



**DEPARTMENT OF BIOTECHNOLOGY**  
**SCHOOL OF ENGINEERING AND TECHNOLOGY**  
**GIET UNIVERSITY, GUNUPUR, ODISHA -765022**

**Course Structure for the Academic Session 2020-2021**

**M.Tech Biotechnology**

**I SEMESTER [FIRST YEAR]**

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
<b>THEORY</b>							
1	PC	MPCBT1010	Applied Biochemistry & Molecular Biology	3	0	0	3
2	PC	MPCBT1020	Bioprocess Engineering and Technology	3	0	0	3
3	PC	MPCBT1030	Ethics, IPR & Biosafety	2	0	0	2
4	PE	MPEBT1041	Plant Biotechnology	3	0	0	3
		MPEBT1042	Diagnostic Techniques in Biotechnology				
		MPEBT1043	Animal Biotechnology				
5	PE	MPEBT1051	Advanced Microbiology & Microbial Techniques	3	0	0	3
		MPEBT1052	Advanced Biochemical Engineering				
		MPEBT1053	Environmental Biotechnology				
6	AUDIT	MAUBT1060	Audit course	2	0	0	0
<b>PRACTICAL / SESSIONAL</b>							
7	PC	MPCBT1170	Laboratory- 1(Applied Biochemistry & Molecular Biology)	0	0	4	2
8	PC	MPCBT1180	Laboratory- 2 (Bioprocess Engineering and Technology)	0	0	4	2
<b>TOTAL</b>				<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>

## M. Tech in Biotechnology

### II SEMESTER [FIRST YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
<b>THEORY</b>							
1	PC	MPCBT2010	Applied Immunology and Immunotechnology	3	0	0	3
2	PC	MPCBT2020	Genetic Engineering and r-DNA Technology	3	0	0	3
3	PE	MPEBT2031	Genomics and Proteomics	3	0	0	3
		MPEBT2032	Applied Bioinformatics				
		MPEBT2033	Process Control and Instrumentation				
4	PE	MPEBT2041	Food Biotechnology	3	0	0	3
		MPEBT2042	Bioreactor design and optimization				
		MPEBT2043	Metabolic engineering and metabolomics				
5	AUDIT	MAUBT2050	Audit Course	2	0	0	0
<b>PRACTICAL / SESSIONAL</b>							
6	PC	MPCBT2110	Laboratory-3(Applied Immunology and Immunotechnology)	0	0	4	2
7	PC	MPCBT2120	Laboratory- 4 (Genetic Engineering and r-DNA Technology)	0	0	4	2
8	PC	MPCBT2130	Mini Project with Seminar	0	0	2	2
<b>TOTAL</b>				<b>14</b>	<b>0</b>	<b>10</b>	<b>18</b>

## M.Tech in Biotechnology

### III SEMESTER [SECOND YEAR]

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
<b>THEORY</b>							
1	PE	MPEBT3011	Nanobiotechnology	3	0	0	3
2	PE	MPEBT3012	Pharmaceutical Biotechnology				
3	PE	MPEBT3013	Molecular modeling and Drug designing				
4	OE	MOEBT3021	Green Technology	3	0	0	3
		MOEBT3022	Industrial Safety				
		MOEBT3023	Research Methodology				
<b>PRACTICAL / SESSIONAL</b>							
5	PC	MPCBT3110	Dissertation-I/ Industrial Training	0	0	20	10
6							
7							
<b>TOTAL</b>				<b>6</b>	<b>0</b>	<b>12</b>	<b>16</b>

## M.Tech in Biotechnology

### IV SEMESTER [SECOND YEAR]

Sl. No.	Course Category	CourseCode	Course Title	L	T	P	Credits
<b>THEORY</b>							
1	PC	MPCBT4110	Dissertation-II	0	0	32	16
<b>TOTAL</b>							<b>16</b>



