

**ANNA UNIVERSITY, CHENNAI**  
**AFFILIATED INSTITUTIONS**  
**B.E. AGRICULTURE ENGINEERING**  
**REGULATIONS – 2017**  
**CHOICE BASED CREDIT SYSTEM**  
**OPEN ELECTIVES (Offered By Other Branches)**

**SEMESTER V**  
**OPEN ELECTIVE - I**

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OCY551	Advanced Engineering Chemistry	OE	3	3	0	0	3
2.	OCE551	Air Pollution and Control Engineering	OE	3	3	0	0	3
3.	OBT552	Basics of Bioinformatics	OE	3	3	0	0	3
4.	OBM551	Bio Chemistry	OE	3	0	0	0	3
5.	OIT552	Cloud Computing	OE	3	3	0	0	3
6.	OIT551	Database Management Systems	OE	3	3	0	0	3
7.	OME551	Energy Conservation and Management	OE	3	3	0	0	3
8.	OBT553	Fundamentals of Nutrition	OE	3	3	0	0	3
9.	OCE552	Geographic Information System	OE	3	3	0	0	3
10.	OCH551	Industrial Nanotechnology	OE	3	3	0	0	3
11.	OBT551	Introduction to Bioenergy and Biofuels	OE	3	3	0	0	3
12.	OBT554	Principles of Food Preservation	OE	3	3	0	0	3
13.	OMF551	Product Design and Development	OE	3	3	0	0	3
14.	ORO551	Renewable Energy Sources	OE	3	3	0	0	3

**SEMESTER VII**  
**OPEN ELECTIVE - II**

Sl. No.	COURSE CODE	COURSE TITLE	CATEGORY	CONTACT PERIODS	L	T	P	C
1.	OCY701	Chemistry in Food Industry	OE	3	3	0	0	3
2.	OGI751	Climate Change and its impact	OE	3	3	0	0	3
3.	OME751	Design of Experiments	OE	3	3	0	0	3
4.	OCH752	Energy Technology	OE	3	3	0	0	3
5.	OCE751	Environmental and Social Impact Assessment	OE	3	3	0	0	3
6.	OGI752	Fundamentals of Planetary Remote Sensing	OE	3	3	0	0	3
7.	OEN751	Green Building Design	OE	3	3	0	0	3
8.	OME754	Industrial Safety	OE	3	3	0	0	3
9.	OCS752	Introduction to C Programming	OE	3	3	0	0	3
10.	OAN751	Low Cost Automation	OE	3	3	0	0	3
11.	OBT752	Microbiology	OE	3	3	0	0	3

12.	OCH751	Process Modeling and Simulation	OE	3	3	0	0	3
13.	OIE751	Robotics	OE	3	3	0	0	3
14.	OME752	Supply Chain Management	OE	3	3	0	0	3
15.	OME753	Systems Engineering	OE	3	3	0	0	3

**OBJECTIVES:**

- To make the students conversant with basics of polymer chemistry
- Principles of electrochemical reactions, redox reactions in corrosion of materials and methods for corrosion prevention and protection of materials.
- To acquaint the student with concepts of important photophysical and photochemical processes and spectroscopy.
- To make the student acquire sound knowledge of second law of thermodynamics and second law based derivations of importance in engineering applications in all disciplines.
- To acquaint the students with the basics of nano materials, their properties and applications.

**UNIT I POLYMERS AND SPECIALITY POLYMER 9**

Polymers – Types of polymerization – degree of polymerization – plastics and types – mechanism of polymerization (free radical mechanism) properties of polymers - T<sub>g</sub> and tacticity – compounding of plastics – fabrication of plastics – Blow and extrusion mouldings. Speciality polymers-conducting polymers: polyacetylene, polyaniline, synthesis, mechanism of conduction – applications of conducting polymers. Bio-degradable polymers: requirements, factors affecting degradation – PLA– preparation, properties –applications.

**UNIT II ELECTROCHEMISTRY, CORROSION AND PROTECTIVE COATINGS 9**

Electrode potential – Nernst equation, numerical problems – Emf series, applications, electrochemical cells, galvanic cells, electrolytic concentration cells – Emf measurement problems. Corrosion: dry & wet corrosion – mechanism, factors affecting corrosion - corrosion control, material selection and design aspects – corrosion protection – sacrificial anode and impressed current methods. Protective coatings: Metallic coatings – electroplating of Cu - electroless plating of Ni. Organic coatings: Paints - constituents and function, special paints – water repellent, heat resistant and luminous paints.

**UNIT III PHOTOCHEMISTRY & ANALYTICAL TECHNIQUES 9**

Photochemistry: Laws of photochemistry - Grothuss–Draper law, Stark–Einstein law and Beer-Lambert's Law. Quantum efficiency – determination - photophysical processes (Jablonski diagram) - photosensitization - chemiluminescence and bioluminescence. Analytical techniques: IR, UV – principle, Instrumentation and applications. Thermal analysis: TGA & DTA - principle, instrumentation and applications.

Chromatography: Basic principles of column & TLC – principles and applications.

**UNIT IV THERMODYNAMICS 9**

Terminology of thermodynamics - Second law: Entropy - entropy change for an ideal gas, reversible and irreversible processes; entropy of phase transitions; Clausius inequality. Free energy and work function- Helmholtz and Gibbs free energy functions (problems); criteria of spontaneity; Gibbs- Helmholtz equation (problems); Clausius-Clapeyron equation; Maxwell relations – Van't Hoff isotherm and isochore (problems).

**UNIT V NANOCHEMISTRY 9**

Basics - distinction between molecules, nanoparticles and bulk materials; size-dependent properties (surface to volume ratio, melting point, optical and electrical). nanoparticles, nanocluster, nanorod, nanotube (CNT: SWNT and MWNT) and nanowire, synthesis - precipitation, thermolysis, hydrothermal, solvothermal, electrodeposition, chemical vapour deposition, laser ablation, sol-gel process and applications (electronic and biomedical). Fullerenes: Types - C<sub>60</sub> - preparation, properties and applications.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

- The knowledge gained on polymer chemistry, thermodynamics. spectroscopy, phase rule and nano materials will provide a strong platform to understand the concepts on these subjects for further learning.

**TEXT BOOKS**

1. Shikha Agarwal, "Engineering Chemistry-Fundamentals and Applications", Cambridge University Press, Delhi, 2015.
2. S. Vairam, P. Kalyani and Suba Ramesh, "Engineering Chemistry", Wiley India PVT, LTD, New Delhi, 2013
3. Sivasankar B., "Engineering Chemistry", Tata McGraw-Hill Publishing Company Ltd.,2012.

**REFERENCES**

1. P. C. Jain and Monika Jain, "Engineering Chemistry" Dhanpat Rai Publishing Company (P) LTD, New Delhi, 2015
2. S. S. Dara and S. S. Umare, "A Textbook of Engineering Chemistry", S. Chand & Company LTD, New Delhi, 2015
3. B. K. Sharma, "Engineering Chemistry", Krishna Prakashan Media (P) Ltd, Meerut, 2012

**OCE551****AIR POLLUTION AND CONTROL ENGINEERING****L T P C  
3 0 0 3****OBJECTIVE:**

- To impart knowledge on the principle and design of control of Indoor/ particulate/ gaseous air pollutant and its emerging trends.

**UNIT I INTRODUCTION****7**

Structure and composition of Atmosphere – Definition, Scope and Scales of Air Pollution – Sources and classification of air pollutants and their effect on human health, vegetation, animals, property, aesthetic value and visibility- Ambient Air Quality and Emission standards.

**UNIT II METEOROLOGY****6**

Effects of meteorology on Air Pollution - Fundamentals, Atmospheric stability, Inversion, Wind profiles and stack plume patterns- Atmospheric Diffusion Theories – Dispersion models, Plume rise.

**UNIT III CONTROL OF PARTICULATE CONTAMINANTS****11**

Factors affecting Selection of Control Equipment – Gas Particle Interaction – Working principle - Gravity Separators, Centrifugal separators Fabric filters, Particulate Scrubbers, Electrostatic Precipitators.

**UNIT IV CONTROL OF GASEOUS CONTAMINANTS****11**

Factors affecting Selection of Control Equipment – Working principle - absorption, Adsorption, condensation, Incineration, Bio filters – Process control and Monitoring.

**UNIT V INDOOR AIR QUALITY MANAGEMENT****10**

Sources, types and control of indoor air pollutants, sick building syndrome and Building related illness- Sources and Effects of Noise Pollution – Measurement – Standards –Control and Preventive measures.

**TOTAL: 45 PERIODS****OUTCOMES:**

The students completing the course will have

- an understanding of the nature and characteristics of air pollutants, noise pollution and basic concepts of air quality management
- ability to identify, formulate and solve air and noise pollution problems

- ability to design stacks and particulate air pollution control devices to meet applicable standards.
- Ability to select control equipments.
- Ability to ensure quality, control and preventive measures.

#### TEXTBOOKS:

1. Lawrence K. Wang, Norman C. Pareira, Yung Tse Hung, "Air Pollution Control Engineering", Tokyo, springer science + science media LLC,2004.
2. Noel de Nevers, "Air Pollution Control Engineering", Waveland press, Inc 2017.
3. Anjaneyulu. Y, "Air Pollution and Control Technologies", Allied Publishers (P) Ltd., India 2002.

#### REFERENCES:

1. David H.F. Liu, Bela G. Liptak, "Air Pollution", Lweis Publishers, 2000.
2. Arthur C. Stern, "Air Pollution (Vol.I – Vol.VIII)", Academic Press, 2006.
3. Wayne T.Davis, "Air Pollution Engineering Manual", John Wiley & Sons, Inc, 2000.
4. M.N Rao and HVN Rao, "Air Pollution",Tata Mcgraw Hill Publishing Company limited,2007.
5. C.S.Rao, "Environmental Pollution Control Engineering",New Age International(P) Limited Publishers,2006.

