,** Windows Explorer, Recycle Bin, Clipboard, My Computer, My Network Places Control Panel : Adding New Hardware and Software, Display, Font, Multimedia, Mouse, International System Accessories: Paint, Media Player, Scan disk, System Information.	**8**
Unit – III	**Information Concepts and Processing:** Definition of Data, Information**,** Need of Information**,** Quality of Information**,** Concepts of Data Security, Privacy, Protection**,** Computer Virus and their types**,** Scanning & Removing Virus **Computer and Communication:** Need of Data Transmission**,** Data Transmission Media**,** Baud rate and Bandwidth, Digital and Analog Transmission Serial and Parallel Data Transfer, Protocols, MODEM. Networking of Computers : LAN, WAN, MAN, Blue tooth 6.6 LAN Topologies: Bus, Star, Ring, Hybrid Introduction to Ports : RS232, IEEE 488, PS2, USB, UTP	**8**
Unit – IV	**Information Processing:** Word processor**,** Introduction to MS-Word**,** Starting MS-Word Special Features of MS-Word**,** Using Help**,** Opening Document, Typing and Editing**,** Copying, Inserting, Moving, Deleting**,** Copying from One Document to Others , Undo, Redo, Spell Check, Find and Replace**,** Formatting**,** Characters and Fonts **,**Spacing Removing Characters Formatting**,** Inserting Symbols**,** Paragraphs, Page Setting**,** Header and Footer**,** Page Breaks**,** Borders and Shading**,** Print Preview and Printing**,** Tables and Columns**,** Mail Merge**.** Auto Text and Auto correct**,** Introduction to Macro**,** Electronic Spread Sheet**,** Introduction to MS-Excel**,** Working with Spread Sheet**,** Editing the Worksheet**,** Worksheet Formatting**,** Formula Entering**,** Function Wizard**,** Saving and Printing Work Book**,** Analysis Tools **Data Tools** Charts Linking Work Sheets**,** Report Wizard**,** Data Base Application**,** Data Base Components**,** Working with Database**,** Creating Excel Database**,** Adding Records using Data Form**,** Deleting Records using Menu Command**,** Deleting Records using Data Form**,** Editing Records**,** Finding Records based on Criteria	**8**
Unit – V	**Internet:** Introduction to Internet**,** Bridges, Routers, Switch, Gate way**,** www, Web Site, URL**,** e-mail, e-Commerce**,** Web browsing, Web page**,** Introduction to Hyper text & HTML**,** Introduction to http & ftp Protocol. **Power Point:** Introduction to Power Point**,** Creating a Presentation/Slide**,** Adding Animation in Slide**,** Running a Slide Show	**8**
	Suggested Text Books: 1. Computer Fundamental V.K. Jain, Standard Pub.& Distributors2. PC Software for Windows made simple R.K. Taxali, TMH3. Mastering Windows XP TMH4. BPB Computer Course BPB Editorial Board,5.**1.** Computer Fundamental V.K. Jain, (Hindi Edition) **Suggested Reference Books:**1. Introduction to	

	Networking NANCE, PHI2. First Course in Computer Science Sanjeev Saxena, Vikas Publishing House First Look Microsoft Office 2003 Murray, Phi3.Web Based Application Development Ivan Beyross, TMHusing HTML, DHTML, Java script Pearl/ CGI	

1D06: Applied Chemistry Lab-I		
Objective: Develop the ability of students to carry out experiments, collect and interpret data, and critically report results through "hands-on" laboratory experiences.		
	List of Experiments	
	1. Identification of Acid and Basic Radicals in a Salt (Total Numbers = 5)2. Analysis of a Mixture Containing Two Salts (Not Containing Interfacing Radicals). (Total Numbers = 5)3. Determination of Percentage Purity of an Acid by Titration With Standard Acid.4. Determination of Percentage Purity of a Base by Titration With Standard Alkali Solution.5. Determination of the Strength of Ferrous Sulphate using Standard Ferrous Ammonium Sulphate and Potassium Dichromate as Intermediate Solution6. Determination of the Strength of Farrous Sulfate Solution using Standard7.Solution of Thiosulphate.To determine the strength of NaOH and Na_2CO_3 in a given alkali mixture8.Estimation of percentage of iron in plain carbon steel.9.To find the eutectic point for a two component system by using method of cooling curve.10.Determine the reaction rate constant for the Ist order reaction	
Text Books: 1.Engineering Chemistry , Mathur and Aggarwal2. A text Book of Engineering Chemistry , S.K. Jain & K.D. Gupta**Reference Books**:1.Practical Chemistry For Engineers , Dr. Renu Gupta & Dr. Sapna Dubey		
1D07: Applied Physics Lab-I		
Objective: : An experiment or test can be carried out using the scientific method to answer a question or investigate a problem. he results are analyzed, a conclusion is drawn, sometimes a theory is formed, and results are communicated through research papers.		
	List of Experiments	
	1. To Measure Internal Dia, External Dia and Depth of a Calorimeter usingVernier Callipers.2. To Measure Density of a Wire using Screwgauge3. To Measure Radius of Curvature of a Lens, Mirror using Spherometer.4. To Determine Refractive Index of Glass using Prism.5. To Determine the Refractive Index of Glass using Travelling Microscope6. To Determine Focal Length of a Convex Lens by Displacement Method.7. To Determine the Velocity of Sound at O0c using Resonance Tube.8. To Determine Young's Modulus of Elasticity using Searle's Apparatus.9. To Determine Acceleration due to Gravity using simple pendulum.10. To verify Newton's law of cooling.	
	Text Book: 1. Advanced Practical Physics – B.L. Workshop and H.T. Flint (KPH) 2. Practical Physics – S.L.Gupta&V.Kumar (PragatiPrakashan). **Reference Books:**1.. Advanced Practical Physics Vol.I& II – Chauhan& Singh (PragatiPrakashan)	
1D08: Computer Fundamental & IT Lab- I		
Objective: The choice of language used is subject to many considerations, such as company policy, suitability to task, availability of third-party packages, or individual preference. Ideally, the programming language best suited for the task at hand will be selected.		
	List of Experiments	
	1. Study of Computer Components 2. Practice of Computer Booting Process in XP 3. Demonstration of Windows Environment 4. Practice of using My Computer, Windows Explorer 5. Practice of using Control Panel 6. Practice of My Network Places 7. Practice	

	of CD and DVD Writing 8. Practice of Paint 9. Installation of Windows XP by using NTFS File System. 10. Demonstration of Network	
	Suggested Text Books: Yadav DS, Foundations of IT, New Age, Delhi. Curtin, Information Technology: Breaking News, Tata Mo Grew Hill. **Suggested Reference Books:**Nelson, Data Compression, BPB.	

1D09: Engineering Drawing		
Objective: In order to produce a good product, a neat drawing is a must. Therefore students must be well acquainted with the knowledge of Engineering drawing. Engineering drawing is the universal language of engineers and student must be made familiar with all the relevant aspect topics of machine drawing.		
	List of Experiments	
	1. Preparation of following on Imperial Size Drawing Sheet :-1.1 Lines, Letters and Scales 1.2 Geometrical Constructions and Engineering Curves. 1.3 Projection of Lines 1.4 Projection of Planes 1.5 Projection of Solids 1.6 Orthographic Projections of Simple objects 1.7 Section and Development of Surfaces of Solids i.e. Cone, Cylinder, Sphere etc.1.8 Section and Development of Surfaces of Prism and Pyramids1.9 Isometric Projections 1.10 Riveted Joints. 1.11 Screw Threads and Fasteners 1.12 Pulleys 1.13 Couplings 1.14 Bearing 1.15 Building Drawing**2. Preparation of following Drawings in Sketch Book (Home Assignment)**2.1 Lettering (On Graph Sheet)2.2 Projection of Points In Different Quadrants2.3 Isometric Projection of Various Planes2.4 Various Types of Rivet Heads2.5 Section and Conventions2.6 Set Screws2.7 Machine Screws2.8 Foundation Bolts, Keys	
	Text Books: 1. Engineering Drawing N D Bhatt2. Machine Drawing N D Bhatt3. Engineering Graphics V. Laxmi Narayan4. Machine Drawing V. Laxmi Narayan5. Engineering Drawing P S Gill6. Machine Drawing M L Mathur **Reference Books:** 1. A Text Book of Machine Drawing Laxmi Narayana and Mathur, M/s. Jain Brothers, New Delhi.	

2D10: Workshop Practice – I		
Objective: This subject is designed to give basic knowledge of carpentry shop , fitting shop , welding shop & sheet metal shop with practical expose		
	List of Experiments	
	Carpentry Shop1. Preparation of Cross-Half Lap Joint.2. Preparation of Dovetail Joint3. Preparation of Bridle Joint4. Preparation of Mortise and Tenon Joint5. Preparation of Mitre Joint6. Demonstration of Job on Wooden Polishing Work**Welding**7. Preparation of a Butt Joint by Gas Welding.8. Preparation of Lap Joint by Electric arc Welding.9. Preparation of T-Joint by Electric arc Welding.10. Demonstration on Brazing by the Instructor.11. Demonstration on Soldering.12. Demonstration on Gas Cutting.	
1	**Suggested Text Books :**1. Workshop Technology Gupta & Malani2. Workshop Technology Kumar & Mittal3. Workshop Technology Hajra, Chaudhary **Suggested Reference Books:** Work shop Manual - P.Kannaiah/ K.L.Narayana/ Scitech Publishers.	

Semester-II

2D01: Applied Chemistry-II **(Cr, L:T:P:-3,3:1:0)**		
Objective: The reactions & synthesis procedures of materials like water analysis, chemical kinetics, corrosion and basic chemistry (IUPAC) behind them will makes interesting the topic & improve the research ability with their wide ideas.		
Unit	**Topic**	**40Hours**
Unit – I	**Fuels:** Definition, Classification, Calorific Value (HCV and LCV) and Numerical Problems on Calorific Value, Combustion of Fuels, Numerical Problems on Combustion**Solid Fuels:** Coal and Coke **Liquid Fuels:** Petroleum and its Distillation Cracking, Octane and Cetane Values of Liquid Fuels Synthetic Petrol, Power AlcoholBio-Gas, Nuclear Fuels – Introduction to Fission and Fusion Reactions.	**8**
Unit – II	**Corrosion:** Definition **Theories ff Corrosion:** Acid Theory (Rusting) **,** Direct Chemical Corrosion or Dry Corrosion**,** Wet Corrosion or Electro-Chemical Corrosion(Galvanic and Concentration Cell Corrosion)Various Methods for Protection from Corrosion	**8**
Unit – III	**Polymers:** Definition **Plastics:** Classification, Constituents**,** Preparation, Properties and Uses of Polythene, Bakelite Terylene and Nylon. **Rubber:** Natural Rubber, Vulcanization **,**Synthetic Rubbers - Buna - N, Buna-S, Butyland Neoprene	**8**
Unit – IV	**Cement and Glass:** Manufacturing of Portland Cement**,** Chemistry of Setting and Hardening of Cement**,** Glass : Preparation, Varieties and Uses. **Lubricants:** Definition, Classification Properties of Lubricants : Viscosity, Oiliness, Flash Point, Fire Point, Acid Value, Saponificatin, Emulsification, Cloud and PourPoint., Artificial Lubricants	**8**
Unit-V	**Miscellaneous Materials:** Refractory's: Definition, Classification and Properties Abrasives : Natural and Synthetic Abrasives**,** Paint and Varnish : Definition and Function of Constituents**,** Soap and Detergents : Definition, Properties and Uses**15. _ew Engineering Materials: (Brief Idea of Following)** Superconductors, Organic Electronic Materials Fullerences Optical Fibres	**8**
1 **Text Books**1. Practical Chemistry for Engineers Virendra Singh (Hindi)2. Hand book of Technical Analysis Bannerji Jain Bros.Jodhpur3. Engineering Chemistry-I(Hindi) Mathur & Agrawal.4.. Inorganic Chemistry Shivhare & Lavania**Suggested Reference Books:** Engineering Chemistry, Jain & Jain, Dhanpat RaiEngineering Chemistry, M.M. Uppal		

2D02:	Applied Physics-II	
Objective: physics is combined with problem solving and engineering skills, which then has broad applications. Career paths for Engineering physics is usually (broadly) "engineering, applied science or applied physics through research, teaching or entrepreneurial engineering".		
Unit	**Topics**	**38 Hours**
Unit – I	**A.C. Circuits:** Faraday's Laws of Electro Magnetic Induction, Lenz's Law Self and Mutual Inductance Alternating Current, Phase & Phase Difference**,** Instantaneous, Average and rms value of AC, Behaviour of Resistance, Capacitance and Inductance in anAC Circuit, AC Circuits Containing, R-L, R-C and LCR in Series ,Power in AC Circuit and Power Factor,Choke Coil	**8**
Unit – II	**Semi Conductor Physics:** Energy Bands in Conductor, Semi Conductor & Insulator**,** Chemical Bonds in Semiconductor**,** Intrinsic and Extrinsic Semiconductors**,**PN-Junction Diode, Working, Biasing and Characteristics Curves**,**Zener Diode and Voltage Regulation using it**,** Half Wave & Full Wave Rectifiers (only working, no derivations),Junction Transistors, Working, Biasing and Characteristic Curves, Brief Idea of Using Transistors as an Amplifier (without mathematical analysis)	**10**
Unit – III	**Modern Physics:** Photo Electric Effect**,** Einstein's Equation**,** Photo Cells**, Lasers:** Stimulated Emission and Population Inversion, Types of Laser - Helium Neon and Ruby Laser, Application of Lasers (brief idea only),Material Processing, Lasers in Communication Medical Applications	**8**
Unit – IV	**Nuclear Physics:** Idea of Nuclear Force**,** Mass - Defect and Binding Energy**,** Nuclear Reactions, Natural and Artificial Radioactivity **,** Law of Radioactive Disintegration Half Life & Mean Life, Idea of Nuclear Fission and Fusion. Chain Reaction, Nuclear Reactor	**8**
Unit –V	**Pollution and its control:** Introduction to Pollution – Water, Air, Soil , Noise, Nuclear andmental pollution, Types of Pollution , Brief idea about Noise Pollution and its Control, Nuclear Hazards, Nuclear Waste Management	**4**
1	**Suggested Text :1.**A Text Book of Applied Physics N.S. Kumar (Hindi)**2.**Principles of Physics Brijlal, Subhramanyam 3.Applied Physics Vol.-II Hari Harlal, NITTTR **Reference Books:**A Text Book of Applied Physics N.S. KumarPrinciples of Physics Brijlal, Subhramanyam	