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<b>THEORY</b>							
1	PC	MPCBT1010	Applied Biochemistry & Molecular Biology	3	0	0	3
2	PC	MPCBT1020	Bioprocess Engineering and Technology	3	0	0	3
3	PC	MPCBT1030	Ethics, IPR & Biosafety	2	0	0	2
4	PE	MPEBT1041	Plant Biotechnology	3	0	0	3
		MPEBT1042	Diagnostic Techniques in Biotechnology				
		MPEBT1043	Animal Biotechnology				
5	PE	MPEBT1051	Advanced Microbiology & Microbial Techniques	3	0	0	3
		MPEBT1052	Advanced Biochemical Engineering				
		MPEBT1053	Environmental Biotechnology				
6	AUDIT	MAUBT1060	Audit course	2	0	0	0
<b>PRACTICAL / SESSIONAL</b>							
7	PC	MPCBT1170	Laboratory- 1(Applied Biochemistry & Molecular Biology)	0	0	4	2
8	PC	MPCBT1180	Laboratory- 2 (Bioprocess Engineering and Technology)	0	0	4	2
<b>TOTAL</b>				<b>16</b>	<b>0</b>	<b>8</b>	<b>18</b>

## APPLIED BIOCHEMISTRY & MOLECULAR BIOLOGY

L: T: P

3: 0: 0

### UNIT- I

Structures and functions of Bio-molecules: Carbohydrates: classification, mono, di, oligo and polysaccharides. Lipids: fatty acids, simple, complex & derived lipids. Protein: Amino Acids Structure and function, Protein Structure and Hierarchy. Nucleic acids: nucleosides, nucleotides, DNA & RNA.

### UNIT- II

Metabolism: Glycolysis, Citric Acid Cycle, Gluconeogenesis, Electron Transport and Oxidative phosphorylation, Fatty Acid Catabolism: Fatty acid oxidation, Protein Metabolism: The Urea Cycle

### UNIT- III

Gene structure, DNA as a genetic material, RNA World, packaging of DNA as chromosome, DNA replication- Prokaryotic and eukaryotic DNA replication, Mechanism of replication. Telomeres, telomerase and end replication. Role of telomerase in aging and cancer.

### UNIT- IV

Transcription, genetic code, reverse transcription, mRNA processing. Translation, Gene regulation, operons: Lac operon, Trp operon, transposons.

#### Text Books:

1. Principles of Biochemistry- A. Lehninger, CBS Publishers and Distributors.
2. Biochemistry- Voet & Voet.
3. Watson. J. D, Baker. T. A, Bell. S. P, Gann. A, Levine. M, Losick. R. Molecular Biology of Gene. 6th The Benjamin / Cummings Pub. Co. Inc, 2008.
4. Darnell, Lodish and Baltimore. Molecular Cell Biology, Scientific American Publishing Inc, 2000.

#### Reference Books:

1. Biochemistry- L. Stryer, Third Edition
2. Zubay. Biochemistry. 4th ed. William C. Brown Publication, 1998.
3. Biochemistry- S C Rastogi, Tata Mcgraw- Hill Publishing Com. Ltd., IInd Edition, 2003.
4. Bruce Alberts, Alexander Johnson, Julian Lewis, Martin Raff, Keith Roberts, Peter Walter. Molecular biology of the Cell. 4th ed. Garland publishing Inc, 2002.
5. Benjamin Lewin. Gene VII. Oxford University Press, Nelson Cox.

## BIOPROCESS ENGINEERING & TECHNOLOGY

L: T: P

**UNIT- I**

Yield coefficients, black box stoichiometries, elemental balances, heat balance, degrees of freedom balances, systematic analysis of black box stoichiometries, identification of gross measurement errors. Energetic analysis of microbial growth and product formation, oxygen consumption and heat evolution in aerobic cultures, thermodynamic efficiency of growth.

**UNIT- II**

Kinetics of substrate utilization, biomass growth and product formation, inhibition on cell growth and product formation. Design and operation of continuous cultures, chemostat in series, batch and fed batch cultures, total cell retention cultivation. Mass transfer includes transport phenomena in bioprocesses, Factors affecting oxygen transfer rate in bioreactors, Techniques for measurement of volumetric oxygen transfer coefficient, Fluid rheology and factors affecting bioreactor processes, Flow Patterns in agitated tanks, Mechanism & Power requirements of mixing, Scale up of mixing systems.

**UNIT-III**

Basic design and construction of CSTR, bioreactor design of agitator/agitator motor, power consumption in aerated bioreactor, design of sparger, mixing time estimation, oxygen mass transfer capability in bioreactor, Removal of Heat in bioreactor, Main parameters to be monitored and controlled in fermentation processes.