**OBT552** **BASICS OF BIOINFORMATICS** **L T P C**  
**3 0 0 3**

**UNIT I** **BIOLOGICAL DATA ACQUISITION** **9**

The form of biological information. Retrieval methods for DNA sequence, protein sequence and protein structure information

**UNIT II** **DATABASES** **9**

Format and Annotation: Conventions for database indexing and specification of search terms, Common sequence file formats. Annotated sequence databases - primary sequence databases, protein sequence and structure databases, Organism specific databases

**UNIT III** **DATA PROCESSING** **9**

Data – Access, Retrieval and Submission: Standard search engines; Data retrieval tools – Entrez, DBGET and SRS; Submission of (new and revised) data; Sequence Similarity Searches: Localversus global. Distance metrics. Similarity and homology. Scoring matrices.

**UNIT IV** **METHODS OF ANALYSIS** **9**

Dynamic programming algorithms, Needleman-wunsch and Smith-waterman. Heuristic Methods of sequence alignment,FASTA , and PSI BLAST. Multiple Sequence Alignment and software tools for pairwise and multiple sequence alignment;

**UNIT V** **APPLICATIONS** **9**

Genome Annotation and Gene Prediction; ORF finding; Phylogenetic Analysis : Comparative genomics, orthologs, paralogs. Genome analysis – Genome annotation

**TOTAL : 45 PERIODS**

#### TEXT BOOKS:

1. Introduction to Bioinformatics by Arthur K. Lesk , Oxford University Press.
2. Algorithms on Strings, Trees and Sequences by Dan Gusfield, Cambridge University Press.
3. Biological Sequence Analysis Probabilistic Models of proteins and nucleic acids by Durbin, S.Eddy, A.Krogh, G.Mitchison.

4. Bioinformatics Sequence and Genome Analysis by David W. Mount, Cold Spring Harbor Laboratory Press.
5. Beginning Perl for Bioinformatics: An introduction to Perl for Biologists by James Tindall, O'Reilley Media

**REFERENCE:**

1. Bioinformatics The Machine Learning Approach by Pierre Baldi and Soren Brunak.

**OBM551**

**BIO CHEMISTRY**

**L T P C**  
**3 0 0 3**

**OBJECTIVES:**

- To study the structural and functional properties of carbohydrates, proteins, lipids and nucleic acids
- To discuss the impairments in metabolism of the above, including inborn errors of metabolism.

**UNIT I BIOLOGICAL PRINCIPLE**

**8**

Composition & properties of the cell membrane, membrane transports, permeability Coefficient & partition coefficient, body fluids, electrolytes, acid-base balance, blood viscosity and Newtonian nature, colloids, filtration, diffusion, osmosis, dialysis, ultrafiltration, ultracentrifugation, cellular fractionation, electrophoresis, radioimmunoassay, Photochemical reaction, law of photochemistry, fluorescence and phosphorescence.

**UNIT II MACROMOLECULES**

**10**

Classification and functions of carbohydrates, glycolysis, TCA cycle, Blood Sugar analysis and glucose tolerance test, Classification and functions of proteins, architecture of proteins, Classification of amino acids, Oxidative and non oxidative deamination, transamination, decarboxylation, urea cycle, Purification/separation of proteins, Classification and functions of lipids, biosynthesis of long chain fatty acids, oxidation and degradation of fatty acids.

**UNIT III ENZYMES**

**9**

Chemical Nature, General Properties, Spectrophotometric measurement of enzymes, Isolation techniques, Diagnostic enzymes.

**Hormones:** Chemical Nature, Properties of hormones, Hormonal Assay and their Significance.

**UNIT IV METABOLIC DISORDER**

**9**

Diabetes mellitus, Diabetic ketoacidosis, lactose intolerance, Glycogen storage disorders, Lipid storage disorders, obesity, atherosclerosis, Plasma proteins in health and disease, Inborn error of amino acid metabolism, Disorders associated with abnormalities in the metabolism of bilirubin – Jaundice.

**UNIT V**

**9**

Liver Function tests, Renal Function Tests, Blood gas Analysis, Measurement of Electrolytes. Their abnormal and Normal Values and Conditions. Biochemistry of Urine and Stools testing.

**TOTAL: 45 PERIODS**

**OUTCOMES:**

**After the successful completion of this course, the students will be able to,**

- Explain the fundamentals of biochemistry
- Have in-depth knowledge about the classification, structures and properties of carbohydrates, lipid, protein and amino acid.
- Demonstrate about the mechanism of actions of enzymes and co-enzymes, clinical importance of enzymes, hormonal assay and significance.

**TEXT BOOKS:**

1. Keith Wilson & John Walker, "Practical Biochemistry - Principles & Techniques", Oxford University Press, 2009.
2. Rafi MD —Text book of biochemistry for Medical Student, Second Edition, University Press, 2014.
3. W. Rodwell, David Bender, Kathleen M. Botham, Peter J. Kennelly, P. Anthony Weil—Harper's Review of biochemistry, 30 th Edition, LANGE Medical Publications, 2015.
4. Trevor palmer and Philip L Bonner "Enzymes: Biochemistry, Biotechnology, Clinical Chemistry", 2<sup>nd</sup> Edition, Woodhead Publishing, 2009.

**REFERENCES:**

1. Lehninger Principles of Biochemistry, Fourth Edition - by David L. Nelson & Michael M.Cox , - W. H. Freeman; 4 edition (April 23, 2004)
2. Fundamentals of Biochemistry: Life at the Molecular Level - by Donald J. Voet , Judith G. Voet & Charlotte W. Pratt. - Wiley; 2 edition (March 31, 2005)
3. Pamela.C.Champe & Richard.A.Harvey, — Lippincott Biochemistry Lippincott's Illustrated Reviews, 6th Edition, LWW publishers, 2013.

**OIT552****CLOUD COMPUTING****L T P C  
3 0 0 3****OBJECTIVES:**

- To learn about the concept of cloud and utility computing.
- To have knowledge on the various issues in cloud computing.
- To be familiar with the lead players in cloud.
- To appreciate the emergence of cloud as the next generation computing paradigm.

**UNIT I INTRODUCTION TO CLOUD COMPUTING 9**

Introduction to Cloud Computing – Roots of Cloud Computing – Desired Features of Cloud Computing – Challenges and Risks – Benefits and Disadvantages of Cloud Computing.

**UNIT II VIRTUALIZATION 9**

Introduction to Virtualization Technology – Load Balancing and Virtualization – Understanding Hypervisor – Seven Layers of Virtualization – Types of Virtualization – Server, Desktop, Application Virtualizat

**UNIT III CLOUD ARCHITECTURE, SERVICES AND STORAGE 9**

NIST Cloud Computing Reference Architecture – Public, Private and Hybrid Clouds - IaaS – PaaS – SaaS – Architectural Design Challenges – Cloud Storage.

**UNIT IV RESOURCE MANAGEMENT AND SECURITY IN CLOUD 9**

Inter Cloud Resource Management – Resource Provisioning Methods – Security Overview – Cloud Security Challenges – Data Security –Application Security – Virtual Machine Security.

**UNIT V CASE STUDIES 9**

Google App Engine(GAE) – GAE Architecture – Functional Modules of GAE – Amazon Web Services(AWS) – GAE Applications – Cloud Software Environments – Eucalyptus – Open Nebula – Open Stack.

**TOTAL: 45 PERIODS****OUTCOMES:**

**On Completion of the course, the students should be able to:**

- Articulate the main concepts, key technologies, strengths and limitations of cloud computing.
- Learn the key and enabling technologies that help in the development of cloud.
- Develop the ability to understand and use the architecture of compute and storage cloud, service and delivery models.

- Explain the core issues of cloud computing such as resource management and security.
- Be able to install and use current cloud technologies.
- Choose the appropriate technologies, algorithms and approaches for implementation and use of cloud.

**TEXT BOOKS:**

1. Buyya R., Broberg J., Goscinski A., "Cloud Computing: Principles and Paradigm", First Edition, John Wiley & Sons, 2011.
2. Kai Hwang, Geoffrey C. Fox, Jack G. Dongarra, "Distributed and Cloud Computing, From Parallel Processing to the Internet of Things", Morgan Kaufmann Publishers, 2012.
3. Rittinghouse, John W., and James F. Ransome, "Cloud Computing: Implementation, Management, And Security", CRC Press, 2017.

**REFERENCES:**

1. Rajkumar Buyya, Christian Vecchiola, S. ThamaraiSelvi, "Mastering Cloud Computing", Tata Mcgraw Hill, 2013.
2. Toby Velte, Anthony Velte, Robert Elsenpeter, "Cloud Computing - A Practical Approach", Tata Mcgraw Hill, 2009.
3. George Reese, "Cloud Application Architectures: Building Applications and Infrastructure in the Cloud: Transactional Systems for EC2 and Beyond (Theory in Practice)", O'Reilly, 2009.

**OIT551**

**DATABASE MANAGEMENT SYSTEMS**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To learn the fundamentals of data models
- To learn conceptual modeling using ER diagrams.
- To study SQL queries and database programming
- To learn proper designing of relational database.
- To understand database security concepts
- To understand Information retrieval techniques

**UNIT I DBMS AND CONCEPTUAL DATA MODELING**

**9**

Purpose of Database System – Data independence - Data Models – Database System Architecture – Conceptual Data modeling: ER models - Enhanced-ER Model. Introduction to relational databases – Relational Model – Keys – ER-to-Relational Mapping. Modeling of a library management system.

**UNIT II DATABASE QUERYING**

**11**

Relational Algebra – SQL: fundamentals – DDL – Specifying integrity constraints - DML – Basic retrieval queries in SQL - Complex SQL retrieval queries – nested queries – correlated queries – joins - aggregate functions. Creating a table, populating data, adding integrity constraints, querying tables with simple and complex queries.

**UNIT III DATABASE PROGRAMMING**

**7**

Database programming with function calls, stored procedures - views – triggers. Embedded SQL. ODBC connectivity with front end tools. Implementation using ODBC/JDBC and SQL/PSM, implementing functions, views, and triggers in MySQL / Oracle.

**UNIT IV DATABASE DESIGN**

**9**

Functional Dependencies – Design guidelines – Normal Forms: first, second, third – Boyce/Codd Normal Form – Normalization algorithms. Design of a banking database system / university database system.