2D03: Applied Mathematics-II		
Objective: Engineering mathematics is a branch of mathematics that concerns itself with mathematical methods that are typically used in science, engineering, business, and industry. Thus, "applied mathematics" is a mathematical science with specialized knowledge.		
Unit	**Topics**	**40 Hours**
Unit – I	**Limits:** Concept of Limit**,** L.H.L., R.H.L., Limit of Standard Functions , Concept of Continuity and Differentiability at a Point (simple Problems)**Function:** Definition of Function**,** Range and Domain of Function**,** Types of Function**,** Absolute Value Function**,** Exponential value Function**,** Identity Function**,** Reciprocal Function**,** Rational and Irrational Function, Increasing and decreasing Function	**8**
Unit – II	**Differential Calculus :** Standard Formulae (Except Hyperbolic Function)**,** Derivative of Sum, difference, Multiplication and Division of two Functions**,** Differentiation of Function of a Function**,** Logarithmic Differentiation**,** Differentiation of Implicit Functions**,** Differentiation of Parametric Functions**,** Differentiation by Trigonometric Transformations**,** Differentiation of a Function w.r.t. Another Function**,** Second Order Derivative**Applications of Differential Calculus:** Geometrical meaning of dy / dx . Tangents and Normals **,** Angle of Intersection between two Curves**,** Derivative as a Rate Measurer**,** Errors and Approximations**,** Maxima and Minima of Function with one Variable	**10**
Unit – III	**Integral Calculus:** General Introduction of Integral Calculus**,** Integration of Sum and difference of Functions, Integration by Simplification**,** Integration by Substitution Integration by Parts, Integration of Rational and Irrational Functions, Additional standard **F**ormulae, Integration of Trigonometric Functions, Definite Integral and its Properties.	**10**
Unit – IV	C**OORDINATE GEOMETRY Straight Lines: Differential Equations:** Definition of differential Equation. Order, Degree and Solution of a differential Equation. Solution of a differential Equation of First Order and First Degree using, Variable Separable Method**,** Homogenous Form**,** Reducible to Homogenous Form**,** Linear differential Equation Bernoulli's Equation**,** Exact differential Equation**,** Substitution Method**,** Solution of Linear Differential Equation of Higher order with Constant Coefficients Applications of Differential Equations to L-R, L-C, L-C-R ,Circuits of Standard Forms	**8**
Unit-V	**Vector Algebra:** Definition, Addition and Subtraction of Vectors Scalar and Vector Product of two Vectors Scalar Triple Product and Vector Triple Product , Applications of Vectors in Engineering Problems **Numerical Integration :** Trapezoidal Rule, Simpson's 1/3 Rule, Simpson's 3/8 Rule, Newton - Raphson Rule	**4**
Suggested Text1. Text Book on Differential Calculus Chandrika Prasad (Hindi)2. Text Book on Integral Calculus Chandrika Prasad3. Differential Calculus M. Ray, S. S. Seth, & G. C. Sharma4. Integral Calculus M. Ray, S. S. Seth, & G. C. Sharma **Reference Books:** 1.Integral Calculus, M.Ray, S.S.Seth&G.C.sharma. 2.Vector Calculus, R.Kumar.		
2D04:	**Electrical & Electronics Technology**	
Objective: At the end of the course the student will be able to gauge various fundamentals aspects of Basic Electrical and Electronics engineering covering networks theory, single and three phase circuits, transformers and dc machines. Also it will impart knowledge about transistors and thyristor.		
Unit	**Topic**	**36 Hours**

Unit – I	**DC Networks :** Resistance, inductance, capacitance, current, voltage, power, Ohms law**,** Kirchhoff's Laws, Node Voltage and Mesh Current Analysis; Delta-Star and Star-Delta Transformation, Source Conversion. Classification of Network Elements, Superposition Theorem, Thevenin's Theorem.	**10**
Unit – II	**Single Phase AC Circuits :** Generation of Single Phase AC Voltage, EMF Equation, Average, RMS and Effective Values. RLC Series, Parallel and Series- Parallel Circuits, Complex Representation of Impedances. Phasor Diagram,Power and Power Factor.**Three Phase A.C. Circuits :** Generation of Three-Phase AC Voltage, Delta and Star-Connection, Line & Phase Quantities, 3-Phase Balanced Circuits, Measurement of Power in Three Phase Balanced Circuits.	**10**
Unit – III	**Transformer :** Faraday's Law of Electromagnetic Induction, Construction and Operation of Single Phase Transformer, EMF Equation, Voltage & Current Relationship and Phasor Diagram of Ideal Transformer.	**8**
Unit – IV	**Transistor:** Bipolar Junction Transistor, Transistor Current Components, Characteristics of CE, CB and CC Transistor Amplifiers.**Thyristors:** Diode and VI characteristic, four layer diode, Bi-directional thyristors.	**8**
Suggested Text /: Sahdev – Basic Electrical and Electonics Engg.J.B.Gupta – Basic Electrical and Electronics Engg.(Hindi)B.L. Thareja- Electrical Technology-Vol I**Reference Readings** 1.H.P. Tiwari – Electrical and Electronics Engg. 2. Basic Electrical and Electonics Engg, Tata Mcgraw Hill		

2D05:	Applied Mechanics	
Objective: This subject is design to give the basic knowledge of equilibrium of forces, center of gravity, centroid, moment of inertia and concept and application of work power energy**.**		
Unit	**Topics**	**40 Hours**
Unit – I	**Force:** Definition**,** Units**,** Different Types of Forces. **Coplanar Forces:** Resolution of Forces**,** Law of Parallelogram of Forces**,** Resultant of two or more Forces**,** Basic Conditions of Equilibrium**,** Lami's Theorem (No Proof)**,** Jib Crane**,** Law of Polygon of Forces (Only Statement)**Moment:** Definition, Units & Sign Convention., Principle of Moments, Application of Equilibrium Conditions for non-concurrent Forces	**8**
Unit – II	**Application of Principles of Forces & Moments:** Levers & their Types.**,** Reactions of Simply Supported Beams (Graphical & Analytical Method)**,** Steel Yard .**,**Lever Safety ValveFoundry Crane**Centre of Gravity:** Concept**,** Centroid**,** Calculation of C.G. of Regular Bodies**,** Calculation of C.G. of Plain Geometrical Figures **Friction:** Types of Friction**,** Laws of Friction**,** Angle of Friction**,** Angle of Repose**,** Friction on Horizontal and Inclined Plains**,** Application of.	**10**
Unit – III	**Simple Machines:** Basic Concepts**,** Loss in Friction**,** Inclined Plane**,** Simple & Differential Wheel and Axle (Neglecting Rope thickness) Screw Jack Lifting Crabs Systems of Pulleys**,** Worm and Worm Wheel **Rectilinear Motion:** Concept**,** Motion under Constant Velocity**,** Motion under Constant Acceleration**,** Velocity-time graph and its uses **Motion under Gravity:** Concept**,** Vertical Motion**,** Smooth Inclined Plane **Projectiles:** Concept	**10**
Unit – IV	**Simple Machines:** Basic Concepts**,** Loss in Friction**,** Inclined Plane**,** Simple & Differential Wheel and Axle (Neglecting Rope thickness)**,** Screw Jack**,** Lifting CrabsSystems of Pulleys, Worm and Worm Wheel **Rectilinear Motion:** Concept**,** Motion under Constant Velocity**,** Motion under Constant Acceleration**,** Velocity-time graph and its uses	**8**
Unit-V	**Motion under Gravity:** Concept**,** Vertical Motion**,** Smooth Inclined Plane **Projectiles:** Concept, Range, Maximum Height and Time of Flight, Equation of Trajectory Calculation of Velocity of Projectile at Certain Height, And at Certain instant **Newton's Laws of Motion:** Definitions**,** Momentum and it's Unit**,** Application of Second Law of Motion	**4**
1. **Suggested Text Books**Engineering Mechanics by, RK Rajpoot (Hindi)Engineering Mechanics by, RS Khurmi Engineering Mechanics By Chitranjan Aggarwal**Suggested Reference BooksEngineering Mechanics by Nelson , Tata Mcgraw HillEngineering Mechanics by Shailesh Kumar**		

2D06:Applied Chemistry Lab-II		
Objective: Develop the ability of students to carry out experiments, collect and interpret data, and critically report results through "hands-on" laboratory experiences.		
	List of Experiments	
	1. Determination of the Strength of Copper Sulphate Solution using a Standard Solution of thio Sulphate.2. Determination of pH Values of Given Samples. 3.Determination of Hardness of Water by EDTA Method.4. Estimation of Free Chlorine in Water.5.Determination of Acid Value of an Oil.6. Preparation of Soap.7.To determine the Viscosity & Viscosity Index of a given lubricating oil by Redwood Viscometer No. 1	
Text Books: 1.Engineering Chemistry , Mathur and Aggarwal2. A text Book of Engineering Chemistry , S.K. Jain & K.D. Gupta**Reference Books**:1.Practical Chemistry For Engineers , Dr. Renu Gupta & Dr. Sapna Dubey		
2D07: Applied Physics Lab-II		
Objective: This lab is to help the student to understand the concept of Diode, PN junctions, Half deflection method and the concept of cells**.**		
	List of Experiments	
	1. To Determine Acceleration due to Gravity using Simple Pendulum.2. To Verify Newton's Law of Cooling.3.. To Verify Law of Resistances.4. To Determine Specific Resistance of Material using Meter Bridge.5. To Determine Internal Resistance of a Primary Cell using Potentiometer.6. To Compare emf of two Primary Cells using a Potentiometer.7. To Draw Characteristic Curves of PN Diode and Determine its Static andDynamic Resistance.8. To Draw Characteristic Curves of a PNP/NPN Transistor in CB/CEConfiguration.9.. To Measure Resistance of a Galvanometer by Half-Deflection Metho	
Text Book: 1. Advanced Practical Physics – B.L. Worshnop and H.T. Flint (KPH) 2. Practical Physics – S.L.Gupta&V.Kumar (PragatiPrakashan). **Reference Books:**1.. Advanced Practical Physics Vol.I& II – Chauhan& Singh (PragatiPrakashan)		

2D08: **Electrical & Electronics Workshop**		
Objective: this lab will help the students learn about key and basic electrical devices and apparatus used in day-to-day life. Also this will be useful in gaining knowledge about house hold electrical circuits.		
	List of Experiments	
	1. Study of Symbol, Specification and Approximate Cost of Common Electrical Accessories, Tools and Wires & Cables Required for Domestic Installation. Study of : 2.1 Basic Electricity Rules for a Domestic Consumer2.2 Safety Precautions & use of Fire Fighting Equipments3. Use of series of Phase Tester, Series Test Lamp, Tong Tester and Megger in Testing of Electrical Installation.4. 4.1 Prepare a Potential Divider and Measure Resistance of a Filament Lamp Using Voltmeter and Ammeter.4.2 Measurement of Power and Energy Consumption by an Electric Heater using Watt Meter and Energy Meter.5. Preparation of Wiring Diagram, Wiring, Testing, Fault Finding & Costing for :5.1 Control of one Lamp by one Switch (using Batten and Tumbler Switch)5.2 Control of Stair Case Wiring (using Casing Capping, CFL and Flush Type Switches)5.3 Control of one Bell Buzzer and Indicator by one Switch(using Conduit and Flush type Switch)6. Prepare one Switch Board as per Institutional Requirement (using Flush type Switches, Sockets, MCB, ELCB, Etc.)7. Study, Connecting, Testing and Fault Finding of 7.1 Fluorescent Tube and its Accessories7.2 Ceiling Fan with resistance type and Electronic Regulator8. Study, Functioning, Fault Finding & Repairing of following Domestic Appliances -8.1 Automatic Electric Iron8.2 Air Cooler8.3 Electric Water Pump9. Design, Draw and Estimate the Material required for Installation For a small Residential Building/ Office/ Hall. **Identification of following Resistors and finding their Values:** 1.1 Carbon and Metal Film1.2 Variable Resistance Log and Linear1.3 Semi Variable Preset of One Turn & Multiturn**2. Identification of following Capacitor and finding their Values:** 2.1 Mica2.2 Ceramic2.3 Polysterene2.4 Electrolytic2.5 Tantalum**3. Identification of following Switches and Study of their Working Mechanism:** 3.1 Toggel3.2 Bandswiteh3.3 Rotary3.4 Push to on and off3.5 Press to on and off**4. Identification and Testing of following type of Connectors:** 4.1 Rack and Panel4.2 Printed Circuit Edge4.3 Coaxial4.4 Tape & Ribbon4.5 Plate**5. Study of Different Relays and their Contacts.6. Study of following Tools used in Electronic Workshop:** 6.1 Component Lead Cutter6.2 Wire Strippers6.3 Soldering Iron & Soldering Station6.4 De-Solder Pump**7. Measurement of Voltage, Current and Resistance using Analog &Digital Millimeter. 8. Testing of Electronic, Component such as Capacitor, Inductor, Diode and Transistor. 9. Measurement of Amplitude & Frequency of a Signal using CRO. 10. Verification of Ohm's law using Resistive Circuit and Analog Meters.11. Soldering of different passive component combination on general purpose PCB.12. Sketching of different Electronic Components Symbol on Drawing**	
Text Books : Electrical Workshop M.L. Gupta2. Domestic Devices & Appliances K.B. Bhatia3. Electrical Workshop S.L. Uppal4. Electrical Component & Shop Practice K.R. Nahar5. Maintenance of Electrical Equipments K. S. Janwal6. Hand Book of Philips Component **Reference Books:** 1.Electrical Components and Shop Practice ,K.R. Nahar		
2D09: Workshop Practice -II		

Objective: This Lab is design to give practical exposure of engineering workshop in different shop like smithy shop, machine shop, foundry shop, and student should be able to understand different types of tool, material and measuring instrument and their application.

	List of Experiments	
	Sheet Metal Shop: Preparation of following utility Jobs Involving Various Sheet Metal Joints (Single and Double Hem Joints, Wired Edge, Lap Joint Grooved Seam Joint, Single and Double Seam Joint) and Exercises (Soldering and Riveting Joints)1 Preparation of a Soap Tray &Mug2. Preparation of Funnel **Fitting and Plumbing Shop**1. Marking Filing & Hack Sawing Practice.2. Production of Utility Job involving Marking, Filling and Hack Sawing.3. Production of Utility Job involving Marking, Filling and Hack Sawing Drilling and Tapping.4. Cutting and Threading on G.I. Pipe5. Exercise on PVC Pipe Fitting.6. Repair of Taps and Cocks.	