**UNIT- IV**

Unit Operation: Filtration, filter aids, filtration Equipment and filtration theory, Centrifugation process and its equipment, Cell disruption, Aqueous Two-Phase Liquid Extraction. Adsorption process and its operations, Chromatography: Theory and mechanism, Scaling-up chromatography.

**Textbooks:**

1. Principles of fermentation technology" by P F Stanbury and A Whitaker, Pergamon press.
2. Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press.
3. Unit operations of Chemical Engineering" 5th ed. by W L McCabe, J C Smith and P. Harriot Mc Graw-Hill (1993).
4. Bioprocess Engineering Principles" by Pauline M. Doran, Academic Press.

### **UNIT- I**

Bioethics in Biomedical Research Nature, Concept and Relevance of Bioethics, Legal, Social, Moral and Economic Impacts of the Products and Techniques in Biotechnology, Ethical issues in Healthcare, Biopiracy and Bioethics: Application of IPR regime to Biological Resources and Biopiracy, Access to Biological Resources, Benefit Sharing and Informed Consent, Independent Ethics Committee, Constitution of institutional ethics committee, Conflicts of Interest.

### **UNIT-II**

Introduction to Intellectual Property, Types of IP: Patents, Trademarks, Copyright & Related Rights, Industrial Design, Traditional Knowledge, Geographical Indications, Protection of New GMOs; International framework for the protection of IP, IP as a factor in R&D; IPs of relevance to Biotechnology and few Case Studies; Introduction to History of GATT, WTO, WIPO and TRIPS

### **UNIT- III**

Biosafety: an Introduction; Historical Background; Introduction to Biological Safety Cabinets; Primary Containment for Biohazards; Biosafety Levels; Biosafety Levels of Specific Microorganisms; Recommended Biosafety Levels for Infectious Agents and Infected Animals;

### **UNIT-IV**

Biosafety guidelines - Government of India; Roles of Institutional Biosafety Committee, Risk Analysis; Risk Assessment; Risk management and communication; Overview of National Regulations and relevant International Agreements including Cartagena Protocol.

Text Books 1. Stanley SA, Bioethics, Wisdom educational services  
Sateesh MK, Bioethics and Biosafety, IK International Pvt. Ltd.

## **Animal Biotechnology**

**L: T: P**  
**3: 0: 0**

### **UNIT-I**

Techniques in animal tissue culture: Primary and secondary cell culture and maintenance; Embryonic fibroblast isolation and culture; stem cell isolation and cultures; measurement of cell viability/ toxicity, cell separation, development and, in vitro culture of embryo, cryopreservation and transport of germplasm; Embryonic and pluripotent stem cell culture and sorting.

#### **UNIT-II**

Organ and histotypic cultures: cell synchronization, Bioreactors for tissue/ mass culture, design, characterization and recent development (scaling up animal cell culture; In Vitro fertilization and embryo transfer; Tissue engineering; Polyclonal and monoclonal antibody production; Organ Culture.

#### **UNIT-III**

Transgenesis: Gene propagation methods; Use of cloning and expression vectors, Adeno viral vectors and Baculoviruses; Genetically engineered proteins, vaccines, hormones etc. produced in the host; newly emerging transgenic tools.

#### **UNIT-IV**

Animal genetic engineering: Chemical and electrochemical gene transfection methods - microinjection, viral and other methods of gene transfection; Production of transgenic animals with new traits using embryonic stem cell; Use conditional knockouts for the lethal genes; Use transgenic animals for producing important compounds required for pharmaceutical and therapeutic purposes; Bioethical issues related to animal biotechnology.

#### **Text Books:**

1. Animal Cell biotechnology: R.E. Spier and J.B. Griffiths (1988), Academic press.
2. Animal Biotechnology: Murray Moo-Young (1989), Pergamon Press, Oxford.

#### **Reference Books:**

1. Living resources for Biotechnology, Animal cells: A. Doyle, R. Hay and B.E. Kirsop (1990), Cambridge University Press, Cambridge.
2. Jennie P. Mather and David Barnes, 1998, Methods in Cell Biology, Volume 57: Animal Cell Culture Methods Academic Press.