**UNIT V          ADVANCED TOPICS****9**

Database security issues – Discretionary access control – role based access – Encryption and public key infrastructures – challenges. Information Retrieval: IR Concepts, Retrieval Models, Queries in IR systems.

**TOTAL: 45 PERIODS****OUTCOMES:****Upon completion of the course, the students will be able to:**

- understand relational data model, evolve conceptual model of a given problem, its mapping to relational model and Normalization
- query the relational database and write programs with database connectivity
- understand the concepts of database security and information retrieval systems

**TEXT BOOKS:**

1. Ramez Elmasri, Shamkant B. Navathe, “Fundamentals of Database Systems”, Sixth Edition, Pearson, 2011.
2. Abraham Silberschatz, Henry F. Korth, S. Sudharshan, “Database System Concepts”, Sixth Edition, Tata McGraw Hill, 2011

**REFERENCES:**

1. C.J.Date, A.Kannan, S.Swamynathan, “An Introduction to Database Systems”, Eighth Edition, Pearson Education, 2006.
2. Raghu Ramakrishnan,—Database Management Systems|| , Fourth Edition, McGraw-Hill College Publications, 2015.

**OME551****ENERGY CONSERVATION AND MANAGEMENT****L T P C  
3 0 0 3****OBJECTIVES:**

At the end of the course, the student is expected to

- understand and analyse the energy data of industries
- carryout energy accounting and balancing
- conduct energy audit and suggest methodologies for energy savings and
- utilise the available resources in optimal ways

**UNIT I          INTRODUCTION****9**

Energy - Power – Past & Present scenario of World; National Energy consumption Data – Environmental aspects associated with energy utilization – Energy Auditing: Need, Types, Methodology and Barriers. Role of Energy Managers. Instruments for energy auditing.

**UNIT II          ELECTRICAL SYSTEMS****9**

Components of EB billing – HT and LT supply, Transformers, Cable Sizing, Concept of Capacitors, Power Factor Improvement, Harmonics, Electric Motors - Motor Efficiency Computation, Energy Efficient Motors, Illumination – Lux, Lumens, Types of lighting, Efficacy, LED Lighting and scope of Encon in Illumination.

**UNIT III          THERMAL SYSTEMS****9**

Stoichiometry, Boilers, Furnaces and Thermic Fluid Heaters – Efficiency computation and encon measures. Steam: Distribution &U sage: Steam Traps, Condensate Recovery, Flash Steam Utilization, Insulators & Refractories

**UNIT IV          ENERGY CONSERVATION IN MAJOR UTILITIES****9**

Pumps, Fans, Blowers, Compressed Air Systems, Refrigeration and Air Conditioning Systems – Cooling Towers – D.G. sets

**UNIT V ECONOMICS****9**

Energy Economics – Discount Rate, Payback Period, Internal Rate of Return, Net Present Value, Life Cycle Costing –ESCO concept

**TOTAL: 45 PERIODS****OUTCOMES:**

Upon completion of this course, the students can able to analyse the energy data of industries.

- Can carry out energy accounting and balancing
- Can suggest methodologies for energy savings

**TEXT BOOKS:**

1. Energy Manager Training Manual (4 Volumes) available at [www.energymanagertraining.com](http://www.energymanagertraining.com), a website administered by Bureau of Energy Efficiency (BEE), a statutory body under Ministry of Power, Government of India, 2004.

**REFERENCES:**

1. Witte. L.C., P.S. Schmidt, D.R. Brown, "Industrial Energy Management and Utilisation" Hemisphere Publ, Washington, 1988.
2. Callaghn, P.W. "Design and Management for Energy Conservation", Pergamon Press, Oxford, 1981.
3. Dryden. I.G.C., "The Efficient Use of Energy" Butterworths, London, 1982
4. Turner. W.C., "Energy Management Hand book", Wiley, New York, 1982.
5. Murphy. W.R. and G. Mc KAY, "Energy Management", Butterworths, London 1987.

**OBT553****FUNDAMENTALS OF NUTRITION****L T P C  
3 0 0 3****OBJECTIVES:**

- The course aims to develop the knowledge of students in the basic area of Food Chemistry.
- This is necessary for effective understanding of food processing and technology subjects.
- This course will enable students to appreciate the similarities and complexities of the chemical components in foods.

**UNIT I OVERVIEW OF NUTRITION****9**

Definition, six classes of nutrients, calculating energy values from food, using the RDA, nutritional status, nutritional requirement, malnutrition, nutritional assessment of individuals and populations, dietary recommendations, Balanced diet planning: Diet planning principles, dietary guidelines; food groups, exchange lists, personal diet analysis;

**UNIT II DIGESTION****9**

Digestion, Absorption and Transport: Anatomy and physiology of the digestive tract, mechanical and chemical digestion, absorption of nutrients.

**UNIT III CARBOHYDRATES****9**

Glycemic and Non-glycemic carbohydrates, blood glucose regulation, recommendations of sugar intake for health, health effects of fiber and starch intake, Artificial sweeteners; Importance of blood sugar regulation, Dietary recommendations for NIDDM and IDDM

**UNIT IV PROTEINS & LIPIDS****9**

Proteins; Food enzymes ; Texturized proteins; Food sources, functional role and uses in foods. Review of structure, composition & nomenclature of fats. Non-glyceride components in fats & oils; Fat replacements; Food sources, functional role and uses in foods. Health effects and recommended intakes of lipids. Recommended intakes of proteins, Deficiency- short term and long term effects.

**UNIT V METABOLISM, ENERGY BALANCE AND BODY COMPOSITION 9**

Energy Balance; body weight and body composition; health implications; obesity, BMR and BMI calculations; Weight Control: Fat cell development; hunger, satiety and satiation; dangers of unsafe weight loss schemes; treatment of obesity; attitudes and behaviours toward weight control. Food and Pharmaceutical grades; toxicities, deficiencies, factors affecting bioavailability, Stability under food processing conditions.

**TOTAL : 45 PERIODS**

**TEXT BOOKS:**

1. Chopra, H.K. and P.S. Panesar. "Food Chemistry". Narosa, 2010.
2. Vaclavik, V. A. and Christian E. W. "Essentials of Food Science". II Edition, Kluwer-Academic, Springer, 2003.
3. Mann, Jim and Stewart Truswell "Essentials of Human Nutrition". 3rd Edition. Oxford University Press, 2007.
4. Gibney, Michael J., et al., "Introduction to Human Nutrition". 2nd Edition. Blackwell,2009.
5. Gropper, Sareen S. and Jack L.Smith "Advanced Nutrition and Human Metabolism". 5<sup>th</sup> Edition. Wadsworth Publishing, 2008.

**REFERENCES:**

1. Gopalan C., B.V. Rama Sastri, and S.C. Balasubramanian S. C. "Nutritive Value of Indian Foods". NIN, ICMR, 2004.
2. Damodaran, S., K.L. Parkin and O.R. Fennema. "Fennema's Food Chemistry". 4th Edition, CRC Press, 2008
3. Belitz,H.-D, Grosch W and Schieberle P. "Food Chemistry", 3rd Rev. Edition, Springer-Verlag, 2004.
4. Walstra, P. " Physical Chemistry of Foods". Marcel Dekker Inc. 2003.
5. Owusu-Apenten, Richard. "Introduction to Food Chemistry". CRC Press, 2005

**OCE552**

**GEOGRAPHIC INFORMATION SYSTEM**

**L T P C  
3 0 0 3**

**OBJECTIVES :**

- To introduce the fundamentals and components of Geographic Information System
- To provide details of spatial data structures and input, management and output processes.

**UNIT I FUNDAMENTALS OF GIS 9**

Introduction to GIS - Basic spatial concepts - Coordinate Systems - GIS and Information Systems – Definitions – History of GIS - Components of a GIS – Hardware, Software, Data, People, Methods – Proprietary and open source Software - Types of data – Spatial, Attribute data- types of attributes – scales/ levels of measurements.

**UNIT II SPATIAL DATA MODELS 9**

Database Structures – Relational, Object Oriented – ER diagram - spatial data models – Raster Data Structures – Raster Data Compression - Vector Data Structures - Raster vs Vector Models- TIN and GRID data models - OGC standards - Data Quality.

**UNIT III DATA INPUT AND TOPOLOGY 9**

Scanner - Raster Data Input – Raster Data File Formats – Vector Data Input –Digitiser – Topology - Adjacency, connectivity and containment – Topological Consistency rules – Attribute Data linking – ODBC – GPS - Concept GPS based mapping.

**UNIT IV DATA ANALYSIS 9**

Vector Data Analysis tools - Data Analysis tools - Network Analysis - Digital Education models - 3D data collection and utilisation.

**UNIT V APPLICATIONS****9**

GIS Applicant - Natural Resource Management - Engineering - Navigation - Vehicle tracking and fleet management - Marketing and Business applications - Case studies.

**TOTAL: 45 PERIODS****OUTCOMES:**

This course equips the student to

- Have basic idea about the fundamentals of GIS.
- Understand the types of data models.
- Get knowledge about data input and topology.
- Gain knowledge on data quality and standards.
- Understand data management functions and data output

**TEXT BOOKS:**

1. Kang - Tsung Chang, Introduction to Geographic Information Systems, McGraw Hill Publishing, 2nd Edition, 2011.
2. Ian Heywood, Sarah Cornelius, Steve Carver, Srinivasa Raju, "An Introduction Geographical Information Systems, Pearson Education, 2nd Edition, 2007.