1. **Suggested Text Books :** 1 Workshop Technology B.S. Raghhuwanshi2. Workshop Technology (Hindi) Tahil Maghnani3. Workshop Technology (Hindi) Vinay Kumar4. Domestic Devices and Appliances K.B. Bhatia**Suggested Reference Books:** Work shop Manual - P.Kannaiah/ K.L.Narayana/ Scitech Publishers

2D10 : Computer Fundamental & IT Lab-II		
Objective: This lab is designed so that the better presentations and documents could be made by the students. It comprises the M.S. Excel, M.S. and PowerPoint presentations.		
	List of Experiments	
	1. Visit to Internet Site 2. Creating e-mail Account, Sending and Receiving e-mails. 3. Sending e-mail with Attachment & Signature 4. Searching Web Page/ Site using Search Engine (eg. google.com, yahoo.com, altavista.com etc.) 5. Exercise Based on MS-Word: 5.1 Document Preparation 5.2 Printing Document 5.3 Mail Merge usage5.4 Draw Table 6. Exercise Based on Ms-Excel: 6.1 Work Book Preparation 6.2 Printing Workbook6.3 Data-base usage6.4 Draw Charts7. Exercise Based on Power Point : 7.1 Creating Slide7.2 Adding, Animations in Slide7.3 Running Slide8. Creating Simple Web Page using HTML.	
Suggested Text Books: 1. Yadav DS, Foundations of IT, New Age, Delhi. 2.Curtin, Information Technology: Breaking News, Tata Mo Grew Hill. **Suggested Reference Books:1.**Nelson, Data Compression, BPB.		

BASIC CELL BIOLOGY

Course Objectives: *To provide an overview of structural and functional aspects of cells and basic mechanisms underlying cell signalling and cell division.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Basic properties of cell, Major types of cell: Prokaryotic, animal and plant cell, their characteristics, cell wall, composition, function of bacterial cell wall. Plasma membrane, structure, function, fluid mosaic model, membranes, lipids and proteins transport across the membrane – passive and active.

UNIT II **10 h**

Endoplasmic reticulum, golgi complex – exocytosis; Lysosomes: phagocytosis, endocytosis, autophagy, Peroxisomes, Role of clatherin coated vesicles, Plant cell vacuoles; Structure of mitochondria and organization of respiratory chain; Structure of chloroplast and photophosphorylation; Structure of nucleus, nucleolus, nuclear membrane, transport across nuclear membrane.

UNIT III **8 h**

Molecular aspects of normal and cancer cell cell division: cell cycle stages, cyclins, cyclin dependent kinases (Cdks), Cdk inhibitors, transcription factors, tumor suppressors, checkpoints proteins, etc., cell death; apoptosis events and related proteins, necrosis and senescence.

UNIT IV **8 h**

Organic and inorganic constituents of cell: Water, minerals, polysaccharides, proteins, lipids, nucleic acid, vitamins and enzymes and their role(s) in cell function.

UNIT V **9 h**

Extracelluar matrix, collagen, proteoglycans, fibronectin, laminins, integrins, selectin, cadherins, role of tight junctions and gap junctions, Signal transduction; cell signalling; cAMP, Role of G-proteins coupled receptors, Tyrosine kinases, etc.

References:

1. Cell Biology, 3rd Edition.Elsevier. Thomas Pollard, William C. Earnshaw, Jennifer Lippincott-Schwartz, Graham Johnson. 2017. International Edition.
2. Cell Biology. 7th Edition. 2013. Wiley. Gerald Karp. International Student version.
3. The Cell. A molecular approach. Seventh edition. 2015. Geoffrey M. Cooper & Robert E. Hausman.
4. Molecular Biology of the Cell, 6th edition, 2014, W. W. Norton & Company, Alberts. B, Johnson. AD, Lewis. J, Morgan. D, Raff. M, Roberts. K and Walter. P.

Course Outcome: *Students will understand the fundamentals of cell biology and cell signalling.*

GENERAL MICROBIOLOGY

Course Objective:
The main objective of "Microbiology" course is to introduce basic principles and applications. In order to provide fundamental knowledge to students, this course was designed to provide insights on microscopy, microbial diversity, nutrition, growth and host-interaction.

UNIT I **10h**

Introduction to microbiology: Scope, relevance, discovery and origin of microbial world, theories-spontaneous generation and conflict, germ theory of diseases. Interaction of light with objects. Microscopy and applications. Types and applications of microscopy, Bright field, Dark field, Fluorescence, Phase-contrast, Confocal microscopy, Scanning and Transmission electron microscopy.

UNIT II **10h**

Microbial diversity: Early evolution, complex metabolism and microbial diversity based on energy and carbon sources and distribution of microbes. Phylogeny of procaryotes and eucaryotes. Classification of bacteria, algae and fungi. General characteristics of virus, groups of viruses, viroids, prions, bacteriophage structure and life cycle.

UNIT III **10h**

Microbialnutrition : Heterotrophs, autotrophs. Macro and micro nutritionalrequirements. Nutritional sources and types. Enrichment culture techniques-Isolation and selection of specific groups such as sporulatingbacteria, propionicbacteria, chemoheterotrophs, chemoautotrophs and photosynthetic microbes. Transformation of elements. Microbial transformation. Carbon, Nitrogen, Phosphorous and Sulphur cycles.

UNIT IV **10h**

Microbial growth: Growth phases: Measurement, Mean Generation time, Factors affecting growth. Effect of temperature, pH, osmotic pressure, hydrostatic pressure and radiation on microbial growth.Synchronous culture. Kinetics of microbial growth; Batch culture, continuous culture, types of continuous culture system-turbidostat, chemostat.

UNIT V **10h**

Host-microbe interaction: Microbial ecology, molecular plant microbe interaction, molecular biology of disease resistance, gene-for-gene interaction, plant chemicals and defense pathways. Biological control of microbes. Plant growth-promoting rhizobacteria and their mechanisms for growth promotion and antagonism.

TEXT BOOKS

1. Bauman, RW, Microbiology. 2nd edition. Pearson Benjamin Cummings, 2009.
2. Prescott, LM. Prescott, Harley and Klein's Microbiology. 6thEdition, McGraw-Hill, 2007.
3. Tortora GJ, Funke BR, Case CL. Microbiology: An introduction 8th Edition. San Francisco: Pearson, 2004.
4. Joan L. Slonczewski and John W. Foster. Microbiology: An evolving science. W. W. Norton & Company, 2013.
5.

REFERENCES

1. Madigan, MT, Martinko, JM, Parker J. Brock Biology of Microorganisms. 10th Ed., Prentice-Hall, 2003.
2. Matthai,W, Berg, CY, Black, JG. Microbiology, Principles & Explorations. John Wiley&Sons, 2005.
3. Black, JG.Microbiology. 8th Edition, Wiley John Wily & Sons, Inc. Singapore, 2013.
4. Journal reviews and research articles.

Course Outcome: *The students will understand the basics of microscopy, microbial diversity, nutrition, growth and host-interaction etc.*

BIOCHEMISTRY

Course Objectives: *The objectives of this course are to build upon undergraduate level knowledge of biochemical principles with specific emphasis on different metabolic pathways. The course shall make the students aware of various disease pathologies within the context of each topic.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **7 h**

Historical Basis and overview of Biochemistry, Biochemical basis of life, Biomolecules - Classification, Structure, Function and Significance of macromolecules – Carbohydrates, Proteins, Lipids and Nucleic Acids. Biomolecular hierarchy, Molecular assemblies and Molecular interactions in understanding cellular processes.

UNIT II **8 h**

Enzymes – Nomenclature and classification of enzymes – protein & non-protein enzymes (ribozymes, DNAzymes); Mechanisms of enzyme action – specificity of enzyme action, single and multienzymes, isoenzymes, coenzymes and cofactor; Factors affecting enzyme activity-Michaelis-Menten Equation, Lineweaver-Burk Equation; Enzyme kinetics- single and multisubstrates; Enzymes inhibition-competitive, non-competitive, uncompetitive and allosteric inhibition; Enzyme Regulation and their relevance in metabolic pathways; Biological role of enzymes.

UNIT III **10 h**

Introduction to Metabolism- Anabolic and catabolic reactions, Integrated approach to metabolism**;** Metabolism of Carbohydrates, glycogen & starch – Glycolysis and gluconeogenesis, Energetics and ATP production, glucose homeostasis and its regulation. TCA cycle and its regulation, its role in energy generation and biosynthetic intermediates, HMP pathway and its significance.Synthesis and breakdown of glycogen and its regulation mediated by hormones. Metabolic disorders associated with carbohydrate metabolism.

UNIT IV **10 h**

Lipid Metabolism:Metabolism of Fatty acids - α,β,ω oxidation, fatty acid biosynthesis, saturated and unsaturated, endogenous synthesis of triacylglycerols, phospholipids, cerebrosides, gangliosides. Synthesis and degradation of cholesterol.Transport and storage of cholesterol. Arachidonic acid metabolism-Significance and synthesis of prostaglandins, leucotrienes and thromboxanes. Metabolic disorders associated with lipid metabolism.

UNIT V **10 h**

Metabolism of proteins, nucleic acids and protein turnover- disposal of ammonia, urea cycle, non-protein aminoacids and amines and their role in cellular function; Metabolism ofessential and non-essential amino acids- Purine and Pyrimidine biosynthesis and degradation, salvage pathways, regulation. Metabolic disorders associated with aminoacid and nucleotide metabolism.

Text Books:

1. Lehninger's Principles of Biochemistry by David L. Nelson and Michael M. Cox, Macmillan worth publisher, 6th Edition 2013.
2. Murray, R.K., Granner, B.K., Mayes. P.A., Rodwell, V.W., Harper's Biochemistry Prentice Hall International, 32nd edition, 2016.

References:

1. Voet and Voet's Biochemistry, D.Voet and J.Voet5th edition, 2016, John Wiley and Sons Inc., 2005.
2. Biochemistry 8th edition by Jeremy M Berg, LubertStryer, John L.Tymoczko, 2015

Course Outcome: *Students would be able to: Gain fundamental knowledge in biochemistry; Understand the molecular basis of various pathological conditions from the perspective of biochemical reactions to apply for translational research.*

TECHNIQUES IN BIOTECHNOLOGY

Course Objectives: *To understand the principles and basics of all Instruments used in a biotechnology lab*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Acid, base and buffers: Definition and theories proposed for acids and bases, titration curves of amino acids, Henderson-Hasselbalch equation and its application. Determination of pH - standard hydrogen electrode, glass electrode. Definition of colloids: types and properties of colloids, colloidal state of membrane.

UNIT II **8 h**

Colorimetry: Principle, Beer and Lambert laws, instrument and techniques. Spectrophotometry: Description of the instrument - photometer, single beam and dual beam spectrophotometers; FTIR, ESR,NMR. Polarimetry, ORD and CD spectrophotometers. Flame and Atomic absorption Spectrophotometer.

UNIT III **8 h**

Centrifugation: Principle, types of centrifugation, description of the analytical and ultracentrifuge. Determination of molecular weight by sedimentation velocity method, separation of cell organelles and sarcolemma.

UNIT IV **9 h**

Electrophoresis: Principle, types of electrophoresis, separation of serum proteins: (i) moving boundary electrophoresis, (ii) paper electrophoresis, (iii) starch gel electrophoresis, (iv) agar gel electrophoresis. Ag-Ab reaction – Immuno electrophoresis; DNA electrophoresis, DNA ladders, PFGE; Staining methods.

UNIT V **10 h**

Chromatography: Principle, types of chromatography: (i) Paper chromatography – separation of amino acids by ascending chromatography, (ii) Adsorption chromatography: Principle and separation of phospholipids, (iii) Ion-exchange chromatography: Principle, resin types and separation of amino acids, proteins, (iv) Affinity chromatography: Principle and separation of enzymes and (v) Gel filtration chromatography: Principle, estimation of Mw of biological macro-molecules; Mass Spectrometry: basic principle, Hard and soft ionization, ICP, photo-ionization; LCMS, MALDI-TOF/QTOF, ICPMS, GCMS/MS.

Text Books:

1. Wilson, K. and Walker, J. Principles and Techniques of Biochemistry and Molecular Biology Cambridge University Press. 2010.
2. Morris and Morris Separation methods in Biochemistry. Pitman London, 1960.

References:

1. Brawer, I M., Perce, A.M., Experimental techniques in Biochemistry. Prentice Hall Foundation, New York, 1974.

Course Outcome: *The students acquires the basic knowledge in handling of equipments and its principles*

RADIATION BIOLOGY

Course Objectives: *This course addresses the biological effects of different radiations, free radical interactions in DNA at cellular and organism level. The details pertaining to utilization and mechanism of radiation both ionizing and non ionizing radiation leading to biological manifestations. As a result of nuclear fallout the different radiation syndromes and the recovery. The course addresses the DNA lesions associated with radiation damage, cataractogenesis and provides mechanistic details.*

Pre-requisite: Bachelor's level course in Life Sciences, Physics & Chemistry.

Unit I **9 h**

Physics of ionizing radiation interactions α, β, ϒ, n and plasma. Radiolytic events leading to formation of free radicals. LET, Absorption dosimetry. Units of radiation dose measurements. The radiation levels and limits. Direct and indirect effects of radiations. Gamma-irradiation induced free radicals produced in water, G-values, Fricke's dosimetry. Radioisotopes for biological applications, ^{14}C dating, radioisotopes in water resources and environment.

Unit II **9 h**

Cell survival curves, Target theory, RBE, Dose response relationship model, Laws of Bergoneau and Tribondeau, Applications of radiation therapy, differential response, mitotic cycle and radiation sensitivity, Heritable effect of radiations. Dose rate-effects, dose fractionation, oxygen-effect, Post-irradiation oxygen effect in plants, radio protectors, radio sensetisers, radiation hormesis. Biological effects of dose fractionation.

Unit III **9 h**

Acute radiation effects of whole body irradiation, late somatic effects, effect on the immune responses, LD50, radiation syndrome, bone marrow, gastrointestinal and cerebrovascular acute radiation syndrome, Leukemia and other cancer, Radiation cataractogenesis, Dose response relationship in model normal tissue. Effect of radiation on Embryo and Foetus.

Unit IV **9 h**

Radiation damage to DNA, RNA and proteins. DNA strand breaks, Chromosomal aberrations, Methods of detecting the damage caused by ionizing radiation and UV radiations.DNA cluster damage.DNA damage caused by heavy ionizing radiations, DNA repair mechanisms and Xenoderma Pigmentosum, Ataxia Telengiectasia disorders

Unit V **9 h**

Radiation Carcinogenesis, biology and exploitation of tumor hypoxia, heritable effects of radiations, chemotherapeutic agents, Effect of non-ionizing radiations, ultrasound, optical radiations, microwave radiations.

Text Book

1. Eric J Hall and Amato J Giaccia. Radiation Biology for the Radiation Biologist Seventh Edition, J B Lipincott Company, UK, 2012.