# Advanced Microbiology & Microbial Techniques

**L: T: P**

**3: 0: 0**

## **UNIT-I**

Microbial Diversity & Systematics: Classical and modern methods and concepts; Domain and Kingdom concepts in classification of microorganisms; Criteria for classification; Classification of Bacteria according to Bergey's manual; Classification fungi and Viruses.

## **UNIT-II**

Microbial growth and its kinetics, Microbial processes-production, optimization, screening, strain improvement, factors affecting downstream processing and recovery.

## **UNIT-III**

Microbiology of foods, Types of microbes associated with food spoilage, Food preservation methods, and Food poisoning, Microbiology of Milk and dairy products. Medical Microbiology: disease causing bacteria, virus and fungi; Basic concepts, action of pathogens, human pathogenic viruses and bacteria.

## **UNIT-IV**

Methods of Microbiology- Culture media, Sterilization, Establishment of pure culture, staining of bacteria (Gram's, Acid Fast, Capsule). Techniques of sterilization.

## M. Tech in Biotechnology

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2	PC	MPCBT2020	Genetic Engineering and r-DNA Technology	3	0	0	3
3	PE	MPEBT2031	Genomics and Proteomics	3	0	0	3
		MPEBT2032	Applied Bioinformatics				
		MPEBT2033	Process Control and Instrumentation				
4	PE	MPEBT2041	Food Biotechnology	3	0	0	3
		MPEBT2042	Bioreactor design and optimization				
		MPEBT2043	Metabolic engineering and metabolomics				
5	AUDIT	MAUBT2050	Audit Course	2	0	0	0
<b>PRACTICAL / SESSIONAL</b>							
6	PC	MPCBT2110	Laboratory-3(Applied Immunology and Immunotechnology)	0	0	4	2
7	PC	MPCBT2120	Laboratory- 4 (Genetic Engineering and r-DNA Technology)	0	0	4	2
8	PC	MPCBT2130	Mini Project with Seminar	0	0	2	2
<b>TOTAL</b>				<b>14</b>	<b>0</b>	<b>10</b>	<b>18</b>

**Genetic Engineering and r-DNA Technology****Unit-1: [10 Hours]**

Scope and application of genetic Engineering, Restriction Enzymes: Restriction-Modification system; Cohesive and blunt end ligation; Linkers; Adaptors; Enzymes used in genetic engineering: DNA ligase, Klenow enzyme, T4 DNA polymerase, Polynucleotide kinase, Alkaline phosphatases and other enzymes).

**Unit-2: [10 Hours]**

Plasmids; Bacteriophages; Phagemids; Biology of bacteriophage lambda; Insertion and Replacement vectors; Cosmids; Artificial chromosome vectors (YACs; BACs); Expression vectors; Site directed mutagenesis; Probe preparation (radio labelling and non- radio labelling); Primer extension; RNase protection assays.

**Unit-3: [10 Hours]**

Basic concept and steps of gene cloning, Isolation of mRNA and total RNA; cDNA and genomic libraries; Heterologous Protein production, Phage display; Yeast two hybrid and three hybrid systems. Molecular markers in genome analysis: RFLP, RAPD, AFLP, SNP, SSR.

**Unit-4: [10 Hours]**

DNA Fingerprinting and foot printing, Sequencing methods; Enzymatic DNA sequencing; Chemical sequencing of DNA; Automated DNA sequencing; Gene silencing techniques; Principle and application of gene silencing; Somatic and germ-line therapy- in vivo and ex-vivo; Suicide gene therapy; Differential gene expression.

**Text Books**

1. Nicholl **An Introduction to Genetic Engineering**
2. S.B. Primrose, R.M. Twyman and R.W.Old; **Principles of Gene Manipulation.**
3. Brown TA, **Genomes**, 3rd ed. Garland Science.

**Reference Books**

1. **Genetic engineering** Vol I-VI Setlow and Halander.
2. **Molecular Biotechnology: Principles and applications of recombinant DNA.**

# Advanced Immunology & Immuno technology

## UNIT:1

**10 Hours**

Basic concepts of immunology: Immunity, types of immunity, Innate immune response: pathogen recognition receptors (PRR) and pathogen associated molecular pattern (PAMP), Acquired immune response, Organs of immune system: primary and secondary lymphoid organs, Antigen-properties of antigen: antigenity, immunogenicity, Immunoglobulins: basic structure, classes & subclasses of immunoglobulins.