**REFERENCE:**

1. Lo.C.P., Albert K.W. Yeung, Concepts and Techniques of Geographic Information Systems, Prentice-Hall India Publishers, 2006

**OCH551****INDUSTRIAL NANOTECHNOLOGY****L T P C  
3 0 0 3****OBJECTIVES:**

- To elucidate on advantages of nanotechnology based applications in each industry
- To provide instances of contemporary industrial applications of nanotechnology
- To provide an overview of future technological advancements and increasing role of nanotechnology in each industry

**UNIT I NANO ELECTRONICS****9**

Advantages of nano electrical and electronic devices –Electronic circuit chips – Lasers - Micro and NanoElectromechanical systems – Sensors, Actuators, Optical switches,- Data memory –Lighting and Displays – Batteries - Fuel cells and Photo-voltaic cells – Electric double layer capacitors – Lead-free solder – Nanoparticle coatings for electrical products

**UNIT II BIONANOTECHNOLOGY****9**

Nanoparticles in bone substitutes and dentistry – Implants and Prosthesis – Nanorobotics in Surgery –Nanosensors in Diagnosis– Neuro-electronic Interfaces– Therapeutic applications

**UNIT III NANOTECHNOLOGY IN CHEMICAL INDUSTRY****9**

Nanocatalysts – Smart materials – Heterogenous nanostructures and composites – Nanostructures for Molecular recognition (Quantum dots, Nanorods, Nanotubes) – Molecular Encapsulation and its applications – Nanoporous zeolites – Self-assembled Nanoreactors –

**UNIT IV NANOTECHNOLOGY IN AGRICULTURE AND FOOD TECHNOLOGY****9**

Nanotechnology in Agriculture -Precision farming, Smart delivery system – Insecticides using nanotechnology – Potential of nano-fertilizers - Nanotechnology in Food industry -

**UNIT V NANOTECHNOLOGY IN TEXTILES AND COSMETICS****9**

Nanofibre production - Electrospinning – Controlling morphologies of nanofibers – Tissue engineering application– Polymer nanofibers - Nylon-6 nanocomposites from polymerization - Nano-filled polypropylene fibers - Nano finishing in textiles (UV resistant, antibacterial, hydrophilic, self-cleaning, flame retardant finishes) – Modern textiles Cosmetics – Formulation of Gels, Shampoos, Hair-conditioners

**TOTAL: 45 PERIODS****REFERENCES:**

1. Neelina H. Malsch (Ed.), Biomedical Nanotechnology, CRC Press (2005)
2. Udo H. Brinker, Jean-Luc Mieusset (Eds.), Molecular Encapsulation: Organic Reactions in Constrained Systems, Wiley Publishers (2010).
3. Jennifer Kuzma and Peter VerHage, Nanotechnology in agriculture and food production, Woodrow Wilson International Center, (2006).
4. Lynn J. Frewer, Willehm Norde, R. H. Fischer and W. H. Kampers, Nanotechnology in the Agri-food sector, Wiley-VCH Verlag, (2011).
5. P. J. Brown and K. Stevens, Nanofibers and Nanotechnology in Textiles, Woodhead Publishing Limited, Cambridge, (2007).
6. Y-W. Mai, Polymer Nano composites, Woodhead publishing, (2006).
7. W.N. Chang, Nanofibres fabrication, performance and applications, Nova Science Publishers Inc, (2009)

**OBT551****INTRODUCTION TO BIOENERGY AND BIOFUELS****L T P C  
3 0 0 3****OBJECTIVE:**

- This course will be focussed on achievement, acquisition of knowledge and enhancement of comprehension of information regarding bioenergy and biofuel technologies and their sustainable applications.

**UNIT I CONCEPTS****9**

Biopower, Bioheat, Biofuels, advanced liquid fuels, drop-in fuels, biobased products

**UNIT II FEEDSTOCKS****9**

Harvested Feedstocks: First generation biofuels, Second generation biofuels, third generation biofuels. Residue Feedstocks: Agricultural wastes, forestry wastes, farm waste, organic components of residential, commercial, institutional and industrial waste.

**UNIT III CONVERSION TECHNOLOGIES****9**

Biorefinery concept – biorefineries and end products, Biochemical conversion – hydrolysis, enzyme and acid hydrolysis, fermentation, anaerobic digestion and trans-esterification, Thermochemical conversion – Combustion, Gasification, Pyrolysis, other thermochemical conversion technologies. Scaling up of emerging technologies.

**UNIT IV BIOFUELS****9**

Pros and cons of Biofuels, Algal biofuels, Cyanobacteria and producers of biofuels, Jatropha as biodiesel producer, Bioethanol, Biomethane, biohydrogen, biobutanol, metabolic engineering of fuel molecules, Engineering aspects of biofuels, Economics of biofuels

**UNIT V SUSTAINABILITY & RESILIENCE****9**

Environmental Sustainability, bioenergy sustainability, emissions of biomass to power generation applications, emissions from biofuels. ILUC issues, Carbon footprint, Advanced low carbon fuels

**TOTAL : 45 PERIODS****TEXTBOOKS:**

1. Biorenewable Resources – Engineering new products. Robert C Brown. Blackwell Publishing Professional, 2003.
2. Biofuels. Wim Soetaert and Erik Vandamme (Editors) Wiley. 2009.
3. Biomass for Renewable Energy, Fuels and Chemicals. Donald Klass. Academic press. 1998

**REFERENCES:**

1. Introduction to Bioenergy. Vaughn C. Nelson and Kenneth L. Starcher.
2. Bioenergy: Biomass to Biofuels by Anju Dahiya
3. Bioenergy: Principles and Applications by Yebo Li and Samir Kumar Khanal
4. Bioenergy by Judy D. Wall and Caroline S. Harwood
5. Bioenergy: Sustainable Perspectives by Ted Weyland

**OBT554****PRINCIPLES OF FOOD PRESERVATION****L T P C****3 0 0 3****OBJECTIVE:**

- The course aims to introduce the students to the area of Food Preservation. This is necessary for effective understanding of a detailed study of food processing and technology subjects.

**UNIT I FOOD PRESERVATION AND ITS IMPORTANCE****9**

Introduction to food preservation. Wastage of processed foods; Shelf life of food products; Types of food based on its perishability. Traditional methods of preservation

**UNIT II METHODS OF FOOD HANDLING AND STORAGE****9**

Nature of harvested crop, plant and animal; storage of raw materials and products using low temperature, refrigerated gas storage of foods, gas packed refrigerated foods, sub atmospheric storage, Gas atmospheric storage of meat, grains, seeds and flour, roots and tubers; freezing of raw and processed foods. retort pouch packing, Aseptic packaging.

**UNIT III THERMAL METHODS****9**

Newer methods of thermal processing; batch and continuous; In container sterilization- canning; application of infra-red microwaves; ohmic heating; control of water activity; preservation by concentration and dehydration; osmotic methods

**UNIT IV DRYING PROCESS FOR TYPICAL FOODS****9**

Rate of drying for food products; design parameters of different type of dryers; properties of air-water mixtures. Psychrometric chart, freezing and cold storage. freeze concentration, dehydro-freezing, freeze drying, IQF; calculation of refrigeration load, design of freezers and cold storages.

**UNIT V NON-THERMAL METHODS****9**

Super Critical Technology for Preservation - Chemical preservatives, preservation by ionizing radiations, ultrasonics, high pressure, fermentation, curing, pickling, smoking, membrane technology. Hurdle technology,

**TOTAL: 45 PERIODS**

**OUTCOMES:**

On completion of the course the students are expected to

- Be aware of the different methods applied to preserving foods.

**TEXT BOOKS:**

1. Karnal, Marcus and D.B. Lund "Physical Principles of Food Preservation". Rutledge, 2003.
2. VanGarde, S.J. and Woodburn. M "Food Preservation and Safety Principles and Practice".Surbhi Publications, 2001.
3. Sivasankar, B. "Food Processing & Preservation", Prentice Hall of India, 2002.
4. Khetarpaul, Neelam, "Food Processing and Preservation", Daya Publications, 2005.

**REFERENCES:**

1. Rahman, M. Shafiur. "Handbook of Food Preservation". Marcel & Dekker, 2006.
2. Zeuthen, Peter and Bogh-Sarensen, Leif. "Food Preservation Techniques". CRC / Wood Head Publishing, 2003.
3. Ranganna, S. "Handbook of Canning and Aseptic Packaging". Tata McGraw-Hill, 2000.

**OMF551****PRODUCT DESIGN AND DEVELOPMENT****L T P C  
3 0 0 3****OBJECTIVE:**

- The course aims at providing the basic concepts of product design, product features and its architecture so that student can have a basic knowledge in the common features a product has and how to incorporate them suitably in product.

**UNIT I INTRODUCTION****9**

Need for IPPD – Strategic importance of Product development – integration of customer, designer, material supplier and process planner, Competitor and customer – Behaviour analysis. Understanding customer – prompting customer understanding – involve customer in development and managing requirements – Organization – process management and improvement – Plan and establish product specifications.

**UNIT II CONCEPT GENERATION AND SELECTION****9**

Task – Structured approaches – clarification – search – externally and internally – explore systematically – reflect on the solutions and processes – concept selection – methodology – benefits.

**UNIT III PRODUCT ARCHITECTURE****9**

Implications – Product change – variety – component standardization – product performance – manufacturability – product development management – establishing the architecture – creation – clustering – geometric layout development – fundamental and incidental interactions – related system level design issues – secondary systems – architecture of the chunks – creating detailed interface specifications.

**UNIT IV INDUSTRIAL DESIGN****9**

Integrate process design – Managing costs – Robust design – Integrating CAE, CAD, CAM tools – Simulating product performance and manufacturing processes electronically – Need for industrial design – impact – design process – investigation of for industrial design – impact – design process – investigation of customer needs – conceptualization – refinement – management of the industrial design process – technology driven products – user – driven products – assessing the quality of industrial design.

**UNIT V DESIGN FOR MANUFACTURING AND PRODUCT DEVELOPMENT****9**

Definition – Estimation of Manufacturing cost – reducing the component costs and assembly costs – Minimize system complexity – Prototype basics – principles of prototyping – planning for

prototypes – Economic Analysis – Understanding and representing tasks – baseline project planning – accelerating the project – project execution.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The student will be able to design some products for the given set of applications; also the knowledge gained through prototyping technology will help the student to make a prototype of a problem and hence product design and development can be achieved.

**TEXT BOOK:**

1. Kari T.Ulrich and Steven D.Eppinger, "Product Design and Development", McGraw-Hill International Edns. 1999.

**REFERENCES:**

1. Kemneth Crow, "Concurrent Engg./Integrated Product Development", DRM Associates, 26/3,Via Olivera, Palos Verdes, CA 90274(310) 377-569, Workshop Book.
2. Stephen Rosenthal, "Effective Product Design and Development", Business One Orwin, Homewood, 1992, ISBN 1-55623-603-4.
3. Staurt Pugh, "Tool Design –Integrated Methods for Successful Product Engineering", Addison Wesley Publishing, New york, NY.