Reference:

1. Richard P Baum. Therapeutic Nuclear Medicine, Springer-Verlag, Berlin Heidelberg, 2014.

Course Outcome: *The students will develop interest in the radiation utilization for the cold sterilisation and value addition. The development of procedures for effective radiolysis. The Govt of India and also in many countries the radiation biology and radiation physics for effective usage is feasible and the students could use for entrepreneurship by quantifying the radiation dose and standardization for raw and processed food materials by cold sterilisation.*

BASIC CELL BIOLOGY LAB

32 h

1. Culturing of various cancerous cell lines.
2. Observation of eukaryotic cancer cell lines under microscope; live, dead, starved, etc. and staining methods; trypan blue and DAPI, etc.
3. Observation of drug induced differentiation process of K562 leukemic cell lines
4. Observation of drug induced apoptosis process of cancerous cell lines
5. Overexpression of desired protein with fluorescence tag in eukaryotic cells; transfection and fluorescence microscopy.
6. Isolation of genomic DNA, RNA and proteins from eukaryotic cell lines and detection methods; OD, agarose gel, western blotting, staining of SDS –PAGE gels, etc.
7. Isolation of mono nuclear and RBC from peripheral blood samples.
8. Preparation of bacterial competent cell by calcium chloride method.

Suggested Reading:

1. Current protocols in Cell biology- March 2019- Wiley

GENRAL MICROBIOLOGY LAB

30 h

1. Microbial isolation techniques. Isolation of bacteria and fungi
2. Establishment of pure cultures - streak, pour and spread plating techniques
3. Identification of microbes. Simple, differential, negative staining and spore staining methods.
4. Establishment of bacterial growth curve
5. Bacteriophage plaque assay to enumerate phage titer.
6. Test for *in vitro* antibiosis
7. Screening of microbes for the production of enzymes and hormones
8. Biochemical and genetic fingerprinting of microbes
9. Phylogenetic analysis of microbes
10. Microbial preservation techniques- patch plate, slant, water stock, glycerol stock and lyophilization.

Suggested Reading:

1. Handbook of Microbiological Media (2010). Ed.Atlas, Ronald, CRC Press, USA.
2. Bergey's Manual of Systematic Bacteriology. 2005. Ed. Brenner, Don, J. Vol. 2, Springer Publisher, USA.
3. Basic Practical Microbiology : A Manual (2006). Society for General Microbiology (SGM),ISBN 0 95368 383 4.
4. Microbiology: A Laboratory Manual (2013). Eds. James G. Cappuccino and Natalie Sherman. Publisher-Pearson Benjamin Cummings; 10th Edition.

BIOCHEMISTRY LAB

30 h

1. Qualitative analysis of Simple sugars and Carbohydrates.
2. Qualitative analysis of Amino acids and Proteins.
3. Isolation / Extraction of biochemical metabolites (Carbohydrates, Protein and Lipids) from various tissues (plant & animals).
4. Estimation of glucose by Benedict's method.
5. Estimation of protein by Lowry's/Bradford's method.
6. Estimation of cholesterol by Zak's method.
7. Estimation of enzyme activity.(salivary amylase/LDH)
8. Estimation of enzyme activity under various conditions – pH, temperature and substrate.
9. Estimation of ascorbic acid/Tocopherol
10. Assay of enzyme/hormone by ELISA.

Suggested Reading:

1. Jayaram,J Laboratory manual in Biochemistry. Wiley Eastern 1981.
2. Mu P, Plummer DT. Introduction to practical Biochemistry. Tata Mcgraw-Hill Education: 2011

TECHNIQUES IN BIOTECHNOLOGY LAB

30 h

1. Buffer Preparation: Determination of *pKa*
2. Spectrophotometry: Determination of λmax
3. Centrifugation: High speed centrifugation, density gradient centrifugation
4. Chromatography: IEC / Adsorption / GFC for purification of an enzyme
5. Electrophoresis: Agarose and SDS - PAGE
6. FTIR, ESR & NMR
7. Biological applications of radioisotopes: ^{3}H labeling of liver tissue
8. Polymerase Chain Reaction.
9. Real-time PCR (Demonstration)

Suggested Reading:

1. Alexander J. Ninfa, David Ballou, and Marilee Benore (1998). Fundamental Laboratory Approaches for Biochemistry and Biotechnology. Wiley
2. S. Harisha(2007) Biotechnology Procedures and Experiments Handbook. Infinity Science Press LLC, Hingham, Massachusetts New Delhi, India

RADIATION BIOLOGY LAB

30 h

1. Fricke's dosimetry for calculating the dose rate of gamma-rays and comparing it with source.
2. Agarose gel electrophoresis of gamma-irradiated plasmid DNA.
3. Determination of death rate of the gamma-irradiated bacterial cells.
4. Calculation of seedling injury in irradiated seedlings with different doses of radiation.
5. Effect of dose rate on the seedling injury for a given dose of radiation.
6. Identification of chromosomal damage in the root tips as a result of gamma irradiation.
7. Determination of catalase activity in plant seedlings irradiated with various doses of gamma-irradiation.
8. Effect of electron scavengers on post-irradiation treatment of the seeds
9. Determination of total peroxides obtained after various treatments in 7day old seedlings.
10. FT-IR spectroscopic investigations on the gamma-irradiated biological materials

Suggested Reading:

1. Eric J Hall and Amato J Giaccia. Radiation Biology for the Radiation Biologist Seventh Edition, J B Lipincott Company, UK, 2012.

MOLECULAR GENETICS

Course Objectives: *The course aims to provide students a basic understanding on(i) Genome organization of Prokaryotes and Eukaryotes, (ii) Mendelian and Non-Mendelian Genetics (iii) DNA Replication, Transcription & Translation, (iv) DNA repair mechanisms and (v) Regulation of gene expression*

Pre-requisite: Master level courses in Biochemistry, Cell Biology and Microbiology

UNIT I **6 h**

Mendelian inheritance, Non-Mendelian inheritance, Sex linked inheritance, Experimental evidences for DNA as the genetic material, Organization of prokaryotic and eukaryotic genome, DNA supercoiling, Chromatin organization-histone and DNA interactomes.

UNIT II **8 h**

Structure and assembly of prokaryotic and eukaryotic DNA polymerases, Experimental evidences for the semi conservative nature of replication, DNA replication mechanisms, Accessory proteins for the DNA replication, Regulation of replication initiation in prokaryotes and eukaryotes.

UNIT III **10 h**

Mechanism of transcription in prokaryotes and eukaryotes - RNA polymerases, Promoters and Enhancers, Transcriptional initiation, elongation and termination processes. Post-transcriptional processing events – capping, splicing of introns and polyadenylation, Processing of Pre-ribosomal RNA and the assembly of ribosomes, Structure and the maturation of tRNAs.

UNIT IV **8 h**

Genetic code, degeneracy of codons, Wobble hypothesis, codon bias, Mechanism and fidelity of amino acyl tRNAsynthetases, Mechanism of Translation – initiation, elongation and termination, Post-translational modifications, Antibiotics that target translation, Selenocysteine and Pyrrolysine.

UNIT V **8 h**

Regulation of gene expression in prokaryotes – Operon concept, lac and trp operon, positive and negative regulation of lac operon. Transcriptional attenuation of Trp operon, Regulation of gene expression in eukaryotes by chromatin structure - epigenetic modifications of chromatin-Writers, Readers and Erasers. Role of DNA methylation and histone modifications in the regulation of gene expression.

UNIT IV **5 h**

Spontaneous and Induced mutations, DNA repair pathways – Mismatch repair, Base excision repair, Nucleotide excision repair, Non homologous end joining pathway and Recombinational repair.

References:

1. Lehninger Principles of Biochemistry, 2017, Seventh Edition, W.H. Freeman. Authors: David L. Nelson and Michael M. Cox.
2. Principles of Genetics, 2015, Seventh Edition, Wiley. Authors: D. Peter Snustad and Michael J. Simmons.
3. Molecular Biology of the Gene, 2017, Seventh edition, Pearson. Authors: James D. Watson.
4. Lewin's Gene XII, 2017, Twelth edition, Jones & Bartlett Publishers. Editors: Krebs JE et al.

Course Outcome: *By the end of the course, the students will acquire the knowledge and thorough understanding on genome organization, concept of non-mendelian genetics and the major molecular information pathways and processes of the prokaryotic and eukaryotic cells.*

MOLECULAR IMMUNOLOGY

Course Objectives:- *The course aim to understand fundamentals of immunology, Major components of Immune response and aim to study the Translational research* aspects like *Clinical immunology , vaccines and cancer immunotherapy*

UNIT I: Fundamental concepts and overview of the immune system **5h**

Overview and Concepts, Components of innate and acquired immunity; phagocytosis; complemen and inflammatory responses; pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP); inflammatory response; mucosal immunity; antigens: immunogens and haptens

UNIT II: Components of Immunity **5h**

Cells and Tissues of the Immune system: Different lineages. Organs of immune system, Major Histocompatibility Complex: MHC genes, MHC and immune responsiveness & disease susceptibility

UNIT III: Immune Responses generated by B and T lymphocytes **10h**

Structure and classes of Immunoglobulins, antigenic determinants; multigene organization of immunoglobulin genes; B-cell receptor; Immunoglobulin superfamily; Signal transduction in lymphocytes; basis of self & non-self-discrimination; kinetics of immune response, memory; B cell maturation, activation and differentiation; Generation of antibody diversity. T-cell maturation, activation and differentiation and T-cell receptors; functional T cell subsets; cell-mediated immune responses, ADCC; Cytokines and their therapeutic uses; Antigen processing and presentation- endogenous and exogenous antigens, non-peptide bacterial antigens and super-antigens; cell-cell co-operation, Hapten-carrier system

UNIT IV: Antigen-antibody Interactions **10h**

Precipitation, agglutination and complement mediated immune reactions; Immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay, FACS, immunofluorescence microscopy and immunoelectron microscopy; surface plasmon resonance, biosensor assays for assessing ligand-receptor interaction; Memory and Death in Immune System. CMI techniques: lymphoproliferation assay, mixed lymphocyte reaction, cell cytotoxicity assays, apoptosis, microarrays, transgenic mice, gene knock outs.

UNIT V: Clinical Immunology and Vaccines **15h**

Immunity to infection : bacteria, viral, fungal and parasitic infections (with e. g. from each group); co-evolution of microbes and host immune systems; hypersensitivity: Type I-IV; autoimmunity; types of autoimmune diseases; mechanism and role of CD4+ T cells; MHC & TCR in autoimmunity; MHC genes and their role in autoimmune and infectious diseases, treatment of autoimmune diseases; HLA typing; transplantation: immunological basis of graft rejection; clinical transplantation and immunosuppressive therapy; Tumor immunology and Cancer immunotherapy.

Recombinant DNA vaccines; antibody genes and antibody engineering: Chimeric, generation of monoclonal antibodies, hybrid monoclonal antibodies; catalytic antibodies and generation of immunoglobulin gene libraries, idiotypic vaccines and marker vaccines, viral-like particles (VLPs), dendritic cell based vaccines, vaccine against cancer, T cell based vaccine and therapeutic vaccine. Immunodeficiency, anaphylactic shock, immunosenescence, immune exhaustion in chronic viral infection, immune tolerance, NK cells in chronic viral infection and malignancy

Text Books:

1. Tizard, Ian R. Immunology an introduction, Fourth Ed, Saunders college publishing, New Delhi, 2010
2. Coico R, Sunshine G. Immunology: A short course, Sixth Edition, Wiley-Blackwell publishers, Canada 2009.
3. Coleman, Lombard and Sicard. Fundamental Immunology, **McGraw-Hill Science** publishers 1999.
4. Kindt TJ, Goldsby RA, Osborne BA. Kuby Immunology, Seventh Ed, W.H. Freeman and company, New York, 2017.
5. Delves PJ, Martin SJ, Burton DR, Roitt IM. Roitt's Essential Immunology, Thirteenth Edition, Wiley-Blackwell publishers, USA, 2017.

References:

1. Elgert KD. Immunology: Understanding the immune system, Wiley-Blackwell publishers, Canada, 2009.
2. Hudson, L. and Hay, F.C. Practical Immunology, Black Well publishers 1989.
3. Dixon, F.J. Advances in Immunology, Academic Press 1986.

Course Outcome:- *Students will acquires knowledge on fundamentals of immunology, Major components of Immune response; gain knowledge in Translational research* aspects like *Clinical immunology , vaccines and cancer immunotherapy*

MOLECULAR PLANT BREEDING

Course Objectives: *To understand the Fundamentals and application breeding and molecular plant breeding methods for crop improvement*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **8 h**

Plant breeding- History; Genetic resources- centres of diversity and origin of crop plants, Law of homologous variation, genetics resources

UNIT II **10 h**

Mode of reproduction in plant: Principles and methods of breeding self, cross pollinated and vegetatively propagated plants, Heterosis breeding, Polyploidy and haploids in breeding, Wide hybridization, Mutation breeding, Breeding crops to contain useful and adaptive traits; seed production and variety development and its conservation.

UNIT III **7 h**

Plant genome mapping: Types of mapping population; RFLP and AFLP mapping. Marker assisted breeding using RFLP, AFLP, RAPD, SNP and CAPS marker.

UNIT IV **10 h**

Plant tissue culture and somatic cell genetics – role of growth regulators, Micropropagation, Germplasm storage *in vitro*; Embryo rescue, Haploids and triploids, Secondary products, Protoplast culture and fusion, Cybrids, Somaclonal variation, Mutant selection *in vitro* and by transposon tagging.

UNIT V **10 h**

Plant genetic engineering using recombinant DNA techniques: Genetic engineering for abiotic stress, quality improvement; Strategies for Marker Gene Removal from Transgenic plants; Transgene silencing, Strategies to avoid gene silencing and improve gene expression in transgenic plants, Description and uses of antisense RNA, ribozymes in plants; Gene editing by CRISPR-Cas technology, Ethics and plant genetic engineering.

Text Books:

1. Acquaah, G. Principles of Plant Genetics and Breeding, John Wiley sons, 2012.
2. Xu Y, Molecular Plant Breeding, CAB International, 2010.
3. Bhojwani SS, Razdan MK. Plant Tissue culture. Theory and Practice. Elsevier B. V. Publications, 2009.

References:

1. Sambrook, J and Russell, D, Molecular Cloning: A Laboratory Manual, Third Edition, Cold Spring Harbor Laboratory Press, NY, 2001
2. Sleper, DA and Poehlman, JM. Breeding Field Crops, Wiley-Blackwell, NJ. 2006
3. Allard RW, Principles of Plant Breeding. 2nd Edition, John Wiley & Sons, NJ, 1999.

