PROPOSED STRUCTURE OF B.Sc. (Renewable Energy)

(To be established from Academic Year 2013-2014)

Objectives of the Course:-

The objectives of the B.Sc. (Renewable Energy) Course shall be as follows:-

1. To develop the human recourse in Renewable Energy sector which is the need of the hour.
2. To create the people who will teach the science of Renewable Energy, this will be also helpful for the promotion of Research in this field.
3. To create several self-employment opportunities in renewable energy and energy efficiency sectors for modestly-trained and self-trained human resources exist in all geographic locations of the country.
4. It will help to develop the skills required in renewable energy and energy management fields.
5. To develop proficiencies and skills for becoming successful scientist, technicians in RE sector.
6. To develop the expertise for the innovation of different skills and its implementation in RE Sector.
7. To explore the different techniques in RE sector.

Eligibility:-

- Higher Secondary Certificate (10+2) or its equivalent Examination with English with any three science subjects such as Physics, Chemistry, Biology, Mathematics, etc.
- Higher Secondary school Certificate (10+2) Examination with English and any of the following vocational subjects in technical group of +2 level.
  Subjects are:
  i. Electrical Maintenance
  ii. Mechanical Maintenance
  iii. General Civil Engineering
  iv. Electronics
  v. Computer Science
  vi. Information Technology
  vii. Electronics Technology

Admission Process:-

Admission process is based on the Merit as applicable to general B.Sc. course of University of Pune.
Reservation and relaxation will be as per the rules of University of Pune and Government of Maharashtra.

Medium of Instruction:-

The medium of instruction for the course shall be English.

Duration:-

The duration of B.Sc. (Renewable Energy) course shall be of Three years.

Standard of Passing:-

Standard of passing will be as per general B.Sc. degree course of University of Pune.

Rules of A.T.K.T.:-

Rules of A.T.K.T. rules will be as per general course of University of Pune.

Fees:-

Fees of the course will be decided by competent authority of university.

Qualification of Teacher:- The teachers to be appointed for B.Sc. Renewable Energy Course should be having following qualification:

i. M.Sc. (Physics / Chemistry / Mathematics)
ii. M.Sc. / M-Tech (Energy Studies)
iii. ME / M-Tech (Mechanical / Electrical with Renewable Energy Socialization)
iv. ME / M-Tech (Energy Management & Energy Conservation)

Examination Pattern:-

1. **First Year: Total Marks 1200 Marks (Annual Pattern)**

800 Marks for Theory Papers

400 Marks for Practicals

Examinations will be conducted as per the University Guidelines.

2. **Second and Third Year: (Semester Pattern)**

The Semester Pattern followed for B.Sc. Degree will be applicable.

600 Marks (50 marks for each paper) for 6 Theory Papers per semester.
300 Marks for 3 Practical Courses per year.

***Note:-Second & Third Year Practical Examination for all the Six Practical Courses will be conducted at the end of the respective Academic Year. Each Practical Course will be evaluated for 50 marks. Total Marks for Practical examination is 300. i.e.**

SECOND YEAR PRACTICAL EXAMINATION (Each Practical for 100 Marks)

1. **Practical Paper I -** Practical Course Paper-I (Sem. I) + Practical Course Paper-I (Sem. II)
2. **Practical Paper II -** Practical Course Paper-II (Sem. I) + Practical Course Paper-II (Sem. II)

3. **Practical Paper III -**Practical Course Paper-III (Sem. I) + Practical Course Paper-III (Sem. II)

THIRD YEAR PRACTICAL EXAMINATION (Each Practical for 100 Marks)

1. **Practical Paper I -** Practical Course Paper-I (Sem.III) + Practical Course Paper-I (Sem. IV)
2. **Practical Paper II -** Practical Course Paper-II (Sem. III) + Practical Course Paper-II (Sem. IV)
3. **Practical Paper III -**Practical Course Paper-III (Sem.III) + Practical Course Paper-III (Sem. IV)

Examinations will be conducted as per the University Guidelines.