**ORO551**

**RENEWABLE ENERGY SOURCES**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To get exposure on solar radiation and its environmental impact to power.
- To know about the various collectors used for storing solar energy.
- To know about the various applications in solar energy.
- To learn about the wind energy and biomass and its economic aspects.
- To know about geothermal energy with other energy sources.

**UNIT I PRINCIPLES OF SOLAR RADIATION 10**

Role and potential of new and renewable source, the solar energy option, Environmental impact of solar power, physics of the sun, the solar constant, extraterrestrial and terrestrial solar radiation, solar radiation on titled surface, instruments for measuring solar radiation and sun shine, solar radiation data.

**UNIT II SOLAR ENERGY COLLECTION 8**

Flat plate and concentrating collectors, classification of concentrating collectors, orientation and thermal analysis, advanced collectors.

**UNIT III SOLAR ENERGY STORAGE AND APPLICATIONS 7**

Different methods, Sensible, latent heat and stratified storage, solar ponds. Solar Applications- solar heating/cooling technique, solar distillation and drying, photovoltaic energy conversion.

**UNIT IV WIND ENERGY 10**

Sources and potentials, horizontal and vertical axis windmills, performance characteristics, Betz criteria BIO-MASS: Principles of Bio-Conversion, Anaerobic/aerobic digestion, types of Bio-gas digesters, gas yield, combustion characteristics of bio-gas, utilization for cooking, I.C.Engine operation and economic aspects.



**UNIT V GEOTHERMAL ENERGY:****9**

Resources, types of wells, methods of harnessing the energy, potential in India. OCEAN ENERGY: OTEC, Principles utilization, setting of OTEC plants, thermodynamic cycles. Tidal and wave energy: Potential and conversion techniques, mini-hydel power plants, and their economics. DIRECT ENERGY CONVERSION: Need for DEC, Carnot cycle, limitations, principles of DEC.

**TOTAL : 45 PERIODS****OUTCOMES:**

- Understanding the physics of solar radiation.
- Ability to classify the solar energy collectors and methodologies of storing solar energy.
- Knowledge in applying solar energy in a useful way.
- Knowledge in wind energy and biomass with its economic aspects.
- Knowledge in capturing and applying other forms of energy sources like wind, biogas and geothermal energies.

**TEXT BOOKS:**

1. Rai G.D. , "Non-Conventional Energy Sources", Khanna Publishers, 2011
2. Twidell & Wier, "Renewable Energy Resources", CRC Press (Taylor & Francis), 2011

**REFERENCES:**

1. Tiwari and Ghosal, "Renewable energy resources", Narosa Publishing House, 2007
2. Ramesh R & Kumar K.U , "Renewable Energy Technologies", Narosa Publishing House, 2004
3. Mittal K M, "Non-Conventional Energy Systems", Wheeler Publishing Co. Ltd, New Delhi, 2003
4. Kothari D.P, Singhal ., K.C., "Renewable energy sources and emerging technologies", P.H.I, New Delhi, 2010

**OCY701****CHEMISTRY IN FOOD INDUSTRY****L T P C****3 0 0 3****OBJECTIVES**

- To make the students conversant with food chemistry.
- To impart thorough understanding of theory, concepts are present in chemistry in food industry.
- To implement these methods in finding the quality of raw materials, intermediates and finished products.
- To know about methods of chemistry that is widely used in food industries.

**UNIT I FOOD CHEMISTRY****9**

Definition and importance; Water: functions, physical properties, types of water, water activity and shelf life of food.

**UNIT II CARBOHYDRATES AND PROTEINS****9**

Definition, nomenclature, classification, physical and chemical properties of sugar, functional properties of polysaccharides, modified starch, starch hydrolysates, polyols, glycogen, fibre, gum, proteins, physical and chemical properties of amino acids, proteins, classification and structure, function and properties of protein, animal and plant proteins, effect of processing.

**UNIT III LIPIDS****9**

Classification, estimation of fatty acids, physical properties, Fat constant: saponification number, acid number, iodine value, acetyl value, Reichert Meissel number, effect of freezing, flavour reversion, oxidative and hydrolytic rancidity, hydrogenation, inter-esterification, different types of fats, uses in food processing, food emulsions, fat replacers.

**UNIT IV MINERALS AND VITAMINS****9**

Classification, minerals in meat, milk, plants and their interaction with other components, losses of minerals during processing, metal uptake in canned foods; fat soluble and water soluble vitamins, their food sources, effect of food processing, Enzymes: nature and functions, enzymes in food processing, immobilized enzymes.

**UNIT V NATURAL PIGMENTS AND FLAVOURING AGENTS****9**

Chlorophyll, carotenoids, anthocyanins, anthoxanthins, flavonoids, tannins, natural flavour constituents; Additives and contaminants: intentional additives, incidental additives, antinutritional factors.

**TOTAL: 45 PERIODS****OUTCOMES:**

- Will be familiar with principles of Chemistry in food industry.
- Will gain the knowledge of Chemistry behind in food industries

**TEXTBOOKS:**

1. John DeMan, "Principles of Food Chemistry", Springer-Verlag, 2006.
2. C.M. Weaver and J.R. Daniel, "Food Chemistry Laboratory- A Manual for Experimental Foods", Dietetics and Food Scientists. CRC Press, 2003.

**REFERENCES:**

1. S. Damodaran, S., K.L. Parkin, O.R. Fennema, "Introduction to Food Chemistry". CRC press, 2007.
2. O. R. Fennema, "Principles of Food Science Part I: Food Chemistry", 4<sup>th</sup> Ed. CRC press, 2007.
3. H.D. Belitz, W. Grosch and P. Schieberle, "Food Chemistry", 3<sup>rd</sup> Ed, Springer-Verlag, 2004.

**OGI751****CLIMATE CHANGE AND ITS IMPACT****L T P C  
3 0 0 3****OBJECTIVES:**

- To understand the basics of weather and climate
- To have an insight on Atmospheric dynamics and transport of heat
- To develop simple climate models and evaluate climate changes using models

**UNIT I BASICS OF WEATHER AND CLIMATE:****9**

Shallow film of Air– stratified & disturbed atmosphere – law – atmosphere Engine. Observation of parameters: Temperature – Humidity – Wind - Pressure – precipitation-surface – networks. Constitution of atmosphere: well stirred atmosphere – process around turbopause – in dry air – ozone – carbon Dioxide – Sulphur Dioxide– Aerosol - water. Evolution of Atmosphere. State of atmosphere: Air temperature – pressure – hydrostatic – Chemistry – Distribution – circulation

**UNIT II ATMOSPHERIC DYNAMICS:****9**

Atmosphere dynamics: law – isobaric heating and cooling – adiabatic lapse rates – equation of motion - solving and forecasting. Forces – Relative and absolute acceleration – Earth's rotation *coriolis* on sphere – full equation of motion – Geostrophy;- Thermal winds –departures – small-scale motion. Radiation, convection and advections: sun & solar radiation – energy balance – terrestrial radiation and the atmosphere – Green house effect- Global warming - Global budget – radiative fluxes - heat transport. Atmosphere and ocean systems convecting & advecting heat. Surface and boundary layer – smaller scale weather system – larger scale weather system.

**UNIT III GLOBAL CLIMATE 9**

Components and phenomena in the climate system: Time and space scales – interaction and parameterization problem. Gradients of Radiative forcing and energy transports by atmosphere and ocean – atmospheric circulation – latitude structure of the circulation - latitude – longitude dependence of climate features. Ocean circulation: latitude – longitude dependence of climate features – ocean vertical structure – ocean *thermohaline* circulation – land surface processes – carbon cycle.

**UNIT IV CLIMATE SYSTEM PROCESSES 9**

Conservation of motion: Force – *coriolis* - pressure gradient- velocity equations – Application – geotropic wind – pressure co-ordinates. Equation of State – atmosphere – ocean. Application: thermal circulation – sea level rise. Temperature equation: Ocean – air – Application – decay of sea surface temperature. Continuity equation: ocean – atmosphere. Application: coastal upwelling – equatorial upwelling – conservation of warm water mass. Moisture and salinity equation: conservation of mass – moisture. Source & sinks – latent heat. Moist processes – saturation – convection – Wave processes in atmosphere and ocean.

**UNIT V CLIMATE CHANGE MODELS 9**

Constructing a climate model – climate system modeling – climate simulation and drift – Evaluation of climate model simulation – regional (RCM) – global (GCM) – Global average response to warming – climate change observed to date. .

**TOTAL: 45 PERIODS**

**OUTCOMES:**

At the end of the course the student will be able to understand

- The concepts of weather and climate
- The principles of Atmospheric dynamics and transport of heat and air mass
- The develop simple climate models and to predict climate change

**TEXTBOOKS:**

1. Fundamentals of weather and climate (2<sup>nd</sup> Edition) Robin Moilveen (2010), Oxford University Press
2. Climate change and climate modeling, J. David Neelin (2011) Cambridge University press.

**OME751 DESIGN OF EXPERIMENTS L T P C  
3 0 0 3**

**OBJECTIVE:**

- To impart knowledge on various types of experimental designs conduct of experiments and data analysis techniques.

**UNIT I FUNDAMENTALS OF EXPERIMENTAL DESIGNS 9**

Hypothesis testing – single mean, two means, dependant/ correlated samples – confidence intervals, Experimentation – need, Conventional test strategies, Analysis of variance, F-test, terminology, basic principles of design, steps in experimentation – choice of sample size – Normal and half normal probability plot – simple linear and multiple linear regression, testing using Analysis of variance.

**UNIT II SINGLE FACTOR EXPERIMENTS 9**

Completely Randomized Design- effect of coding the observations- model adequacy checking- estimation of model parameters, residuals analysis- treatment comparison methods-Duncan's multiple range test, Newman-Keuel's test, Fisher's LSD test, Tukey's test- testing using contrasts- Randomized Block Design – Latin Square Design- Graeco Latin Square Design –Applications.