Course Outcome: *The students will acquires the knowledge on Fundamentals and application breeding and molecular plant breeding methods for crop improvement*

ANIMAL BIOTECHNOLOGY

Course Objectives: *The students will learn about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Animal Cell culture primary and established cell line cultures, functions of different constituents of culture media, serum and protein free media and their applications ,scaling up of animal cell culture, cell synchronization, cell cloning and micro manipulation. Organ and histotypic culture. Application of animal cell culture for virus application and *in vitro* testing of drugs, testing of toxicity of environmental pollutants in cell culture. Application of cell culture technology in production of human and animal viral vaccines and pharmaceutical proteins.

UNIT II **10 h**

Reproductive Biotechnology- structure of sperm and ovum, cryopreservation of gametes and embryos in mammals. Embryo transfer-Artificial insemination, ICSI, super ovulation, embryo recovery, In- vitro fertilization, embryo splicing and embryo transfer technology. Production of transgenics birds, mammals and knockout mice. Application of transgenic animals models for diseases, oncogenes, drug screening and gene farming. Animal cloning –basic concept, cloning for conservation of endangered species.

UNIT III **10 h**

Integrated insect pest management using biocides, hormone analogues, pheromones and genetic manipulations. Biotechnology of silk worms-Life cycle, culture of silk worm, diseases of silk worm ,improvement of silk production and quality, Biology of viral vectors-SV40,adeno virus, retro virus, vaccina virus papiloma virus, and baculoviruses. Insect as a bioreactor.

UNIT IV **8 h**

RFLP, RAPD and its applications in domestic animals. Molecular diagnostics of pathogens in animals. Detection of meat adulteration using DNA based methods. Biotechnological approaches to vaccine production Development of animal vaccines for Reinderpest, foot and mouth disease, blue tongue disease, rabies and anthrax. Peptide vaccines, fusion protein vaccines, synthetic peptide vaccines, anti-idotype antibody vaccines.

UNIT V **7 h**

Biotechnology in animal production-manipulation of growth using hormones and probiotics, manipulation of lactation, manipulation of wool growth in sheep and rabbits. Ethical issues in animal biotechnology: animal usage, CPCSEA and IAEC guidelines, Management aspects of biotechnology and genetic engineering.

Text Books:

1. Animal Biotechnology (1989): Comprehensive Biotechnology First Supplement: (Ed.)L.A. Babink and J.P.Phillips. Pregamon press, Oxford,
2. Gordon (2005) Reproductive techniques in Farm Animals,Oxford CAB International
3. Portner, R. (2007) Animal Cell Biotechnology:Methods and Protocols.Totowa.NJ:Human Press.

References:

1. Future Developments in the Genetic Improvements of Animals. Ed. J.S.F.Barrer, K.Hammond and A.E.McClintock, Academic Press, 1992.
2. Human Genetics: Concept and Applications. Ricki Lewis .McGraw Hill. 2003.

Course Outcome: *the students will know about basics function of Animal Cell Culture application, production of transgenic animals, Animal diseases and Biotechnology in animal production*

BIOPROCESS ENGINEERING AND TECHNOLOGY

Course Objectives: *Bioprocess Technology is a course that offers real solutions for the problems of food, medicine, and fuels. The models of microbial growth, the Design, Principles of fluid mechanics, gas–liquid mass transfer Lab fermentor to large scale fermentation and dynamics a special case study of the fermentation of penicillin, beer with special reference to downstream processing.*

Pre-requisite: Bachelor's level course in Life Sciences, physics and chemistry

UNIT I **9 h**

Fermented foods and beverages, food ingredients and additives prepared by fermentation, fermentation as a method of preparing and preserving foods, microbes and their use in pickling, producing colours and flavours, alcoholic beverages and other products, process wastes-whey, molasses, starch substrates and other food wastes for bioconversion to useful products, bacteriocins from lactic acid bacteria, production and applications in food preservation, biofuels and biorefinery. Isolation, screening and maintenance of industrially important microbes, strain improvement for increased yield and other desirable characteristics, preservation- history.

UNIT II **9 h**

Mechanism of enzymatic reactions, Mechanism of enzyme function and reactions in process techniques; enzymatic bioconversions and applications in starch and sugar conversion processes, preparation of high-fructose corn syrup, hydrolyzed protein, baking by amylases, deoxygenation and desugaring by glucoses oxidase, beer mashing and chill proofing, cheese making by proteases and various other enzyme catalytic actions in food processing, large scale animal and plant cell cultivation, fermentation economics.

UNIT III **9 h**

Microbial growth kinetics and death kinetics (an example from each group, particularly with reference to industrially useful microorganisms), Monod model, batch culture, Elemental balance equations, metabolic coupling – ATP and NAD+, yield coefficients, unstructured models of microbial growth, structured models of microbial growth, Batch and continuous fermenters, modifying batch and continuous reactors, chemostat with recycle, multistage chemostat systems, fed-batch operations, conventional fermentation v/s biotransformation, media formulation and optimization, sterilization, aeration, agitation and heat transfer in bioprocess, scale up and scale down measurement and control of bioprocess parameters

UNIT IV **9 h**

Ideal bioreactors, Batch, fed batch, CSTR, PFR, Multiphase bioreactors, packedbed, bubble column fluidized trickle bed, immobilization of cell systems. Aseptic, septic and anaerobic fermentors

UNIT V **9 h**

Separation of insoluble products - filtration, centrifugation, sedimentation, flocculation; Cell disruption; separation of soluble products,liquid-liquid extraction, precipitation, chromatographic techniques, reverse osmosis, ultra and micro filtration, electrophoresis; final purification: drying; crystallization; storage and packaging

Text Books:

1. Bioprocess Engineering by M.Shuler & F.Kargi (Prentice Hall 2017)

2. Bioprocess Engineering Principles by P. M. Doran (Academic Press 2012)

Course Outcome: *The students will understand to determination of titer and identification of suitable strain for utilisation purpose. Working with low volumes, Microbial growth kinetics, Preparation of complex media, industrial operations for preparation of Beer, baking, large scale fermentation, different downstream processing methods for product purifications.*

BIOT 426 STEM CELL BIOLOGY CREDITS: 3

Course Objectives: *To understand the basics of stem cell, types of stem cells, identification, isolation and applications.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Introduction to stem cells – Definition, History, Types and Sources of stem cells. Capacity of stem cells- Totipotent, Pluripotent, Multipotent, Unipotent. Embryonic stem cells and Adult Stem cells- Mesenchymal stem cell, Neuronal stem cell, Gut Epithelial Stem cells, Hematopoietic stem cells; Bone marrow, Peripheral blood and Cord blood stem cells, Cancer stem cells. Stem cell niche/microenvironment. Stem cell cryopreservation.

UNIT II **10 h**

Properties- Self-renewal and Differentiation. Regulation of stem cell: Cell cycle regulation, Gene expression, Chromatin modifications, Epigenetic regulation (DNA and Histone Methylation and Histone Acetylation, etc.), and miRNA roles. Cross talk betweenmiRNAs and epigenetic regulators during stem cell differentiation.

UNIT III **10 h**

Identification of stem cell using specific markers. Isolation of stem cells -Fluorescence based cell sorting. Culture and genetic manipulation of stem cells. Expansion of stem cells using molecular and biochemical approaches. Cloning and nuclear transfer technology. Genetic reprogramming and Induced Pluripotent Cells (iPCs). *In vitro* functional assays- Cobblestone Area-Forming Cell (CAFC), Colony Forming Cell (CFC),*In vivo* serial transplantation assay.

UNIT IV **10 h**

Stem cells and aging.Correlation between stem cells and cancer stem cells, Clinical applications of stem cells. Stem cell therapy and Regenerative medicine. Bone marrow and cord blood stem cell transplantation. Repair of damaged tissues and organs. Use of stem cells in heart and retinal diseases. Stem cell transplantation. Future prospects of stem cells.

UNIT V **5 h**

Ethical issues associated with stem cell research.Implication of human embryonic stem cell research, societal implications: religious vs. scientific views. Ethical guidelines for stem cell research (National (ICMR-DBT) & International).

Text Books:

1. Yanhong Shi, Dennis O.Clegg. Stem Cell Research and Therapeutics. Springer edition. 2010

2. C. S. Potten. Stem Cells. Academic Press. 2008.

References:

1. Julie Audet, William L. Stanford. Stem Cells in Regenerative Medicine. Methods and protocols (Springer edition) 2009.

2. Robert Lanza, Irina Klimanskaya. Essential Stem Cell Methods. (Elsevier- First edition) 2009.

Course Outcome: *The students acquire knowledge over basics of stem cells and its applications.*

ENVIRONMENTAL BIOTECHNOLOGY

Course Objectives: *The students will understand the impact of pollution on the environment and the need for remediation with the use of microbes and biological methods and they also learn about the biorenewal fuels.*

Pre-requisite: Bachelor's level course in Life Sciences

Unit I Introduction to environment **8 h**

Introduction to environment; pollution and its control; pollution indicators; waste management: domestic, industrial, solid and hazardous wastes; strain improvement; Biodiversity and its conservation; Role of microorganisms in geochemical cycles; microbial energy metabolism, microbial growth kinetics and elementary chemostat theory, relevant microbiological processes, microbial ecology.

Unit II Bioremediation **7 h**

Bioremediation: Fundamentals, methods and strategies of application (biostimulation,bioaugmentation) – examples, bioremediation of metals (Cr, As, Se, Hg), radionuclides(U, Te), organic pollutants (PAHs, PCBs, Pesticides, TNT etc.), technological aspects ofbioremediation (in situ, ex situ).

Unit III Role of microorganisms in bioremediation **8 h**

Application of bacteria and fungi in bioremediation: White rot fungi vs specialized degrading bacteria: examples, uses and advantages vs disadvantages; Phytoremediation: Fundamentals and description of major methods of application (phytoaccumulation, phytovolatilization, rhizofiltration phytostabilization).

Unit IV Biotechnology and agriculture **11 h**

Bio insecticides: Bacillus thuringiensis, Baculoviruses, uses, genetic medications and aspects of safety in their use; Biofungicides: Description of mode of actions and mechanisms (e.g. *Trichoderma, Pseudomonas fluorescens*);Biofertilizers: Symbioticsystems between plants – microorganisms (nitrogen fixing symbiosis, mycorrhiza fungisymbiosis), Plant growth promoting rhizobacteria (PGPR) – uses, practical aspects andproblems in application.

Unit V Biofuels **11 h**

Environmental Biotechnology and biofuels: biogas; bioethanol; biodiesel; biohydrogen; Description of the industrial processes involved, microorganisms and biotechnological interventions for optimization of production; Microbiologically enhanced oil recovery(MEOR); Bioleaching of metals; Production of bioplastics; Production of biosurfactants: bioemulsifers; Paper production: use of xylanases and white rot fungi.

Textbooks and References:

1. G. M. Evans and J. C. Furlong (2003), Environmental Biotechnology: Theoryand Applications, Wiley Publishers.
2. B. Ritmann and P. L. McCarty, (2000), Environmental Biotechnology: Principle &Applications, 2nd Ed., McGraw Hill Science.
3. Scragg A., (2005) Environmental Biotechnology. Pearson Education Limited.
4. J. S. Devinny, M. A. Deshusses and T. S. Webster, (1998), Biofiltration for AirPollution Control, CRC Press.
5. H. J. Rehm and G. Reed, (2001), Biotechnology – A Multi-volume ComprehensiveTreatise, Vol. 11, 2nd Ed., VCH Publishers Inc
6. H. S. Peavy, D. R. Rowe and G. Tchobanoglous, (2013), Environmental Engineering, McGraw-Hill Inc.

Course Outcome: *The student acquires the knowledge over nature of pollution, and basic of bioremediation and biofuels.*

MOLECULAR GENETICS LAB

30 h

1. Electrocompetent cell preparation.
2. Transformation of *E.coli* by electroporation.
3. Transformation of S. *cerevisiae*.
4. Mating of S. *cerevisiae*.
5. Genomic DNA isolation from mammalian cells/tissue.
6. Total RNA isolation from mammalian cells/tissue.
7. Quantification of gene expression by quantitative RT-PCR.
8. Histone extraction from mammalian cells.
9. SDS-PAGE analysis of histones.

Suggested Reading:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green.

MOLECULAR IMMUNOLOGY LAB

30 h

1. Immunization and generation of Anti-sera in rabbit against antigen
2. Microscopic analysis of immune cells by Giemsa stain
3. Separation of immunoglobulin G fractions using affinity chromatography
4. Diffusion methods of Immunoelectrophoresis
5. Rocket electrophoresis
6. Titer value determination
7. ELISA for detection of Antigens/Antibodies
8. Blood group mapping
9. Separation of mononuclear cells by Ficoll-hypac method and their cryopreservation
10. Demonstration of FACS

Suggested Reading: -

1. Immunochemical Protocols, Editors: **Burns, Robert** (Ed.) Humana Press Springer Inc., 2005

2. Current Protocols in Immunology Editors: **John E. Coligan** et al., Volume 124, A Wiley Grand publications, 2014.

MOLECULAR PLANT BREEDING LAB

30 h

1. General Breeding Techniques: Emasculation, pollination and tagging.
2. Selection of parents for hybridization and embryo rescue.
3. Tissue culture techniques: Preparation of various tissue culture media.
4. Tissue culture of explants.
5. Isolation and culture of protoplasts
6. Isolation and culture of microspores.
7. Application of RFLP technique in plant breeding.
8. Demonstration of AFLP technique in plant breeding.
9. Detection of multiple genes by employing SNP primers.

Suggested Reading:

1. Breeding Field Crops, David A. Sleper, 5th edition (2006).
2. Handbook of Agriculture, ICAR, 6th edition, 2011.

ANIMAL BIOTECHNOLOGY LAB

30 h

1. Animal cell culture.
2. Protein profile of silk gland and haemolymph of larval forms of silk worm.
3. Morphology of male gametes of different animals-bull, goat and sheep:

   Cryopreservation of gametes of bull.
4. *Invitro* fertilization of fish and hatching.
5. Gene transfer in animal cells –Electroporation.
6. Biopesticide effect on mosquitoe larvae.
7. Identification and partial characterization of Lactic Acid Bacteria.
8. Field visit to semen bank.
9. Field visit to silk worm rearing.

Suggested Reading:

1. Animal Cell Biotechnology: Methods and Protocols by Portner, R.(2007).Totowa NJ:Humana Press
2. Sericulture Manual by R. K. Patnaik (2008). Biotech books, Delhi
3. Cryoconservation of Animal Genetic Resources –Training *manual* for embryo transfer in cattle, by G.E. Seidel, Jr. & S. Moore Seidel.-FAO manual

BIOPROCESS ENGINEERING AND TECHNOLOGY LAB

30 h

1. Microbial culture streaking from frozen vial to agar plate
2. Preparation of inoculum and growth kinetics of microbes
3. Whole cell immobilization of microbes and media utilization studies
4. Batch, CSTR and Fed-batch fermentation.
5. Isolation of microorganisms from soil samples.
6. Assembly of bioreactor and sterilization.
7. Microfiltrations and separation of cells from broth by vacuum method.
8. Demonstration of analytical techniques HPLC
9. Demonstration of GC-MS spectroscopy
10. Bioseparations using chromatographic techniques and extractions.