## UNIT:2

**12 Hours**

Major Histocompatibility Complex (MHC), Antigen processing and presentation, Synthesis and secretion of antibody, B cell maturation, activation and differentiation, T-cell maturation, activation and differentiation and T-cell receptors, Molecular basis of antibody diversity, Polyclonal, Monoclonal antibody and Hybridoma Technology, Complement system.

## UNIT:3

**12 Hours**

Antigen-antibody reaction: precipitation, agglutination, Immune response and tolerance: regulation of immune response and immune tolerance, Hypersensitivity, Autoimmunity, Transplantation immunology, Immuno-deficiency and immuno-proliferate diseases, Immunity to infection : bacteria, viral, fungal and parasitic infections (with examples from each group)

## UNIT:4

**10 Hours**

Immunobiotechnology: Vaccines, Active and passive immunization; live, killed, attenuated, subunit vaccines; vaccine technology, viral, bacterial peptides, genetically engineered production of lymphokines, second generation generation antibodies, Advanced immunological techniques: RIA, ELISA, Western blotting, ELISPOT assay

**Text Books:** 1 Immunology: Lydyard, P.M., Whelan, A., Fanger, M.W., 1st Ed., Viva Books.  
2. Essential Immunology: Roitt, I.M., 9th Ed.(1997) Blackwell Scientific, Oxford, UK.

Ref. Books: 1 Immunology: Kuby, J. 3rd Ed. (1997) Freeman W. H., oxford.  
4. Immunotechnology by A Khan, Pearson Publication

## II Semester

### Professional Electives-I

## Genomics and Proteomics

### Unit-I:

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

## **Unit-II**

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

## **Unit-III**

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

## **Unit-IV**

Pharmacogenetics High throughput screening in genome for drug discovery identification of gene targets, Pharmacogenetics and drug development. Functional genomics and proteomics Analysis of microarray data; Protein and peptide microarray-based technology; PCR directed protein in situ arrays; Structural proteomics

Texts/References:

1. Voet D, Voet JG & Pratt CW, Fundamentals of Biochemistry, 2nd Edition. Wiley 2006
2. Brown TA, Genomes, 3rd Edition. Garland Science 2006
3. Campbell AM &Heyer LJ, Discovering Genomics, Proteomics and Bioinformatics, 2nd Edition. Benjamin Cummings 2007
4. Primrose S &Twyman R, Principles of Gene Manipulation and Genomics, 7th Edition, Blackwell, 2006.
5. Glick BR & Pasternak JJ, Molecular Biotechnology, 3rd Edition, ASM Press, 1998

## **II Semester**

### **Professional Electives-I**

## **Food Biotechnology**

**UNIT:1**

**10 Hours**

Food quality and Production technology: Analysis of food, major ingredients present in different product, Food additives colour, flavour, vitamins, Single cell protein, mushroom, Fermentative production of food, Pickling and alcoholic beverages, probiotics/ prebiotics in food products.

**UNIT:2**

**10 Hours**

Technology for improved process: Enzyme in bakery, Protease in cheese making, Enzymes in beverage production, Utilization of food waste for production of value added products, Genetically modified food.

**UNIT:3**

**10 Hours**

Food spoilage and control Spoilage of food, Microbiology of water, Microbial safety of food products, pesticide and herbicide contamination, Post-harvest technology for food preservation, Technology– canning, dehydration, ultrafiltration, sterilization etc.

**UNIT:4**

**10 Hours**

Microbiology of fruits & vegetable and products like jam, jelly, Microbiology of cereal and cereal products like bread, biscuits, confectionary, Microbiology of milk & milk products like cheese, butter, ice-cream, Microbiology of meat, fish, poultry & egg etc.