**UNIT III FACTORIAL DESIGNS 9**

Main and Interaction effects - Two and three factor full factorial designs- Fixed effects and random effects model - Rule for sum of squares and Expected Mean Squares-  $2^k$  Design with two and three factors- Yate's Algorithm- fitting regression model- Randomized Block Factorial Design - Practical applications.

**UNIT IV SPECIAL EXPERIMENTAL DESIGN 9**

Blocking and Confounding in  $2^k$  Designs- blocking in replicated design-  $2^k$  Factorial Design in two blocks- Complete and partial confounding- Confounding  $2^k$  Design in four blocks- Two level Fractional Factorial Designs- one-half fraction of  $2^k$  Design, design resolution, Construction of one-half fraction with highest design resolution, one-quarter fraction of  $2^k$  Design

**UNIT V TAGUCHI METHODS 9**

Design of experiments using Orthogonal Arrays, Data analysis from Orthogonal experiments- Response Graph Method, ANOVA- attribute data analysis- Robust design- noise factors, Signal to noise ratios, Inner/outer OA design.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Able to apply experimental techniques to practical problems to improve quality of processes / products by optimizing the process / product parameters.

**TEXT BOOK:**

1. Krishnaiah K, and Shahabudeen P, "Applied Design of Experiments and Taguchi Methods", PHI, India, 2011.

**REFERENCES:**

1. Douglas C. Montgomery, "Design and Analysis of Experiments", John Wiley & sons, 2005
2. Phillip J. Ross, "Taguchi Techniques for Quality Engineering", Tata McGraw-Hill, India, 2005.

**OCH752**

**ENERGY TECHNOLOGY**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- Students will gain knowledge about different energy sources

**UNIT I ENERGY 8**

Introduction to energy – Global energy scene – Indian energy scene - Units of energy, conversion factors, general classification of energy, energy crisis, energy alternatives.

**UNIT II CONVENTIONAL ENERGY 8**

Conventional energy resources, Thermal, hydel and nuclear reactors, thermal, hydel and nuclear power plants, efficiency, merits and demerits of the above power plants, combustion processes, fluidized bed combustion.

**UNIT III NON-CONVENTIONAL ENERGY 10**

Solar energy, solar thermal systems, flat plate collectors, focusing collectors, solar water heating, solar cooling, solar distillation, solar refrigeration, solar dryers, solar pond, solar thermal power generation, solar energy application in India, energy plantations. Wind energy, types of windmills, types of wind rotors, Darrieus rotor and Gravian rotor, wind electric power generation, wind power in India, economics of wind farm, ocean wave energy conversion, ocean thermal energy conversion, tidal energy conversion, geothermal energy.

**UNIT IV BIOMASS ENERGY 10**

Biomass origin - Resources – Biomass estimation. Thermochemical conversion – Biological conversion, Chemical conversion – Hydrolysis & hydrogenation, solvolysis, biocrude, biodiesel power generation gasifier, biogas, integrated gasification.

**UNIT V ENERGY CONSERVATION 9**

Energy conservation - Act; Energy management importance, duties and responsibilities; Energy audit – Types methodology, reports, instruments. Benchmarking and energy performance, material and energy balance, thermal energy management.

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- Understand conventional Energy sources, Non- conventional Energy sources, biomass sources and develop design parameters for equipment to be used in Chemical process industries. Understand energy conservation in process industries

**TEXTBOOKS:**

1. Rao, S. and Parulekar, B.B., Energy Technology, Khanna Publishers, 2005.
2. Rai, G.D., Non-conventional Energy Sources, Khanna Publishers, New Delhi, 1984.
3. Nagpal, G.R., Power Plant Engineering, Khanna Publishers, 2008.
4. Energy Management, Paul W.O'Callaghan McGraw – Hill, 1993

**REFERENCES:**

1. Nejat Vezirog, Alternate Energy Sources, IT, McGraw Hill, New York.
2. El. Wakil, Power Plant Technology, Tata McGraw Hill, New York, 2002.
3. Sukhatme. S.P., Solar Energy - Thermal Collection and Storage, Tata McGraw hill, New Delhi, 1981.
4. Handbook of Energy Audit by 7th edition Albert Thumann, P.E., C.E.M & William J Younger C.E.M, Faiment Press 2008

**OCE751 ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT L T P C  
3 0 0 3**

**OBJECTIVE:**

- To impart the knowledge and skills to identify, assess and mitigate the environmental and social impacts of developmental projects

**UNIT I INTRODUCTION 9**

Impacts of Development on Environment – Rio Principles of Sustainable Development- Environmental Impact Assessment (EIA) – Objectives – Historical development – EIA Types – EIA in project cycle –EIA Notification and Legal Framework.

**UNIT II ENVIRONMENTAL ASSESSMENT 9**

Screening and Scoping in EIA – Drafting of Terms of Reference, Baseline monitoring, Prediction and Assessment of Impact on land, water, air, noise, flora and fauna - Matrices – Networks – Checklist Methods - Mathematical models for Impact prediction.

**UNIT III ENVIRONMENTAL MANAGEMENT PLAN 9**

Plan for mitigation of adverse impact on water, air and land, water, energy, flora and fauna – Environmental Monitoring Plan – EIA Report Preparation – Public Hearing-Environmental Clearance

**UNIT IV SOCIO ECONOMIC ASSESSMENT 9**

Baseline monitoring of Socio economic environment – Identification of Project Affected Personal – Rehabilitation and Resettlement Plan- Economic valuation of Environmental impacts – Cost benefit Analysis-

**UNIT V CASE STUDIES****9**

EIA case studies pertaining to Infrastructure Projects – Roads and Bridges – Mass Rapid Transport Systems - Airports - Dams and Irrigation projects - Power plants.

**TOTAL: 45 PERIODS****OUTCOMES:**

The students completing the course will have ability to

- carry out scoping and screening of developmental projects for environmental and social assessments
- explain different methodologies for environmental impact prediction and assessment
- plan environmental impact assessments and environmental management plans
- evaluate environmental impact assessment reports

**TEXTBOOKS:**

1. Canter, R.L, “Environmental impact Assessment “, 2nd Edition, McGraw Hill Inc, New Delhi,1995.
2. Lohani, B., J.W. Evans, H. Ludwig, R.R. Everitt, Richard A. Carpenter, and S.L. Tu, “Environmental Impact Assessment for Developing Countries in Asia”, Volume 1 – Overview, Asian Development Bank,1997.
3. Peter Morris, Riki Therivel “Methods of Environmental Impact Assessment”, Routledge Publishers,2009.

**REFERENCES:**

1. Becker H. A., Frank Vanclay,“The International handbook of social impact assessment” conceptual and methodological advances, Edward Elgar Publishing,2003.
2. Barry Sadler and Mary McCabe, “Environmental Impact Assessment Training Resource Manual”, United Nations Environment Programme,2002.
3. Judith Petts, “Handbook of Environmental Impact Assessment Vol. I and II”, Blackwell Science New York, 1998.
4. Ministry of Environment and Forests EIA Notification and Sectoral Guides, Government of India, New Delhi, 2010.

**OGI752****FUNDAMENTALS OF PLANETARY REMOTE SENSING****L T P C  
3 0 0 3****OBJECTIVES:**

- To provide an insight to the basics of planetary Remote Sensing
- To demonstrate how the Remote Sensing technique is applied to explore the surface characteristics of the planets and its environ.

**UNIT I PLANETARY SCIENCE****9**

History and inventory of solar system – planet-definition –properties – Formation of solar system. Planetary Atmospheres: composition - thermal structure – clouds – meteorology – photo chemistry – Eddy Diffusion. Surfaces and Interiors: Mineralogy and Petrology – Planetary interiors – surface morphology. Terrestrial planets and the Moon: The moon & Mercury – surface – Atmosphere – Interior – Magnetic Field.

**UNIT II SATELLITE ORBIT****9**

Equation of 2 body motion: Energy, orbits and energy – Circular Orbits-EOS Terra-Geosynchronous satellite orbit- orbital elements. Launching Satellites and space probes – Retrograde orbits-Inter planetary Transfer – Hohmann Transfer – Gravity Assist-Cassini-Messenger. Breaking into orbit or landing- Retro Rockets-Aerobraking- Parachutes- Impact.



**UNIT IV UTILITY OF SOLAR ENERGY IN BUILDINGS 9**

Utility of Solar energy in buildings concepts of Solar Passive Cooling and Heating of Buildings. Low Energy Cooling. Case studies of Solar Passive Cooled and Heated Buildings.

**UNIT V GREEN COMPOSITES FOR BUILDINGS 9**

Concepts of Green Composites. Water Utilisation in Buildings, Low Energy Approaches to Water Management. Management of Solid Wastes. Management of Sullage Water and Sewage. Urban Environment and Green Buildings. Green Cover and Built Environment.

**TOTAL: 45 PERIODS**

**TEXT BOOKS:**

1. K.S.Jagadish, B. U. Venkataramareddy and K. S. Nanjundarao. Alternative Building Materials and Technologies. New Age International, 2007.
2. Low Energy Cooling For Sustainable Buildings. John Wiley and Sons Ltd, 2009.
3. Sustainable Building Design Manual. Vol 1 and 2, Teri, New Delhi, 2004.

**REFERENCES:**

1. Osman Attmann Green Architecture Advanced Technologies and Materials. McGraw Hill, 2010.
2. Jerry Yudelson Green building Through Integrated Design. McGraw Hill, 2009.  
Fundamentals of Integrated Design for Sustainable Building By Marian Keeler, Bill Burke

**OME754**

**INDUSTRIAL SAFETY**

**L T P C  
3 0 0 3**

**OBJECTIVE :**

- To impart knowledge on safety engineering fundamentals and safety management practices.

**UNIT I INTRODUCTION 9**

Evolution of modern safety concepts – Fire prevention – Mechanical hazards – Boilers, Pressure vessels, Electrical Exposure.

**UNIT II CHEMICAL HAZARDS 9**

Chemical exposure – Toxic materials – Ionizing Radiation and Non-ionizing Radiation - Industrial Hygiene – Industrial Toxicology.

**UNIT III ENVIRONMENTAL CONTROL 9**

Industrial Health Hazards – Environmental Control – Industrial Noise - Noise measuring instruments, Control of Noise, Vibration, - Personal Protection.