Suggested Reading:

1. Encyclopedia of Industrial Biotechnology: Bioprocess, Bioseparation, and Cell Technology, Edited by Michael C. Flickinger Wiley, New York, Volumes 1-7, 2010,

STEM CELL BIOLOGY LAB

30 h

1. Isolation of mononuclear cells from blood sample.
2. Isolation of Hematopoietic stem cells (CD34+) from peripheral and cord blood.
3. Isolation of Mesenchymal stem cell from cord blood.
4. Identification of CD34+ cells using Fluorescence Activated Cell Sorter.
5. Maintenance of Hematopoietic stem cells.
6. Culture of hematopoietic CD34+ cells.
7. Nuclear transfection of CD34+ cells.
8. Functional assays of Hematopoietic stem cells (CAFC&CFC).

Suggested Reading:

1. Current protocols in stem cell biology-March 2019- Wiley

GENETIC ENGINEERING

Course Objectives: *The course aims to provide students a thorough understanding on various vectors, different cloning strategies and selection methods, mutagenesis strategies, genomic and cDNA library construction methods and applications of genetic engineering in different disciplines.*

Pre-requisite: Master level course in Molecular genetics, Biochemistry & Cell Biology

UNIT I **6 h**

Polymerase Chain Reaction, guidelines for PCR Primer design, degenerate and specific primers, PCR optimization strategies, co-solvents in PCR. Different types of PCR: Hot Start PCR, AP-PCR, Nested PCR, Error-prone PCR and Touch down PCR, Quantitative real time PCR: Principle and Probe chemistry.

UNIT II **8 h**

Essential features of plasmid based vectors, Restriction endonucleases and DNA Ligase, Cloning strategies: Non directional cloning: Use of alkaline phosphatase, Directional cloning, End filling and polishing, Use of Linkers and adapters, Homopolymer tailing and TA cloning. Concept of Insertional inactivation in plasmid based vectors, Transfer of DNA into cells: Transformation, Electroporation, Microinjection and Transfection, Screening and identification of recombinant clones.

UNIT III **10 h**

Lambda Phage based vectors: insertional vector and replacement vector and cosmid. M13 Phage based vectors and phagemid. Random mutagenesis and site directed mutagenesis: Different strategies and methods. Vectors for *S. cerevisiae*: YEP, YRP,YIP and YAC, Plasmid based vector for *B. subtilis*. Investigating the Protein-protein interactions: yeast two-hybrid system, phage display system, ribosome display method and immunoprecipitation, Introduction to high-throughput biology and biological networks.

UNIT IV **6 h**

Genomic DNA library construction, Total RNA preparation and cDNA library construction, 5' RACE and 3' RACE. DNA sequencing: Sanger's sequencing and Next Generation sequencing technologies. Bacterial expression: vector design and problems associated with expression of eukaryotic protein in *E.coli*. Affinity purification of recombinant proteins. Baculovirus mediated protein expression system.

UNIT V **10 h**

Mammalian expression vectors, Transient transfection and stable transfection, Viral vectors for mammalian cells, Gene therapy, Generation of knock-out and knock-in mouse, Vectors for higher plants, Agrobacterium mediated transformation, Removal of marker genes, Applications of plant biotechnology: Insect resistance, herbicide resistance and delaying of fruit ripening, Terminator seed technology.

UNIT VI **5 h**

Application of DNA technologies in Forensic sciences, siRNA and miRNA mediated knock down. Genome engineering technologies: Zinc finger nucleases, TALENS and CRISPR-Cas9 technology.

References:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Principles of Gene Manipulation and Genomics, 2006, Seventh edition, Wiley-Blackwell. Authors:Primrose SB &Twyman R.
3. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green.

Course Outcome: *By the end of the course, the students will acquire the knowledge and thorough understanding on different types of vectors and various methods of recombinant DNA technology.*

MARINE BIOTECHNOLOGY

Course Objectives: *The course aim to understand the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering, extraction of Marine Bioactive Compounds and extremophile.*

Pre-requisite: Master level course in Molecular Biology and Animal Biotechnology

UNIT I **12 h**

Biotechnology in Marine Sciences. Aquaculture: culture of shrimp, crab, edible mollusc, oysters and pearl oysters, Culture of milkfish, mullets and eel. Culture of sea weeds .Culture of live feed organisms-brine shrimp, rotifers.Marine micro algae- aquaculture, antioxidants-carotenoids, astaxanthin

UNIT II **8 h**

Marine hydrocolloids-agar,agarose, carageenan, alginates, chitosans and chitin. Marine enzymes - Applications of enzyme for fish processing. Marine Lipids- application of lipases for modification of fats and oils. Marine flavourants. Bioconversion of organic materials and fish ensilage.

UNIT III **9 h**

Aquaculture biotechnology- hormonal manipulation of sex,chromosomal manipulation of sex fish, cryopreservation of fish gametes and embryo. Diseases of cultured shrimp, fish. Diagnostics and their application to aquaculture.

UNIT IV **8 h**

Production of transgenic fishes.-growth hormone, antifreeze protein, disease resistant fish, application of hormones in induced breeding in aquaculture. Antifreeze protein and its applications.

UNIT V **8 h**

Pharmaceuticals from marine realms, type of drugs from marine organisms and their medical applications. Biofouling and their control. Marine bioremediation-Biosurfactants and Control of oil spills. Extremophiles

Text Books:

1. Aquaculture: Principles and Practices - T.V.R. Pillay -1990
2. Steven M. Colegate and Russel J. Molyneux. 2008. Bioactive Natural Products (II Ed.). CRC Press.
3. Aquaculture: The farming and husbandry of Freshwater & Marine organisms by J.Bardach, Ryther J. Mclarhey.W. 1972.

References:

1. Advances in Fisheries Technology and biotechnology for increased profitability - Ed. Michael N. Voigt, J. Richard Botta. Technomic Publishing Co. Inc.(1990)
2. Biotechnology in the Marine Science- Proceedings of the first Annual MIT Sea Grant Lecture and Seminar - Colwell R.R. 1982.
3. New Developments in Marine BiotechnologyEd. LeGal and H.O.Halvorson Plenum press 1998.

Course Outcome: *The students acquires the knowledge on Marine organisms, Marine hydro colloids, applications of Genetic engineering , extraction of Marine Bioactive Compounds and extremophile.*

PLANT BIOTECHNOLOGY

Course Objectives: *The* objective *of "Plant Biotechnology" course is to provide fundamental knowledge on modern* plant molecular biology and *processes, including plant genome organization, protein targeting into organelles, tissue-specific gene expression, transposons, transformation cassettes, gene transfer tools and genetic engineering.*

Pre-requisite: Master level course in Molecular biology

UNIT I **10 h**

Genome organization and protein targeting: General organization of nuclear, mitochondrial and chloroplast genome. Targeting of proteins synthesized in cytoplasm to chloroplast, mitochondria and within the endomembrane system of plants.

UNIT II **10 h**

Structure and expression of gene: Tissue specific genes, structure and organization of nuclear genes concerning storage proteins, phytochrome, microbial infection and other stresses. Maize transposable elements, organization and function of transposons.

UNIT III **7 h**

Development of plant transformation cassettes: Structure and function of Ti plasmid of *Agrobacterium*, Mechanism of T-DNA transfer to plants. Ti plasmid vectors for plant transformation. Promoter and marker genes in plant transformation. Criticisms regarding the use of different promoters and markers.

UNIT IV **8 h**

Gene transfer and tissue culture techniques: Physical, chemical and biological methods for plant gene transfer. Shoot-tip culture, Rapid clonal propagation, Somoclonal variation and synthetic or artificial seeds, cytoplasmic male sterility.

UNIT V **10 h**

Transgenic plants for virus resistance, herbicide tolerance, delay of fruit ripening, resistance to insect, fungi and bacteria. Production of antibodies, viral antigens and peptide hormones in plants.

Text Books:

1. Lea, PJ, Leegood, RC, Eds. Plant Biochemistry and Molecular Biology, John-Wiley and Sons, Chichester and New York, 1999.
2. Hughes M., A. Harlow. Plant Molecular Genetics. Addison Wesley Longman, England 1996.
3. Kirsi-Marja, Wolfgang Barz. Eds., Plant Biotechnology and Transgenic Plants. Marcel Dekker, 2002.
4. Jones R, Ougham H, Thomas H, Waaland S. The Molecular Life of Plants. First Edition. Wiley-Blackwell publications, 2012.

References:

1. Stewart, CN Jr. Plant Biotechnology and Genetics: Principles, Techniques and Applications. First edition, Wiley-Interscience, 2008.
2. Trigiano RN, Gray DJ., Eds. Plant Development and Biotechnology. CRC press, 2004.
3. Pierce, Benjamin A. Genetics/Conceptual approach. 4th ed. New York, W.H. Freeman & Company, 2012.
4. Journal Review and Research articles.

Course Outcome: *The students understand the application of genetic engineering in plants, transgenic plants as well as tissue culture.*

MEDICAL BIOTECHNOLOGY

Course Objectives: *Students will acquire knowledge on drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.*

Pre-requisite: Master level course in Microbiology and Immunology

UNIT I Drug discovery and Development **10 h**

Introduction, worldwide market in medical biotechnology, revolution in diagnosis, changing approaches of therapy, FDA – Organization chart and regulatory measures for drug discovery: Investigational new drug. Drug discovery: Overview, rational drug design, combinatorial chemistry in drug development, computer assisted drug design, role of bioinformatics in genome – based therapy, antisense DNA technology for drug designing.

UNIT II Molecular Diagnostics **5 h**

Biosensors in clinical diagnosis, Use of nucleic acid probes and antibodies in clinical diagnosis and tissue typing. Nanotechnology in diagnosis.

UNIT III Modern Therapeutics **10 h**

Stem cells in therapy, Gene Therapy: basic approaches to gene therapy, vectors used in gene therapy, applications of gene therapy in cancer, genetic disorders and AIDS. Therapeutic proteins, interleukins, interferons – principle, production and applications. Biotechnological approaches to obtain blood products: Tissue plasminogen activator and erythropoietin. Nutraceuticals- Food derived bioactive peptides.production of single cell protein. Chiral technology - Principle and applications

UNIT IV Vaccines and Vaccine Technologies **10 h**

History of vaccines, Conventional vaccines: Bacterial and Viral vaccine.Vaccine based on routes of administration. Minicells as vaccines, impact of genetic engineering on vaccine production. New Vaccine Technologies - Rationally designed vaccines, DNA vaccination, Mucosal vaccination, New approaches for vaccine delivery, Engineering virus vectors for vaccination, Vaccines for targeted delivery systems. Disease specific vaccines: Tuberculosis vaccine, Malaria vaccine, HIV/AIDS vaccine.New Emerging diseases and vaccine needs –Ebola, Zika

UNIT V Clinical trials and Licensing **10 h**

Clinical trials: Phase I, Phase II, Phase III and Phase IV trail norms, ICMR guidelines for design and conducting clinical trials, licensing procedure in India, intellectual Property Rights and patents in biotechnology.

Text Books:

1. Pongracz J, Keen M. Medical Biotechnology. First Edition, Churchill Livingstone, Elsevier Publication, UK, 2009.
2. Trivedi PC. Medical Biotechnology, First Edition, Aavishkar Publisher Distrib. Jaipur, India, 2008.
3. Albert Sasson. Medical Biotechnology: Achievements, Prospects and Perceptions. United Nations University Press, 2005.
4. Kun LY. Microbial Biotechnology – Principles and applications. World Science publications, 2004
5. Glick BR & Patten CL. Molecular Biotechnology: Principles and applications of Recombinant DNA, Fifth Edition, ASM press, 2017.

References:

1. Marks AR &Neiil US. Textbook of Molecular Medicine - Science in Medicine, Jones and Bartlett Learning, New Delhi; 2010.
2. Glazer AN, Nikaido H. Microbial Biotechnology – Fundamentals of Applied Microbiology WH Freeman, New York 1994.
3. Vyas. Methods in Biotechnology and Bioengineering, CBS publications, 2003.
4. Marshak et al., Stem cell Biology. CSHL publications, 2002.

Course Outcome: *The students understand the concept of drug discovery & development, molecular diagnostics, newer therapeutics, vaccines and vaccine technology.*

MICROBIAL BIOTECHNOLOGY

Course Objectives: *Students are exposed to & sensitized on the importance of microbes & their various biotechno-logical applications including antibiotics, biopolymers, bioplastics, food, feed, colorants, biopulping, biobleaching, biocontrol, biopesticides, biofertilizers, bioreme-diation, bioconversion, biofuels, waste water treatment, degradation of xenobiotics, etc.*

Pre-requisite: Master level course in Microbiology and Genetic Engineering

UNIT I **7 h**

General concepts of microbial biotechnology. Microorganisms as factories for the production of novel compounds. Genetic engineering of microbes to improve production of antibiotics, amino acids, lipids, enzymes, steroids and secondary metabolites. Biopolymers and bioplastics

UNIT II **8 h**

Definition, Concepts- history, biotechnological potentials of microalgae – food, feed Colourant, fuel and pharmaceutically valuable compounds. Cultivation methods of algae with reference to *Dunaliella*. Production of microbial biofertilizers cyanobacteria, *Rhizobium*, *Azotobacter*, *Azospirillum*, *Phosphobacteria*and VAM.

UNIT III **10 h**

Biological pest control, scheme for selection of microbial antagonist for biological control of insects, bacterial, fungal and viral diseases. Mode of action of biological control involved in different biocontrol agents. Genetics of antimicrobial metabolite production in biocontrol bacteria. Risks associated with GMOs, Potential impacts on the environment and human health.

UNIT IV **10 h**

Bioconversion of cellulosic and non-cellulosic wastes. Agrobyproducts, Biopulping, Biobleaching. Bioremediation of wood, lubricants, rubber and plastics. Biofuels.

UNIT V **10 h**

Waste utilization: Waste water treatment - Aerobic and Anaerobic processes, Treatment schemes for waste waters of dairy, distillery, tannery, sugar, antibiotic industries. Sewage disposal, compost making, methane generation. Microbiology of degradation of xenobiotics in environment: Ecological considerations, decay behavior, hydrocarbons, substituted hydrocarbons, oil pollution, surfactants, pesticides and dyes.