Text Books

1. Food Biotechnology by V K. Joshi and R.S. Singh, I K International Publishing House.
2. Food Biotechnology by Rita Singh , Global vision publishing house

Ref. Books

1. Fundamental of food biotechnology by Byong H. Lee, Wiley-BCH.
2. Food biotechnology by S.C. Bhatia, WPI Publishing

## M.Tech in Biotechnology

### III SEMESTER [SECOND YEAR]

Batch: 2020-2022

Sl. No.	Course Category	Course Code	Course Title	L	T	P	Credits
<b>THEORY</b>							
1	PE	MPEBT3011	Nanobiotechnology	3	0	0	3
2	PE	MPEBT3012	Pharmaceutical Biotechnology				
3	PE	MPEBT3013	Molecular modeling and Drug designing				
4	OE	MOEBT3021	Green Technology	3	0	0	3
		MOEBT3022	Industrial Safety				
		MOEBT3023	Research Methodology				
<b>PRACTICAL / SESSIONAL</b>							
5	PC	MPCBT3110	Dissertation-I/ Industrial Training	0	0	20	10
6							
7							
<b>TOTAL</b>				<b>6</b>	<b>0</b>	<b>12</b>	<b>16</b>

### III Semester

## Pharmaceutical Biotechnology

### Module-I:

Introduction History of pharmacy; the pharmaceutical industry & development of drugs; Economics and regulatory aspects; Quality management; GMP. Drug kinetics and biopharmaceutics Mechanism of drug absorption, distribution, metabolism and excretion – factors affecting the ADME process; Bioequivalence; Pharmacokinetics.

### Module-II:

Principles of drug manufacture Liquid dosage forms –solutions, suspensions and emulsions; Topical applications –ointments, creams, suppositories; Solid dosage forms –powders, granules, capsules, tablets, coating of tablets; Aerosols; Preservation; Packing techniques. Advances in drug delivery Advanced drug delivery systems –controlled release; Transdermal, Liposomes and drug targeting.

### Module-III:

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

### Module-IV:

Immunogenicity of biopharmaceuticals: Immunogenicity; Factors contributing to immunogenicity (product related factors, host-related factors), Consequence of immunogenicity to biopharmaceuticals; Measurement of immunogenicity. Case studies: Erythropoietin, Insulin, Somatotropin, Interleukin-2, Interferon Granulocyte macrophage-CSF, DNase, Factor VIIa, Factor IX, Factor VIII, Activated protein C, Tissue plasminogen activator, Monoclonal antibodies.

### Text Books:

1. Pharmaceutical Biotechnology Fundamentals and Application by Dr Chandrakant Kokare
2. Pharmaceutical Biotechnology by S.P. Vyas

### Reference books:

1. Textbook of Pharmaceutical Biotechnology by Kokate
2. Pharmaceutical Biotechnology by Richa Manpal

## **Research Methodology**

### **UNIT I**

Principles of Research ethics: Research misconduct, Objectives and unbiased approach, Accuracy and Authenticity of Results, Plagiarism, Copyright, Honest usage of software, Repetitive reporting of Research outcome, Authorship, Informed Consent, Legality and Decency, Supervisor-student relationship, supervisor-supervisor relationship Research code of conduct responsibilities of administrative bodies.

### **UNIT II**

Research policy: Principles Concerning research Openness in research Academic Freedom Research Support Responsibility towards fellow researcher Dissemination of Research results Academic Authorship Interdisciplinary research collaborative work with other institutions Conflict of interest. Maintenance of Research data and records: Motivation for instituting the practice of retaining Research Data Purpose behind retaining data Laboratory notebook Guidelines of recording Laboratory data and Maintaining Records Responsibility distribution.

### **UNIT III**

Research Method: Objectives, Types, and Approaches Identification of Research, Problem Research Design: Exploratory, Descriptive, Experimental, Observational Studies & Survey

### **UNIT IV**

Literature Review Hypotheses Sampling Data Sources Data Collection Tools Data analysis Reliability and Validity Introduction to Qualitative Research Methods Interpretation and Report Writing Writing papers for journals, conference paper, Writing Project proposals.

### **TEXT BOOKS**

1. Dane, Francis C, *Research methods*, Pacific Grove: Brooks /Cole, 1990
2. Devlin, Ann Sloan, *Research methods: Planning, Conducting and Presenting Research*, Belmont, Calif.: Thomson / Wadsworth, 2006

### **REFERENCES**

1. Patrick F. Dunn, *Measurement and Data Analysis for Engineering and Science*, 2/e, CRC Press, 2010
2. Ranjit Kumar, *Research Methodology: A Step-By-Step Guide for Beginners*, Sage Publications, 2010