Syllabus Framework :- (Structure)

1) First Year B.Sc. (Renewable Energy)

Theory Course:-

A. Physics

i. Mechanics and Heat & Thermodynamics
ii. Emerging Physics and Electricity & Magnetism

B. Chemistry

i. Physical & Inorganic Chemistry
ii. Organic & Inorganic Chemistry

C. Mathematics

i. Algebra and Geometry
ii. Calculus

D. Renewable Energy

i. Fundamentals of Energy Systems
ii. Energy Conversion System

*** Theory & Practical Course Examination shall be conducted at the end of the Year (Annual Pattern). Rules for paper setting & assessment are according to B.Sc. examinations.**

2) Second Year B.Sc. (Renewable Energy)

Semester - I (*Theory Courses*)

A. Physics

i. Mathematical Methods in Physics
ii. Electronics / Instrumentation*

B. Chemistry

i. Physical Chemistry
ii. Organic Chemistry

C. Renewable Energy

i. Solar Photovoltaic Energy Conversion – 1

ii. Bio-Energy – 1 (Biochemical Conversion Systems)

Practical Course:- Number of Practicals – 3

Semester – II (*Theory Courses*)

A. Physics

i. Oscillations, Waves and Sound
ii. Optics

B. Chemistry

i. Inorganic Chemistry
ii. Analytical Chemistry

C. Renewable Energy

i. Solar Photovoltaic Energy Conversion - 2
ii. Bio-Energy – 2 (Thermo-chemical Conversion Of Biomass)

Practical Course: - Number of Practicals - 3

Note: - Examination for all the Six Practical Courses will be conducted at the end of Academic Year.

3) Third Year B.Sc. (Renewable Energy)

Semester - I (*Theory Courses*)

Renewable Energy

i. Solar Thermal Energy - 1
ii. Wind Energy - 1
iii. Energy Storage System - 1
iv. Other Renewable Energy sources - 1
v. Energy Efficiency in Building & ECBC
vi. Energy Management

Practical Course:- Number of Practicals – 3

Project Work

Semester – II (*Theory Courses*)

Renewable Energy

i. Solar Thermal Energy - 2
ii. Wind Energy - 2
iii. Energy Storage System - 2
iv. Other Renewable Energy Sources - 2
v. Project Management
vi. Energy & Environment
vii. Project

Practical Course:- Number of Practicals – 3

Project Work

Note: - Examination for all the Six Practical Courses will be conducted at the end of Academic Year.

Detailed Syllabus of B.Sc. Renewable Energy Course

F. Y. B. Sc.	
Semester - I	
Paper No. 1	**Marks: 50**
PHYSICS	**No. of Lectures: 36**

Sr. No.	Details	No. of Lectures
	MECHANICS	
1.	**Kinematics** 1.1 Displacement, Time and Average Velocity (x-t graph illustrations to be included) 1.2 Instantaneous Velocity (Finding of velocity on an x-t graph) 1.3 Average and Instantaneous Acceleration (Illustration with v – t and a – t graph) 1.4 Motion with Constant Acceleration (Illustration with a – t and v – t graph) 1.5 Freely Falling Bodies (Up and Down motion in fall with y-t and vy-t graph) 1.6 Velocity and Position by Integration 1.7 Position and Velocity Vectors 1.8 Acceleration Vector 1.9 Problems	**8**
2.	**Newton's laws of motion** 2.1 Newton's First and Second Law and their explanation 2.2 Working with Newton's First and Second Law 2.3 Newton's Third Law of motion and its explanation with problems, Various types of forces in nature (explanation) 2.4 Pseudo Forces (e.g. Centrifugal Force) 2.5 Problems	**6**
3.	**Work and Energy** 3.1 Kinetic Energy 3.2 Work and Work-Energy Theorem 3.3 Calculation of Work done with i) Constant Force ii) Spring Force 3.4 Work-Energy Theorem	**8**