**UNIT IV HAZARD ANALYSIS 9**

System Safety Analysis –Techniques – Fault Tree Analysis (FTA), Failure Modes and Effects Analysis (FMEA), HAZOP analysis and Risk Assessment



**UNIT V SAFETY REGULATIONS****9**

Explosions – Disaster management – catastrophe control, hazard control ,Safety education and training - Factories Act, Safety regulations Product safety – case studies.

**TOTAL : 45 PERIODS****OUTCOMES:**

- Students must be able to identify and prevent chemical, environmental mechanical, fire hazard through analysis and apply proper safety techniques on safety engineering and management.

**TEXT BOOK:**

1. John V.Grimaldi, “Safety Management”, AITB S Publishers, 2003.

**REFERENCES:**

1. Safety Manual, “EDEL Engineering Consultancy”, 2000.
2. David L.Goetsch, “Occupational Safety and Health for Technologists”, 5th Edition, Engineers and Managers, Pearson Education Ltd., 2005.

**OCS752****INTRODUCTION TO C PROGRAMMING****L T P C  
3 0 0 3****OBJECTIVES:**

- To develop C Programs using basic programming constructs
- To develop C programs using arrays and strings
- To develop applications in C using functions and structures

**UNIT I INTRODUCTION****9**

Structure of C program – Basics: Data Types – Constants –Variables - Keywords – Operators: Precedence and Associativity - Expressions - Input/Output statements, Assignment statements – Decision-making statements - Switch statement - Looping statements – Pre-processor directives - Compilation process – Exercise Programs: Check whether the required amount can be withdrawn based on the available amount – Menu-driven program to find the area of different shapes – Find the sum of even numbers

Text Book: Reema Thareja (Chapters 2,3)

**UNIT II ARRAYS****9**

Introduction to Arrays – One dimensional arrays: Declaration – Initialization - Accessing elements – Operations: Traversal, Insertion, Deletion, Searching - Two dimensional arrays: Declaration – Initialization - Accessing elements – Operations: Read – Print – Sum – Transpose – Exercise Programs: Print the number of positive and negative values present in the array – Sort the numbers using bubble sort - Find whether the given is matrix is diagonal or not.

Text Book: Reema Thareja (Chapters 5)

**UNIT III STRINGS****9**

Introduction to Strings - Reading and writing a string - String operations (without using built-in string functions): Length – Compare – Concatenate – Copy – Reverse – Substring – Insertion – Indexing – Deletion – Replacement – Array of strings – Introduction to Pointers – Pointer operators – Pointer arithmetic - Exercise programs: To find the frequency of a character in a string - To find the number of vowels, consonants and white spaces in a given text - Sorting the names.

Text Book: Reema Thareja (Chapters 6 & 7)

**UNIT IV FUNCTIONS****9**

Introduction to Functions – Types: User-defined and built-in functions - Function prototype - Function definition - Function call - Parameter passing: Pass by value - Pass by reference - Built-in functions (string functions) – Recursive functions – Exercise programs: Calculate the total amount of power consumed by 'n' devices (passing an array to a function) – Menu-driven program to count the numbers which are divisible by 3, 5 and by both (passing an array to a function) – Replace the punctuations from a given sentence by the space character (passing an array to a function)

Text Book: Reema Thareja (Chapters 4)

**UNIT V STRUCTURES****9**

Introduction to structures – Declaration – Initialization – Accessing the members – Nested Structures – Array of Structures – Structures and functions – Passing an entire structure – Exercise programs: Compute the age of a person using structure and functions (passing a structure to a function) – Compute the number of days an employee came late to the office by considering his arrival time for 30 days (Use array of structures and functions)

Text Book: Reema Thareja (Chapters 8)

**TOTAL:45 PERIODS****OUTCOMES:**

**Upon completion of this course, the students will be able to**

- Develop simple applications using basic constructs
- Develop applications using arrays and strings
- Develop applications using functions and structures

**TEXT BOOK :**

1. Reema Thareja, "Programming in C", Oxford University Press, Second Edition, 2016

**REFERENCES:**

1. Kernighan, B.W and Ritchie,D.M, "The C Programming language", Second Edition, Pearson Education, 2006
2. Paul Deitel and Harvey Deitel, "C How to Program", Seventh edition, Pearson Publication
3. Juneja, B. L and Anita Seth, "Programming in C", CENGAGE Learning India pvt. Ltd., 2011
4. Pradip Dey, Manas Ghosh, "Fundamentals of Computing and Programming in C", First Edition, Oxford University Press, 2009

**OAN751****LOW COST AUTOMATION****L T P C  
3 0 0 3****OBJECTIVES:**

- To give basic knowledge about automation
- To understand the basic hydraulics and pneumatics systems for automation
- To understand the assembly automation

**UNIT I AUTOMATION OF ASSEMBLY LINES****9**

Concept of automation - mechanization and automation - Concept of automation in industry - mechanization and automation - classification, balancing of assembly line using available algorithms - Transfer line-monitoring system (TLMS) using Line Status - Line efficiency - Buffer stock Simulation in assembly line

**UNIT II AUTOMATION USING HYDRAULIC SYSTEMS****9**

Design aspects of various elements of hydraulic systems such as pumps, valves, filters, reservoirs, accumulators, actuators, intensifiers etc. - Selection of hydraulic fluid, practical case studied on hydraulic circuit design and performance analysis - Servo valves, electro hydraulic valves, proportional valves and their applications.

**UNIT III AUTOMATION USING PNEUMATIC SYSTEMS 9**

Pneumatic fundamentals - control elements, position and pressure sensing -logic circuits - switching circuits - fringe conditions modules and these integration - sequential circuits - cascade methods - mapping methods – step counter method - compound circuit design - combination circuit design. Pneumatic equipments - selection of components - design calculations -application - fault finding – hydro pneumatic circuits - use of microprocessors for sequencing - PLC, Low cost automation - Robotic circuits.

**UNIT IV AUTOMATION USING ELECTRONIC SYSTEMS 9**

Introduction - various sensors – transducers - signal processing - servo systems - programming of microprocessors using 8085 instruction - programmable logic controllers

**UNIT V ASSEMBLY AUTOMATION 9**

Types and configurations - Parts delivery at workstations - Various vibratory and non vibratory devices for feeding - hopper feeders, rotary disc feeder, centrifugal and orientation - Product design for automated assembly.

**OUTCOMES:**

- Upon completion of this course, the students can able to do low cost automation systems
- Students can do some assembly automation

**TEXT BOOKS:**

1. Anthony Esposito, “Fluid Power with applications”, Prentice Hall international, 2009.
2. Mikell P Groover, “Automation, Production System and Computer Integrated Manufacturing”, Prentice Hall Publications, 2007.

**REFERENCES:**

1. Kuo .B.C, “Automatic control systems”, Prentice Hall India, New Delhi, 2007.
2. Peter Rohner, “Industrial hydraulic control”, Wiley Edition, 1995.
3. Mujumdar.S.R, “Pneumatic System”, Tata McGraw Hill 2006.

**OBT752**

**MICROBIOLOGY**

**L T P C**

**3 0 0 3**

**OBJECTIVE**

- To introduce students to the principles of Microbiology ,to emphasize the structure and biochemical aspects of various microbes.

**Microbial classification, Diseases,**

**UNIT I INTRODUCTION TO MICROBIOLOGY 9**

classification and nomenclature of microorganisms, microscopic examination of microorganisms: light, fluorescent, dark field, phase contrast, and electron microscopy.

**UNIT II MICROBES- STRUCTURE AND REPRODUCTION 9**

Structural organization and multiplication of bacteria, viruses (TMV, Hepatitis B), algae (cyanophyta, rhodophyta) and fungi (Neurospora), life history of actinomycetes (Streptomyces), yeast (Sacharomyces), mycoplasma (M. pneumoniae) and bacteriophages ( T4 phage,  $\lambda$  phage)

**UNIT III MICROBIAL NUTRITION, GROWTH AND METABOLISM 9**

Nutritional classification of microorganisms based on carbon, energy and electron sources. Definition of growth, balanced and unbalanced growth, growth curve and different methods to quantify bacterial growth: (counting chamber, viable count method, counting without equipment, different media used for bacterial culture (defined, complex, selective, differential, enriched) the mathematics of growth-generation time, specific growth rate.

**UNIT IV CONTROL OF MICROORGANISMS 9**

Physical and chemical control of microorganisms. Definition of sterilization, dry and moist heat, pasteurization, tyndalization; radiation, ultrasonication, filtration. Disinfection, sanitization, antiseptics, sterilants and fumigation. mode of action and resistance to antibiotics; clinically important microorganisms.

**UNIT V INDUSTRIAL MICROBIOLOGY 9**

Microbes involved in preservation (Lactobacillus, bacteriocins), spoilage of food and food borne pathogens (*E.coli*, *S.aureus*, *Bacillus*, *Clostridium*). Industrial use of microbes (production of penicillin, alcohol, vitamin B-12); biogas; bioremediation (oil spillage leaching of ores by microorganisms, pollution control); biofertilizers, biopesticides. Biosensors.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- To provide to the students the fundamentals of Microbiology, the scope of microbiology and solve the problems in microbial infection and their control,

**TEXT BOOKS:**

1. Pelczar, M.J. "Microbiology", 5th Edition, Tata McGraw-Hill, 1993.
2. Prescott. Harley, Klein. "Microbiology": McGraw-Hill Higher Education, 2008
3. Ananthanarayanan, R. and C.K. Jayaram Paniker, "Textbook of Microbiology", 4th Edition, Orient Longman, 1990.

**OCH751 PROCESS MODELING AND SIMULATION L T P C  
3 0 0 3**

**OBJECTIVE:**

- To give an overview of various methods of process modeling, different computational techniques for simulation.

**UNIT I INTRODUCTION 7**

Introduction to modeling and simulation, classification of mathematical models, conservation equations and auxiliary relations.

**UNIT II STEADY STATE LUMPED SYSTEMS 9**

Degree of freedom analysis, single and network of process units, systems yielding linear and non-linear algebraic equations, flow sheeting – sequential modular and equation oriented approach, tearing, partitioning and precedence ordering, solution of linear and non-linear algebraic equations.