Text Books:

1. Bernad R. Glick and Jack J. Pasternak. Molecular Biotechnology Principles and Applications of Recombinant DNA. WCB, 2002
2. Dasilva EJ, Dommergues YR, Nyns EJ, Ratledge C. Microbial Technology in the Developing world, Oxford Scientific Publications, 1987.
3. Glazer, A.N. and Nikaido, H. (2008). Microbial Biotechnology. Cambridge University Press. 576 pp.

References:

1. Braun, V. and Gotz, F. (2002). Microbial Fundamentals of Biotechnology. Wiley-Vch.
2. Baltz, R.H., Demain, A.L. and Davies, .E. (2010). Manual of Industrial Microbiology and Biotechnology, Third Edition. American Society for Microbiology. 788 pp.
3. Crueger, W., Crueger, A. and Aneja, K.R. (2017). Cruegers Biotechnology: A Textbook of Industrial Microbiology. 3rd edition. Medtech. 408pp.

4. Harzevili, F.D. and Chen, H. (2017). Microbial Biotechnology: Progress and Trends. 379 pp. CRC Press. Taylor and Francis Group.
5. Walker, J.M. and Raply, R. (2009). Molecular Biology and Biotechnology 5th Edition. Royal Society of Chemistry, Cambridge, UK.
6. Clark, D. P. and Pazdernik, N.J. (2009). Biotechnology Applying the Genetic Revolution. – Elsevier Academic Press.
7. Singh, J.S. and Singh, D.P. (2019). New and Future Developments in Microbial Biotechnology and Bioengineering. Elsevier.

Course Outcome: T*he students will understand the detailed application of micro organisms and Mushroom cultivation as additional income generation activity, bioconversion of agroresidues to useful products, isolation & screening of antibiotic producing microbes may help in finding new drugs in clinical labs, use of green technologies such as biopulping, biobleaching and biofuels.*

IMMUNOTECHNOLOGY

Course Objectives: *The students will acquires knowledge on immunochemical methods and protocols, methods involved in antibody production and antibody engineering*

Pre-requisite: Master level course in Immunology

UNIT I **8 h**

Introduction Scope of Immunotechnology, Kinetics of immune response, memory; Preparation and purification of Antigens, Extraction of antigens from pathogens, parasites and other biological materials. Antigen fractionation and purification. Preparation of synthetic antigens, Recombinant antigens.

UNIT II **6 h**

Principles of Immunization, different kinds of Immunization procedures; Techniques for analysis of Immune response. Production, purification and characterization of antibodies. Purification of Immunoglobulins, Characterization of Immunoglobulins.

UNIT III **10 h**

Hybridoma and monoclonal antibody (MAb) techniques, Production of murine hybridoma, Production of MAbs in cultures and animal (Ascites), Purification of MCAbs. Characterization of MAbs/ and Labelling of antibodies Antibody engineering; Phage display libraries; Antibodies as *in vitro* and *in vivo* probes.

UNIT IV **11 h**

Cellular immunological methods, CD nomenclature, Markers of immune cells, Separation and purification of immunocompetant cells. Flow cytometry and FACS, Functional tests for immunocompetant cells, Cytokine expression assays; Cell cloning and reporter assays and Histocompatibility testing.

UNIT V **10 h**

Immunological assays; Agglutination tests, Complement fixation tests, *In vivo* tests, Neutralization tests, Radioimmunoassays, Enzyme immunoassays, ELISPOT assayImmunoblotting, Immunohistochemistry and immunohistopathology and Immunofluorescenece techniques.

Text books:

1. Hannigan BM, Moore CBT, Quinn DG. Immunology, Second edition, Viva books Publishers, New Delhi, 2010.
2. Chakrawarty AK. Immunology and Immunotechnology. Second edition, Oxford University press. India, 2008.
3. Kindt TJ, Goldsby RA, Osborne BA. Kuby Immunology, Sixth Ed, W.H. Freeman and company, New York, 2007.
4. Pandian MR, Senthil Kumar B. Immunology and Immunotechnology, First Edition, Panima Publishers, New Delhi, 2007.

References:

1. Benny K. C. Lo Editor. Antibody Engineering: Methods and Protocols (Methods in Molecular Biology) Humana Press, 2003.
2. Rose et al., Manual of Clinical laboratory Immunology, 6th Ed ASM Publications, 2002.

Course Outcome: *The student will understand the concepts and immunochemical protocols, methods involved in antibody production and antibody engineering*

APPLIED MICROBIOLOGY

Course Objectives: *The student will understand the elaborated application of micro organism in fermentation, industrial process using microbes for production of alcohol, lactic acids, organic acids, antibiotics and therapeutic and diagnostic proteins*

Pre-requisite: Master level course in Microbiology and Molecular Biology

UNIT I **10 h**

History and development-Growth phase, Isolation, Preservation Screening of microbes used in Industry: Strain improvement by mutation, selection and enrichment. Bioreactors-types. Air lift, cavitator, acetator, fluid Bed reactors.

UNIT II **10 h**

Production of beverage and industrial alcohols, wine, beer. Production of organic acids -lactic acid, acetone-butanol, citric acid and acetic acid. Production of microbial biomass –SCP.

UNIT III **10 h**

Industrial Production of antibiotics- Penicillin, erythromycin and streptomycin; Bacterial production of enzymes-protease,cellulase, amylase, glucose isomerase, etc, Immobilization of enzymes and development of biosensors.

UNIT IV **8 h**

Role of Microorganisms in cheese production –cheddar cheese, blue cheese, Swiss cheese, camembert cheese, yogurt, buttermilk , sour cream, koumiss,kefir manufacturing. Leather processing.

UNIT V **7 h**

Production of therapeutic and diagnostic proteins –Interferon, somatotropin,cytokines, insulin, growth factors and steroids. Microbial leaching of ores.

Text Books:

1. Gerald (Ed.) Reed. Prescott and Dunn's Industrial Microbiology, Fourth Edition, CBS Publishers and Distributors, 2004.
2. Glick BR and Pasternak JJ. Molecular Biotechnology - Principles & applications of Recombinant DNA. ASM Press, 2009
3. Alani, DI. Murray MY. Perspectives in Biotechnology and applied Microbiology. Elsevier Publication. 1986.
4. Ketchun PA. Applied Microbiology, Microbiology- Concepts and applications. Cassida Jr. Tata McGraw hill Publications, 1994.

References:

1. Glick BR and Pasternak JJ. Molecular Biotechnology - Principles & applications of Recombinant DNA. ASM Press, 2006.
2. Staneberry et al. Fermentation Technology, 1998.

Course Outcome: *The students acquired the knowledge over various use of microbes in industries and the its production.*

PROTEOMICS AND GENOMICS

Course Objectives: *The student will understand the important aspects of proteomics and genomics which are the backbone of biotechnology.*

Pre-requisite: Bachelor's level course in Life Sciences/ Chemical Sciences

UNIT I **10 h**

Whole genome analysis: Prokaryotes and Eukaryotes, Foundations of genomics. Mapping of genome – linkage mapping, High resolution physical mapping – Marker associated and clone assisted genome mapping: Genome library construction – YAC, BAC and PAC libraries of genome.

UNIT II **9h**

Genome sequencing – Hierarchical and shot gun sequencing methods – variation in sequencing methods – Pyroseqencing – Automation in genome sequencing – Sequence analysis – Databanks – Data mining.

UNIT III **9h**

Annotation of genome – experimental and computational approaches – Functional genomics – Experimental and computational approaches – Gene knockouts, yeast two hybrid system – gene expression profiling – microarrays – cDNA and Oligo arrays – DNA chips – Application of DNA arrays – SNPs.

UNIT IV **8h**

Genomics versus Proteomics – Tools for proteomics – 2D Electrophoresis – Protein digestion techniques and mass spectrometry – MALDI TOF/QTOF – Analysis of proteins.

UNIT V **9h**

Proteome analysis – Algorithms for proteomics – Protein expression profiling – protein arrays – Protein-Protein interactions – Protein microarrays. Advantages and disadvantages of DNA and protein microarrays.

Text Books:

1. Twyman, RM, Primrose SB.Principle of Genome analysis and Genomics. 3rd Edition, Wiley-Blackwell publications, Australia 2007.
2. Westermeier, Reiner. Proteomics in Practices. 3rd edition, Weinheim, Wiley, 2002.
3. Simpson RJ. Purifying Proteins for Proteomics / A Laboratory Manual, First edition. Cold Spring Harbor Laboratory Press, 2004.
4. Brown TA. Introduction to Genetics: A Molecular Approach. First Edition, Garland Science, Taylor & Francis group. 2012.

References:

1. Veenstra, TW and Tates III, JR, 2006. Proteomics for biological discovery, Wiley Publications, 2006.
2. Durbin R, Eddy SR, Krogh A, Mitchison G. Biological Sequence Analysis, Probabilistic Models of Proteins and Nucleic Acids, Cambridge University Press, 2000.

Course Outcome: *The students acquire the knowledge on genomics and proteomics analysis method and its application in various field researches. An insight into whole genome proteomics would enable them to modify technologies provided in the course.*

GENETIC ENGINEERING LAB **1**

30 h

1. PCR amplification of mammalian gene and purification of PCR product.
2. Estimation of PCR product concentration and purity by UV spectrophotometer.
3. Restriction digestion of the DNA and purification.
4. Ligation and transformation.
5. Screening of transformants by colony PCR.
6. Isolation of recombinant plasmid from positive transformants.
7. Confirmation of the cloning by double digestion of recombinant plasmid.
8. Transfection of the recombinant plasmid in HEK293 cells.
9. Estimating the transfection efficiency by fluorescence microscope.
10. Analysis of the protein expression by western blotting.

Suggested Reading:

1. Gene Cloning & DNA Analysis, 2016, Seventh edition, Wiley-Blackwell. Author: T. A. Brown.
2. Molecular Cloning: A Laboratory Manual, 2012, Fourth edition, Cold Spring Harbor Laboratory Press. Author: Michael R. Green

MARINE BIOTECHNOLOGY LAB

30 h

1. Estimation of water quality parameters in Sea Water (Dissolved Oxygen,Salinity Ammonia and Nitrates)
2. Identification and partial characterization of fish bacterial pathogen
3. PCR detection of White Spot Virus or MonodonBaculoVirus in shrimps
4. Production and characterization of Marine protease
5. Production and characterization of Marine lipase
6. Production and characterization of Marine carotenoids
7. Enrichment of live feed organisms –Artemia
8. Field visit to shrimp hatchery, farms,diagnostic laboratory and salt pans

Suggested Reading:

1. Methods in Marine Biotechnology 2001 –CMST, ManonmaniumSundranar University publications.
2. Manual on Fish Genetics and Aquaculture biotechnology T.J.Pandian 2005,Science Pub
3. Practical Handbook of Estuarine and Marine Pollution M.J.Kennish 1996 CRC marine Science

MEDICAL BIOTECHNOLOGY LAB

30 h

1. Identification and characterization of selected medically important pathogens – *Escherichia coli*, *Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptococcuspneumoniae* and *Acinetobacter baumannii*
2. Culturing of single cell protein (SCP) (Spirullina)
3. Ammonium sulfate precipitation of parasite (cystic sacrosis) antigen
4. Quality control of antibodies – HPLC
5. Introduction and use of various genome databases.
6. Similarity searches using tools like BLAST and interpretation of results
7. Multiple Sequence alignment using ClustalW
8. Phylogenetic analysis of protein and nucleotide (16S) sequences
9. Role of bioinformatics in drug development computer assisted drug designing and computer based ligand and Receptor interaction
10. Genetic and biochemical analysis of novel molecules

Suggested Reading:

1. Bernard R. Glick, Terry L. Delovitch, Cheryl L. Patten. Medical Biotechnology, ASM Press. 2014

MICROBIAL BIOTECHNOLOGY LAB

30 h

1. Production of *Taq*polymerase using recombinant *E. coli*

2. Mushroom cultivation

3. Different methods of antimicrobial susceptibility testing

4. Isolation of antagonistic bacteria for growth suppression of pathogens

5. Isolation and characterization of Nitrogen fixers

6. Microbial bioconversion of agricultural wastes using fungi and/or bacteria

7. Microbial degradation agricultural pollutants, fungicides and insecticides

8. Cultivation and mass multiplication of *Azolla*

9. Microbial degradation of hydrocarbons.

Suggested Reading:

1. Verma, S., Das, S. and Singh, A. (2014). Laboratory Manual for Biotechnology Students. S. Chand. 1000pp
2. Das, S. and Dash, H.R. (2015). Microbial Biotechnology – A Laboratory Manual for Bacterial Systems. Springer
3. Gupta, V.K., Tuohy, M.G., Ayyachamy, M., Turner, K.M. and O'Donovan, A. (2013). Laboratory Protocols in Fungal Biology. Current Methods in Fungal Biology. Springer.
4. Aneja, K.R. (2014). Laboratory Manual of Microbiology and Biotechnology. Medtech. 424 pp.
5. Harisha, S. (2007). Biotechnology procedures and experiments handbook. Infinity Science Press LLC. New Delhi.

IMMUNOTECHNOLOGY LAB

30 h

1. Preparation of antigens from pathogens and parasites
2. Slide and Tube agglutination reaction
3. Immunofluorescence technique
4. Separation of mononuclear cells by Ficoll-Hypaque
5. SDS-PAGE and Immunoblotting
6. Rapid detection of HBV/ HCV candidate antigens and Diagnostic PCR
7. Demonstration of Phagocytosis of latex beads
8. Separation of CD cells using Flow cytometry
9. Isolation and Identification of lymphocytes and their subsets
10. Immunodiagnostics using commercial kits

Suggested Reading:

1. Immunochemical Protocols, Editors: Burns, Robert (Ed.) Humana Press Springer Inc., 2005
2. Current Protocols in Immunology Editors: John E. Coligan et al., Volume 124, A Wiley Grand publications, 2014.

APPLIED MICROBIOLOGY LAB

30 h

1. Estimation of Microbial biomass
2. Red and White wine fermentation/Alcohol production from molasses using yeast
3. Production of amylase using bacillus under submerged conditions
4. Production of protease using Protease vulgaris under submerged conditions
5. Production of protease using rice bran / Cottage cheese production
6. Production of penicillin-G
7. Mass culture of LAB in fermentor
8. Industrial visit to brewery and distillery

Suggested Reading:

1. Microbial Biotechnology: Fundamentals of Applied Microbiology (2007). Alexander N. Glazer and Hiroshi Nikaido. 2nd edition. Cambridge University Press

PROTEOMICS AND GENOMICS LAB

30 h

1. One and two dimensional separation of protein
2. Scanning and image analysis of 2D gels and spectral analysis of proteins.
3. Computer assisted demonstration of microarray technology: DNA and protein.
4. Liposome preparation
5. Identification of cystic fibrosis gene from Human genome and fatty acyl desaturase gene in *Arabidopsis* genome.
6. Characterization of the protein coded by gene sequence above (in Expt 4) using NCBI software online.
7. Primer designing methods: degenerate and specific oligonucleotide primers.
8. Protein-protein interaction: immune-neutralization (Antigen-antibody precipitation).