	3.5 Potential Energy 3.6 Conservative and Non-conservative Forces 3.7 Definition of potential energy and conservation of Mechanical energy 3.8 Change in the potential energy in a rigid body motion 3.9 Mass-energy equivalence, problems	
4.	**Surface Tension** 4.1 Surface Tension (Definition), Angle of Contact, Revision of Capillary Rise Method. 4.2 Rise of liquid in capillary tube of insufficient length 4.3 Rise of liquid in a conical capillary tube. 4.4 Energy required to raise a liquid in capillary tube. 4.5 Rise of liquid between two parallel plates. 4.6 Factors affecting surface tension. 4.7 Jeager's Method for Determination of surface tension 4.8 Applications of Surface Tension	**5**
5.	**Viscosity and Fluid Mechanics** 5.1 Fluids, Friction in Solid surfaces in contact verses Friction in Fluid 5.2 Pressure in a fluid (a) Definition of buoyancy 5.3 Pascal's law 5.4 Atmospheric Pressure and Barometer 5.5 Archimedes' Principle 5.6 Pressure difference and Buoyant Force in accelerating fluids 5.7 Steady and Turbulent Flow. 5.8 Equation of continuity 5.9 Bernoulli's Principle 5.10 Application of Bernoulli's equation i. Speed of Efflux ii. Venturi meter iii. Aspirator Pump iv. Change of plane of motion of a spinning ball. v. Atomiser or spray 5.11 Aerodynamics, Concept of Aerofoil, Forces acting on aerofoil.	**9**

MECHANICS

Reference Books:

1. University Physics, Sears and Zeemansky XIth edition, Pearson education.
2. Concepts of Physics H.C. Varma Bharati Bhavan Publishers
3. Problems in Physics P.K. Srivastava Wiley Eastern Ltd.
4. Applied Fluid Mechanics, Mott Robert Pearson Benjamin Cummir, VI Edition, Pearson Education/Prentice Hall International, New Delhi.
5. Properties of Matter, D. S. Mathur, Shamlal Chritable Trust New Delhi.

F. Y. B. Sc.	
Semester - I	
Paper No. 2	**Marks : 50**
PHYSICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	HEAT AND THERMODYNAMICS	
1	**Basic Concepts of Thermodynamics** 1.1 Thermodynamic state of a system 1.2 Thermal Equilibrium 1.3 Zeroth law of Thermodynamics 1.4 Internal Energy of System-Concept of heat 1.5 Equation of State : The Ideal Gas Equation 1.6 Indicator Diagram 1.7 First law of Thermodynamics 1.8 Thermodynamic Process-Isothermal, Adiabatic, Isobaric, Isochoric. 1.9 Adiabatic relations of system for perfect gas. 1.10 Work done during Isothermal and Adiabatic changes. 1.11 Reversible and Irreversible changes. 1.12 Problems	**6**
2	**Second Law of Thermodynamics: Entropy** 2.1 Conversion of Heat into Work and its converse 2.2 Reversible and Irreversible Processes. 2.3 Examples of Irreversible Processes. 2.4 Carnot's Cycle and Carnot's Heat Engine and its efficiency 2.5 Second law of Thermodynamics: Statements 2.6 Carnot Theorem 2.7 Entropy 2.8 Principle of Increase in Entropy 2.9 Generalised form of the First and Second laws: i Entropy changes for an Ideal Gas. ii Entropy of van der Waals' gas. iii Problems	**9**
3	**Heat engines & Refrigerators** 3.1 Heat Engines 3.1.1 Otto cycle and its efficiency 3.1.2 Diesel cycle and its efficiency 3.1.3 Comparison between Otto and Diesel cycle 3.2 Refrigerators:	**9**

	3.2.1 General Principle and Coefficient of performance of refrigerator & Heat Pump 3.2.2 The Carnot Refrigerator & Heat Pump 3.2.3 Simple structure of vapour compression refrigerator 3.3 Air conditioning: principle and its applications 3.4 Problems	
4	**Equation of state and Thermodynamic relations** 4.1 Various equations of state 4.2 Andrew's experiment 4.3 Amagat's experiment 4.4 van der Waals' equation of state, Critical constants, 4.5 Reduced equation of state 4.6 Thermodynamic functions: Internal energy, Helmholtz' function, Enthalpy, Gibb's function. 4.7 Problems	**8**
5	**Thermometry** 5.1 Principle and Types of Thermometry 5.2 Gas filled and Liquid Filled Thermometers 5.3 Problems	**4**