**UNIT III UNSTEADY STATE LUMPED SYSTEMS 9**

Analysis of liquid level tank, gravity flow tank, jacketed stirred tank heater, reactors, flash and distillation column, solution of ODE initial value problems, matrix differential equations, simulation of closed loop systems.

**UNIT IV STEADY STATE DISTRIBUTED SYSTEM 7**

Analysis of compressible flow, heat exchanger, packed columns, plug flow reactor, solution of ODE boundary value problems.

**UNIT V UNSTEADY STATE DISTRIBUTED SYSTEM & OTHER  
MODELLING APPROACHES**

**13**

Analysis laminar flow in pipe, sedimentation, boundary layer flow, conduction, heat exchanger, heat transfer in packed bed, diffusion, packed bed adsorption, plug flow reactor. Empirical modeling, parameter estimation, population balance and stochastic modeling.

**TOTAL : 45 PERIODS**

**OUTCOME:**

- Upon completing the course, the student should have understood the development of process models based on conservation principles and process data and computational techniques to solve the process models.

**TEXT BOOKS:**

1. Ramirez, W.; " Computational Methods in Process Simulation ", 2nd Edn., Butterworths Publishers, New York, 2000.
2. Luyben, W.L., " Process Modelling Simulation and Control ", 2nd Edn, McGraw-Hill Book Co., 1990

**REFERENCES:**

1. Felder, R. M. and Rousseau, R. W., " Elementary Principles of Chemical Processes ", John Wiley, 2000.
2. Franks, R. G. E., " Mathematical Modelling in Chemical Engineering ", John Wiley, 1967.
3. Amiya K. Jana, "Process Simulation and Control Using ASPEN", 2<sup>nd</sup> Edn, PHI Learning Ltd (2012).
4. Amiya K. Jana, "Chemical Process Modelling and Computer Simulation" 2<sup>nd</sup> Edn, PHI Learning Ltd, (2012).

**OIE751**

**ROBOTICS**

**L T P C  
3 0 0 3**

**OBJECTIVES:**

- To understand the functions of the basic components of a Robot.
- To study the use of various types of End of Effectors and Sensors
- To impart knowledge in Robot Kinematics and Programming
- To learn Robot safety issues and economics.

**UNIT I FUNDAMENTALS OF ROBOT**

**6**

Robot - Definition - Robot Anatomy - Co ordinate Systems, Work Envelope Types and Classification- Specifications-Pitch, Yaw, Roll, Joint Notations, Speed of Motion, Pay Load- Robot Parts and their Functions-Need for Robots-Different Applications.

**UNIT II ROBOT DRIVE SYSTEMS AND END EFFECTORS**

**9**

Pneumatic Drives-Hydraulic Drives-Mechanical Drives-Electrical Drives-D.C. Servo Motors, Stepper Motors, A.C. Servo Motors-Salient Features, Applications and Comparison of all these Drives, End Effectors-Grippers-Mechanical Grippers, Pneumatic and Hydraulic- Grippers, Magnetic Grippers,

Vacuum Grippers; Two Fingere d and Three Fingere d Grippers; Internal Grippers and External Grippers; Selection and Design Considerations.

**UNIT III SENSORS AND MACHINE VISION**

**12**

Requirements of a sensor, Principles and Applications of the following types of sensors- Position sensors - Piezo Electric Sensor, LVDT, Resolvers, Optical Encoders, pneumatic Position Sensors, Range Sensors Triangulations Principles, Structured, Lighting Approach, Time of Flight, Range

Finders, Laser Range Meters, Touch Sensors ,binary Sensors., Analog Sensors, Wrist Sensors, Compliance Sensors, Slip Sensors, Camera, Frame Grabber, Sensing and Digitizing Image Data-Signal Conversion, Image Storage, Lighting Techniques, Image Processing and Analysis-Data Reduction, Segmentation, Feature Extraction, Object Recognition, Other Algorithms, Applications-Inspection, Identification, Visual Servicing and Navigation.

**UNIT IV                    ROBOT KINEMATICS AND ROBOT PROGRAMMING                    13**

Forward Kinematics, Inverse Kinematics and Difference; Forward Kinematics and Reverse Kinematics of manipulators with Two, Three Degrees of Freedom (in 2 Dimension), Four Degrees of freedom (in 3 Dimension) Jacobians, Velocity and Forces-Manipulator Dynamics, Trajectory Generator, Manipulator Mechanism Design-Derivations and problems. Lead through Programming, Robot programming Languages-VAL Programming-Motion Commands, Sensor Commands, End Effector commands and simple Programs.

**UNIT V                    IMPLEMENTATION AND ROBOT ECONOMICS                    5**

RGV, AGV; Implementation of Robots in Industries-Variou Steps; Safety Considerations for Robot Operations - Economic Analysis of Robots.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- Upon completion of this course, the students can able to apply the basic engineering knowledge for the design of robotics

**TEXT BOOKS:**

1. Klafter R.D., Chmielewski T.A and Negin M., “Robotic Engineering - An Integrated Approach”, Prentice Hall, 2003.
2. Groover M.P., “Industrial Robotics -Technology Programming and Applications”, McGraw Hill, 2001.

**REFERENCES:**

1. Craig J.J., “Introduction to Robotics Mechanics and Control”, Pearson Education, 2008.
2. Deb S.R., “Robotics Technology and Flexible Automation” Tata McGraw Hill Book Co., 1994.
3. Koren Y., “Robotics for Engineers”, Mc Graw Hill Book Co., 1992.
4. Fu.K.S.,Gonzalz R.C. and Lee C.S.G., “Robotics Control, Sensing, Vision and Intelligence”, McGraw Hill Book Co., 1987.
5. Janakiraman P.A., “Robotics and Image Processing”, Tata McGraw Hill, 1995.
6. Rajput R.K., “Robotics and Industrial Automation”, S.Chand and Company, 2008.
7. Surender Kumar, “Industrial Robots and Computer Integrated Manufacturing”, Oxford and IBH Publishing Co. Pvt. Ltd., 1991.

**OME752**

**SUPPLY CHAIN MANAGEMENT**

**L T P C  
3 0 0 3**

**OBJECTIVE:**

- To provide an insight on the fundamentals of supply chain networks, tools and techniques.

**UNIT I                    INTRODUCTION                    9**

Role of Logistics and Supply chain Management: Scope and Importance- Evolution of Supply Chain - Decision Phases in Supply Chain - Competitive and Supply chain Strategies – Drivers of Supply Chain Performance and Obstacles.

**UNIT II                    SUPPLY CHAIN NETWORK DESIGN                    9**

Role of Distribution in Supply Chain – Factors influencing Distribution network design – Design options for Distribution Network Distribution Network in Practice-Role of network Design in Supply Chain – Framework for network Decisions.

**UNIT III LOGISTICS IN SUPPLY CHAIN 9**

Role of transportation in supply chain – factors affecting transportations decision – Design option for transportation network – Tailored transportation – Routing and scheduling in transportation.

**UNIT IV SOURCING AND COORDINATION IN SUPPLY CHAIN 9**

Role of sourcing supply chain supplier selection assessment and contracts- Design collaboration - sourcing planning and analysis - supply chain co-ordination - Bull whip effect – Effect of lack of co-ordination in supply chain and obstacles – Building strategic partnerships and trust within a supply chain.

**UNIT V SUPPLY CHAIN AND INFORMATION TECHNOLOGY 9**

The role IT in supply chain- The supply chain IT frame work Customer Relationship Management – Internal supply chain management – supplier relationship management – future of IT in supply chain – E-Business in supply chain.

**TOTAL: 45 PERIODS**

**OUTCOME:**

- The student would understand the framework and scope of supply chain networks and functions.

**TEXTBOOK:**

1. Sunil Chopra, Peter Meindl and Kalra, “Supply Chain Management, Strategy, Planning, and Operation”, Pearson Education, 2010.

**REFERENCES:**

1. Jeremy F.Shapiro, “Modeling the Supply Chain”, Thomson Duxbury, 2002.
2. Srinivasan G.S, “Quantitative models in Operations and Supply Chain Management, PHI, 2010
3. David J.Bloomberg , Stephen Lemay and Joe B.Hanna, “Logistics”, PHI 2002.
4. James B.Ayers, “Handbook of Supply Chain Management”, St.Lucle press, 2000.

**OME753 SYSTEMS ENGINEERING L T P C  
3 0 0 3**

**OBJECTIVE:**

- To introduce system engineering concepts to design the manufacturing system for optimum utilization of source for effective functioning.

**UNIT I INTRODUCTION 9**

Definitions of Systems Engineering, Systems Engineering Knowledge, Life cycles, Life-cycle phases, logical steps of systems engineering, Frame works for systems engineering.

**UNIT II SYSTEMS ENGINEERING PROCESSES 9**

Formulation of issues with a case study, Value system design, Functional analysis, Business Process Reengineering, Quality function deployment, System synthesis, Approaches for generation of alternatives.

**UNIT III ANALYSIS OF ALTERNATIVES- I 9**

Cross-impact analysis, Structural modeling tools, System Dynamics models with case studies, Economic models: present value analysis – NPV, Benefits and costs over time, ROI, IRR; Work and Cost breakdown structure,

**UNIT IV ANALYSIS OF ALTERNATIVES-II 9**

Reliability, Availability, Maintainability, and Supportability models; Stochastic networks and Markov models, Queuing network optimization, Time series and Regression models, Evaluation of large scale models

**UNIT V DECISION ASSESSMENT 9**

Decision assessment types, Five types of decision assessment efforts, Utility theory, Group decision making and Voting approaches, Social welfare function; Systems Engineering methods for Systems Engineering Management,

**TOTAL : 45 PERIODS**

**OUTCOMES:**

- The Student must be able to apply systems engineering principles to make decision for optimization.
- Hence an understanding of the systems engineering discipline and be able to use the core principles and processes for designing effective system.

**TEXT BOOK:**

1. Andrew P. Sage, James E. Armstrong Jr. "Introduction to Systems Engineering", John Wiley and Sons, Inc,2000.