Suggested Reading:

1. Bioinformatics, Proteomics and Genomics, Charles Malkoff. Callistro Reference, 2017.

PHARMACEUTICAL BIOTECHNOLOGY

Course Objectives: *The course will give a broad overview of basic pharmacology and extensive overview of research and development carried out in industrial setup towards drug discovery and development*

Pre-requisite: Bachelor's level course in Life Sciences/Biochemistry

UNIT I **9 h**

Introduction to Pharmacology- History, nature and source of drugs, Classification of drugs, Dosage forms (liquid & solid dosage forms, Topical applications and aerosols), routes of drug administration-types, advantages and disadvantages, site of action of drugs, Combined effect of drugs, Factors modifying drug action, tolerance and dependence, Mechanism of action of drugs, drug interactions, Adverse Drug Reactions.

UNIT II **10 h**

Principles of Basic and Clinical pharmacokinetics- Models of pharmacokinetics, Transmembrane transport of drugs. Drug absorption pathway; Bioavailability of drugs-definition, factors influencing bioavailability; Fate of Drug - Drug metabolizing enzymes (hepatic drug enzymes and cytochrome P450), Excretion of drug-types, models of elimination and mechanism. Biological half-life of Drugs, Bioassays and Therapeutic Drug Monitoring, Drug accumulation in continuous medication. Application of drug plasma concentration monitoring

UNIT III **10 h**

Hit to Lead Optimisation by Preclinical Studies & Clinical Trials- Approaches to screen lead molecules-Irrational Approach, Rational approach, Anti sense Approach, High Throughput Screening, Sources of lead molecules, including natural products, synthetic libraries, and in silico structure-based molecules, Prodrugs, Chiral Drugs, Vaccines, Antibodies, Cytokines, Hormones, gene therapy. Preclinical Toxicology- acute,subacuteand chronic toxicity. Animal tests (OECD and CPCSEA guidelines), Prodrugs, Formulation and Drug Delivery Systems. Clinical Trials-Ethical consideration, Regulatory requirements for Clinical Trials, Phases of Clinical Trials.

UNIT IV **8 h**

Good Practices (GMP, GLP, GCP), Regulatory Authorities & Regulatory Applications-Overview, Policies and Procedures: The Process of Drug Discovery, Drug Development Process, Role of Regulatory Authorities, USFDA, WHO, European Union and DCGI Regulations, Drugs and Cosmetics Act, India. Schedule- Y, Schedule-M and Schedule-T, GMP Inspection, Structure of Pharmaceutical Industry, Manufacture of Small Molecules and Large Molecules, Finished Dosage Forms; IPR and patenting.

UNIT V **8 h**

Future Directions of Drug Development in the Pharma Industry- Biosimilars, Novel Drug delivery systems, Drug targeting- Target Identification, Methods used to identify potential drug targets, Target Validation, Drug Interaction with targets or receptors; In silico models in drug discovery and development, Molecular modeling in silico, Computer models to predict ADMET, The 'omics' era in drug development: Proteomics, Genomics, Metalobomics, Pharmacogenomics- The promise of personalized medicine.,

Text Books:

1. 1. R. S. Satoskar & Bhandarkar Pharmacology and Pharmacotherapeutics. Revised 23rd Edition, 2013 Bombay Popular Prakasam Publishers
2. Rang H & MM Dale. Pharmacology, Fifth Edition, Churchill-Livingstone, 2003.

References:

1. Goodman and Gilman's The Pharmacological Basis of Therapeutics 12th Edition, 2013, MacMillan Publishing Company.
2. Ho et al., Biotechnology and Biopharmaceuticals Transferring Proteins and Genes. 2003

Course Outcome: *On completion of this course, students would be able to understand basics of drug discovery and development which would enable them able to apply knowledge gained in respective fields of pharmaceutical industry.*

NANOBIOTECHNOLOGY

Course Objectives: *To teach principles, synthesis methods, characterization and applications of biological nanomaterials.*

Pre-requisite: Bachelor's level course in Life Sciences

UNIT I **10 h**

Introduction to Nanobiotechnology: Definition and concepts, biological, microbial and nano world. Nanomaterials: nanoparticles, nanowires, nanoclusters, nanotubes, nanocomposites, nanovesicles, nanospheres and nanocapsules. Biomolecules as nanomaterials: lipids as nanobridges, proteins as nanomolecules, polysaccharides and nucleic acids in nanotechnology.

UNIT II **10 h**

Biological synthesis of nanomaterials: Synthesis of nanomaterials using plants, extracellular synthesis of nanoparticles by bacteria, extracellular and intracellular synthesis of nanoparticles by fungi. Production of bacterial magnetosomes, hybrid nano-conjugates, DNA-oligomers and aptamers. Optimization of parameters for biological synthesis of nanoparticles. Advantages and limitations of biological synthesis of nanomaterials.

UNIT III **8 h**

Characterization of nanomaterials: Confirmation of synthesis and characterization by UV-Vis spectroscopy, X-ray diffraction (XRD), Transmission electron microscopy (TEM), Scanning electron microscopy (SEM), Selected-area electron diffraction (SAED), Energy dispersive x-ray analysis (EDAX) AFM, Infrared (IR) and Thermo gravimetric analysis (TGA) analysis.

UNIT IV **10 h**

Applications of nanomaterials in medicine, agriculture and environment: Medical applications- Nanomedicines, drug delivery, nanoparticles for pathogen detection, nanodevices, diagnosis and imaging. Nano-based antimicrobial agents and cosmetics. Agricultural applications- Nanofertilizers, Nanopesticides, Nanopigments, Food processing and Smart packing. Nanoparticles for compound and gene delivery. Environmental applications: Antimicrobial nanoparticles in textile industry, Nanopaints and Nanofilters. Nanocatalysts for degradation of pollutants.

UNIT V **7 h**

Impact, ethical issues, challenges, patent issues in nanotechnology. Health and environment risk assessments. Nanoeconomy and commercialization. Impact of nanotechnology on society.

Text Books:

1. D. E. Reisner, Joseph D. Bronzino. Bionanotechnology: Global Prospects. CRC Press (2008).
2. E. Papazoglou and A. Parthasarathy. Bionanotechnology. Morgan & Claypool publishers (2007).
3. E. Gazit. Plenty of room for Biology at the Bottom: An Introduction to Bionanotechnology. Imperial College Press (2006).

References:

1. C. M. Niemeyer, C. A. Mirkin, -Nanobiotechnology: Concepts, Application and Perspectives, Wiley – VCH, (2004).
2. T. Predeep, - Nano: The Essentials, McGraw – Hill education, (2007).
3. D. S. Goodsell, - Bionanotechnology, John Wiley & Sons, (2004).

Course Outcome: *Students will acquire knowledge on the basic concepts of biological nanomaterials and their utility in health, agriculture and environment.*

BIOSAFETY, BIOETHICS AND BIOENTREPRENEURSHIP

Course Objectives: *To become familiar with India's IPR Policy; To learn biosafety and risk assessment of products derived from biotechnology and regulation of such products; To become familiar with ethical issues in biological research. This course will focus on consequences of biomedical research technologies such as cloning of whole organisms, genetic modifications. DNA testingIn a rapidly developing life science industry, there is an urgent need for people to combine business knowledge with the understanding of science & technology. Bio-entrepreneurship, an interdisciplinary course, revolves around the central theme of how to manage and develop life science companies and projects. The objectives of this course are to teach students about concepts of entrepreneurship including identifying a winning business opportunity, gathering funding and launching a business, growing and nurturing the organization and harvesting the rewards.*

Pre-requisite: Bachelor's level course in Life Sciences/ Chemical Sciences

UNIT I BIOSAFTEY **5 h**

Biosafety and Biosecurity - Introduction and overview of biological safety in plants and animals. Environmental risk assessment and food and feed safety assessment including heavy metal contaminations; problem formulation – protection goals, compilation of relevant information, risk characterization and development of analysis plan; National & International Regulations: OECD, EPA, RCGM, GEAC, IBSC, FSSAI and BRAI.

UNIT II BIOETHICS **5 h**

Overview of ethical issues in biological sciences - interference with nature, bioethics in health care - patient confidentiality, informed consent, euthanasia, artificial reproductive technologies, prenatal diagnosis, genetic screening, gene therapy and transplantation. Bioethics in stem cell research, Human and animal experimentation, Animal rights/welfare.

UNIT III BIO-BUSINESS **7 h**

Scope of bio-entrepreneurship, Competitive dynamics of pharma and biotech industries, Strategy and operation of bisector firms, Business implications and communication of innovations and entrepreneurship in biosectors- lab to market activities, IPR and Challenges in bio-marketing.

UNIT IV BIO-MANAGEMENT **7 h**

Basic contracts and agreements for joint ventures and development, Business plan preparation including strategy and legal requirements, Business feasibility study, financial management, collaborations and partnerships.

UNIT V TECHNOLOGY MANAGEMENT **6 h**

Information technology in Biobusiness; Assessment, development and upgradation of technology, Technology transfer, Quality control. Regulatory Compliances and procedures [CDSCO, ISO, NBA GMP, GLP], Public private agencies for bio-entrepreneurship (MSME, BIRAC and TTB-DST).

Text books and References:

1. Shimasaki, C. D. (2014). Biotechnology Entrepreneurship: Starting, Managing, and Leading Biotech Companies. Amsterdam: Elsevier. Academic Press is an imprint of Elsevier.
2. Onetti, A., &Zucchella, A. Business Modeling for Life Science and Biotech Companies: Creating Value and Competitive Advantage with the Milestone Bridge. Routledge.
3. Jordan, J. F. (2014). Innovation, Commercialization, and Start-Ups in Life Sciences. London: CRC Press.
4. Desai, V. (2009). The Dynamics of Entrepreneurial Development and Management. New Delhi: Himalaya Pub. House.
5. Ganguli, P. (2001). Intellectual Property Rights: Unleashing the Knowledge Economy. New Delhi: Tata McGraw-Hill Pub.

6. Office of the Controller General of Patents, Design & Trademarks; Department of Industrial Policy & Promotion; Ministry of Commerce & Industry; Government of India. http://www.ipindia.nic.in/
7. World Trade Organisation. http://www.wto.org
8. World Intellectual Property Organisation. http://www.wipo.int
9. International Union for the Protection of New Varieties of Plants. http://www.upov.int
10. National Portal of India. http://www.archive.india.gov.in
11. National Biodiversity Authority. http://www.nbaindia.org
12. Guidelines for Safety Assessment of Foods Derived from Genetically Engineered Plants. 2008.
13. Guidelines and Standard Operating Procedures for Confined Field Trials of Regulated Genetically Engineered Plants. 2008. Retrieved from http://www.igmoris.nic.in/guidelines1.asp
14. Alonso, G. M. (2013). Safety Assessment of Food and Feed Derived from GM Crops: Using Problem Formulation to Ensure "Fit for Purpose" Risk Assessments. Retrieved from http://biosafety.icgeb.org/inhousepublicationscollectionbiosafetyreviews.

Course Outcome: *Students should be able to understand the rationale for IPR and patents and their regulation. Understand different types of intellectual property rights in general and protection of products derived from biotechnology research and issues related to application and obtaining patents; Gain knowledge of biosafety and risk assessment of products derived from recombinant DNA research and environmental release of genetically modified organisms, national and international regulations; Understand ethical aspects related to biological, biomedical, health care and biotechnology research. They would also gain entrepreneurial skills, understand the various operations involved in venture creation, identify scope for entrepreneurship in biosciences and utilize the schemes promoted through knowledge centres and various agencies. The knowledge pertaining to management should also help students to be able to build up a strong network within the industry.*

NANOBIOTECHNOLOGY LAB

30 h

1. Synthesis of nanoparticles using fungus/bacterium/plant extract.
2. Characterization of nanoparticles using UV-vis spectroscopy/X-ray diffraction (XRD), Transmission electron microscopy (TEM)/Scanning electron microscopy (SEM)/Selected-area electron diffraction (SAED)/Energy dispersive x-ray analysis (EDAX) .
3. Production of nanocomposites.
4. Analysis of intracellularly synthesized mycogenic nanoparticles in the mycelia by Inductively coupled plasma-optical emission spectroscopy (ICP-OES).
5. Analysis of surface-coating molecules in the biologically synthesized nanoparticles using Infrared (IR) and Thermogravimetric analysis (TGA).
6. Antimicrobial activity of nanaoparticles – Agar-diffusion assay, Viable cell count, Cell membrane integrity and Flowcytometry.
7. Cytotoxicity assessment of nanoparticles-Peripheral blood mononuclear (PBMC) culture.
8. Biogenic nanoparticles as catalysts for the degradation of pollutants.

Suggested Reading:

1. A Laboratory Course in Nanoscience and Nanotechnology (2014). Ed. Gerrard Eddy Jai Poinern. CRC Press, USA.
2. Nanobiotechnology Protocols (2005). Eds. Rosenthal, Sandra J, Wright, David. Springer's Humana Press, USA.
3. Nanobiotechnology: Concepts and Applications in Health, Agriculture, and Environment (2019). Eds. Rajesh Singh Tomar, Anurag Jyoti and Shuchi Kaushik. CRC Press, USA.

PHARMACEUTICAL BIOTECHNOLOGY LAB

30 h

1. Qualitative analysis of plant based drugs

2. Isolation of drugs by HPTLC (flavonoids/alkaloids)

3. Quantitative analysis of a drug (aspirin/paracetamol) by spectrophotometer/HPLC

4. Quantitative assay of drug/metabolite by ELISA

5. *Insilico*docking analysis of drug analogs

6. *In vitro* bioactivity assay- antioxidant activity/antidiabetic activity

7. Different routes of drug administration in rodents(Demo)

8. Evaluation of anti-inflammatory/analgesic effect of a drug (Demo)

9. Processing of biological fluids/tissues for biochemical assays

10. Isolation and processing of biological tissues for histopathological analysis

Suggested Reading:

1. A Practical Guide to Pharmacological Biotechnology Authors: Patra, J.K., Das, S.K., Das, G., Thatoi, H. Springer Publications e Book ISBN 978-981-13-6355-9
2. Laboratory Handbook on Biochemistry S. Shanmugam, T. Satish Kumar, Paneer Sevam, PHILearning Pvt Ltd. New Delhi 2010
3. Screening Methods in Pharmacology 1st EditionVolume II Editors: Robert Turner PeterHebborn Elsevier Publications 1971 eBook ISBN: 9781483264233