HEAT AND THERMODYNAMICS

Reference Books:

1. Physics, 4th Edition, Volume I, Resnick/Halliday/Krane JOHN WILEY & SONS (SEA) PTE LTD.
2. Heat and Thermodynamics Mark. W. Zemansky, Richard H. Dittman Seventh Edition, McGraw-Hill International Editions.
3. Thermal Physics (Heat & Thermodynamics) A.B. Gupta, H.P. Roy Books and Allied (P) Ltd, Calcutta.
4. Heat and Thermodynamics Brijlal, N. Subrahmanyam S. Chand & Company Ltd, New Delhi.
5. Thermodynamics and Statistical Physics J.K. Sharma, K.K. Sarkar, Himalaya Publishing House.
6. Concept of Physics H.C. Verma Bharati Bhavan Publishers

F. Y. B. Sc.	
Semester - I	
Paper No. 3	**Marks : 50**
CHEMISTRY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
PHYSICAL & INORGANIC CHEMISTERYCHEMISTRY		
1	**Chemical Mathematics:-** 1.1 Logarithm: Rules of logarithm, Characteristic and mantissa, Change of sign 1.2 Graphical representation of equations: Rules for drawing graph co-ordinates etc., Equation of straight line, slope and intercept, plotting the graph from the data of chemical properties and problems. 1.3 Derivative: Rules of differentiation and partial differentiation, Algebraic, logarithmic and exponential functions and problems. 1.4 Integration: Rules of integration, Algebraic and exponential functions and problems.	**10**
2	**Gaseous and Liquids State:-** 2.1 Ideal and non- ideal gases, deviation of gases from ideal behavior, compressibility factor (Z), van der Waal's equation of state and its application to explain deviation of gases. 2.2 Critical constant of gas in terms of van der Waal's constant, Experimental determination of Pc, Tc and Vc, Reduced equation of state, Law of corresponding state. 2.3 Measurable physical properties of liquid such as vapour pressure, Surface tension and viscosity and their experimental determination (One method of each)	**8**
3	**Chemical Thermodynamics:-** 3.1 Second law of thermodynamics, Carnot cycle, mechanical efficiency 3.2 Entropy changes for system and surroundings for reversible and irreversible processes 3.3 Entropy changes for an ideal gas in isothermal, isobaric and isochoric changes 3.4 Entropy Changes in chemical reactions. Entropy changes accompanying fusion.	**6**

4	**Chemistry of hydrogen** 4.1 Position of hydrogen in periodic table, 4.2 Isotopes of Hydrogen, 4.3 properties of Isotopes, heavy water, its preparation and application	**4**
5	**Hydrogen bonding** 5.1 Types of hydrogen, bonding 5.2 Effect of hydrogen boding on physical properties of substances like. a) Physical State b) MP & BP c) Solubility d) Viscosity	**2**
6	**Stoichiometry** 6.1 Mole concept, Determination of mole wt. By gram molecular volume relationship, problems based on mole concept. 6.2 Methods of expressing concentrations, strength, Normality, Molarity & Molality, ppm. 6.3 Standardization of solutions, primary and secondary standard substances. 6.4 Preparation of standard solution of acids and bases, problems related to acid base titrations only	**6**

Reference Books :-(1 2 & 3)

1. Mathematical preparation for physical Chemistry By F. Daniel, Mc. Graw Hill publication.
2. University General Chemistry. By C.N. R. Rao Mc. Millan Publication.
3. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
4. Physical Chemistry. By G.M. Barrow.

Text Books (for Chapter 4 & 5)

1. Concise Inorganic Chemistry By J.D. Lee, Chapman & Hall 5th Ed. (1996) (Page No. 240 – 247)
2. Advanced Inorganic Chemistry by Satya Prakash Tuli, Basu & Madan 6th edn. (page 301 – 303, 311-318, 319-322)
3. A new guide to Modern Valency Theory by G.I. Brown (Pages 142 – 149, 154 – 160)

References: (6)

1. College Chemistry by Linus Paulling (Page 165 to 171)
2. Calculation of Analytical Chemistry by Hamilton, Simpson &Ellis 7th Edn. (Pages 154 – 199)
3. Quantitative Inorganic Analysis by A.I Vogal. (Page 257-262)
4. Analytical Chemistry by G.D. Christian relevant pages.

F. Y. B. Sc.	
Semester - I	
Paper No. 4	**Marks : 50**
CHEMISTRY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	ORGANIC & INORGANIC CHEMISTRY	
1	**Introduction to Organic Chemistry.-** 1.1 Development of organic chemistry, unique Properties of organic compounds. 1.2 Sources of organic compounds, applications of organic compounds.	**2**
2.	**Structure & Bonding in organic Molecules:-** 2.1 Covalent bond, Hybridization in organic molecules (sp3, sp2, sp), bond length, bond angles, bond energies, localized & delocalized chemical bond, vander Waal's interactions, Inter & Intra molecular forces & their effects on physical properties. 2.2 Structural effects like inductive, Resonance, Hyper conjugation, steric effect, Hydrogen bounding	**8**
3	**Isomerism in organic compounds:-** 3.1 Concept of isomerism, type, (Structural chain, position, functional group) 3.2 Representation of organic, Molecules – zig- zag structures, projection formulae – (Saw horse (Andiron), Newman, Fisher & Dotted – wedge) 3.3 Conformational isomerism in alkanes, free rotation about carbon- carbon single bond, conformation of ethane, propane n, butane , relative stability of different conformations. 3.4 Optical isomers – Isomer number & tetrahedral carbon atom chirality, optical isomerism with one asymmetric carbon atom, Polarimeter, Specific rotation, Enantiomerism R & S Nomenclature. 3.5 Geometrical isomerism – Definition, conditions for geometrical isomerism, cis-trans & E-Z nomenclature, physical & chemical properties of geometrical isomerism	**10**
4	**Modern Periodic table and electronic configurations of elements:-**	**4**

	4.1 Electronic Configuration of Elements, Aufbau principle, Hund's rule of Maximum multiplicity, (n+1) rules, shapes of s, p, and d orbital, Paulis exclusion Principle, Heisenberg's uncertainty principle and problems based on uncertainty in velocity and position 4.2 Periodic table Types of elements: inert gases, representative elements, transition and inner transition elements, Blocks in periodic table S, p, d & f blocks. 4.3 Nomenclature of super heavy elements periodic law periodicity in properties throughout the periodic table (Only general trends in each block.) a) Size and atoms of ions. b) Ionisation energy c) Electron affinity d) Electro negativity. 4.4 Shielding effect and shielding constant, Slater's rule to calculate shielding constant, numerical Problems bases on shielding constant.	
5	**Oxidation & Reduction:-** 5.1 Introduction, definition of related terms like oxidation, reduction, oxidizing agent and reducing agent. 5.2 Balancing of redox reaction using ion electron method and oxidation number method. 5.3 Rules to find oxidation number. 5.4 Problems based on equivalent weight of oxidant and reluctant.	**8**
6	**Chemistry of Alkanes** 6.1 Classification 6.2 Higher Alkanes Homologous Series 6.3 Nomenclature 6.4 Physical Properties 6.5 Laboratory Methods of Preparation 6.6 Industrial Methods of Preparation 6.7 Reactions of Alkanes 6.8 Combustion, Pyrolysis, Cracking 6.9 Analysis of Alkanes	**4**

References (Organic Chemistry)

1. Ref 1 : 1 to 12
2. Ref : - 2, Sec. 1.8 to 1.22, pages – 45 to 72.
   Ref : 3 : Sec. 1.2 to 1.6 , Pages – 4 to 26
3. Ref. 2 Sec. 4.1 to 4.11, 4.13 to 4.16, Pages – 161 to 179, sec. 8.7 , pages 315 to 318.
4. Ref. 2. Sec, 3.1, 3.6 to 3.15, 3.18, 3.34, Pages. – 113, 114, 122 to 135, 138, 139, 158.

References: (Inorganic Chemistry)

1. Consicse Inorganic Chemistry by J.D. Lee, Chaman and Hall, 5th edn. (1996) (Pages 17 to 24).
2. Theoretical Inorganic Chemistry by Day & Selbin.
3. Chemistry by Raymond Chang (pages 292 – 314)
4. Concepts, Models of inorganic chemistry by B. Douglas & D. Mc. Daniels, J. Alexander, Mohan wiley & sons 3rd Edn (2007) Relevant Pages.

F. Y. B. Sc.	
Semester - I	
Paper No. 5	**Marks : 50**
MATHEMATICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	ALGEBRA AND GEOMETRY - II	
1.	**Sets** 1.1 Power set of a set, Product of two sets. 1.2 Equivalence relations, partitions of sets, Equivalence classes	**4**
2.	**Functions** 2. 1 Definition of a function. Domain, co- domain and the range of a function. Review of injective, surjective and bijective functions, Composition of functions. Invertible functions and the inverse of a function. 2. 2 Binary operations.	**4**
3.	**Integers** 3.1 Well Ordering Property (W.O.P) for N. 3.2 Divisibility in Z: Definition and elementary properties. Division Algorithm, G.C.D. and L.C.M of two integers. Basic properties of G.C.D. including G.C.D. for any two integers a and b if it exists, is unique, and can be expressed as ua+vb. Euclidean Algorithm. 3.3 Primes. Euclid's Lemma, Unique Factorization Theorem. 3.4 Congruences: Definition and elementary properties. The set Zn. Fermat's Theorem. Euler phi-function. Addition modulo n, multiplication modulo n and its properties.	**14**
4.	**Complex Numbers** 4.1 Addition and multiplication of complex numbers, Modulus and amplitude of a complex number. Real and imaginary parts and the conjugate of a complex number. Geometric representation of the sum, difference, product and quotient of two complex numbers as well as of the modulus, amplitude and the conjugate of a complex number. 4.2 De-Moivre's Theorem. Roots of unity. Solutions of the equation wn = z.	**10**
5.	**Polynomials** 5.1 The set Q[x] of polynomials in one variable with rational coefficients. Division Algorithm (without proof). G.C.D of two polynomial (without proof) 5.2 Remainder Theorem, Factor Theorem (with proof). 5.3 Relation between the roots and the coefficients of a polynomial. Examples.	**4**

TEXT BOOKS:

1. Complex Variables and Applications: Ruel. V.Churchill; McGraw Hill Co.
2. Elementary Number Theory: David Burton; Tata McGraw Hill (Walter Rudin Series), Indian Edition.
3. Matrices : Shanti Narayan; S.Chand & Co. N. Delhi
4. Analytical Geometry of Two and Three Dimensions: Qazi Zameeruddin; Narosa Publ.

F. Y. B. Sc.	
Semester - I	
Paper No. 6	**Marks : 50**
MATHEMATICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	CALCULUS - I	
1.	**The Real Numbers** 1. 1 Algebraic and order properties of R 1. 2 Absolute Value and the Real Line 1. 3 The Completeness Property of R 1. 4 Applications of the Supremum Property	**8**
2.	**Sequences of Real Numbers** 2. 1 Sequences and their Limits 2. 2 Limit Theorems 2. 3 Monotone Sequences 2. 4 Subsequences and Bolzano - Weierstrass Theorem 2. 5 The Cauchy criterion 2. 6 Properly divergent sequences 2. 7 Introduction to infinite series	**20**
3.	**Limits** 3. 1 Limits of Functions 3. 2 Limit Theorem 3. 3 Some Extensions of Limit Concepts	**8**

Text Books:

1. Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, Third Edition, John Wiley and Sons, 2002
   Sections :
   First Term: 2.1, 2.2, 2.3, 2.4, 3.1 to 3.7 , 4.1, 4.2, 4.3
   Second Term : 5.1, 5.2, 5.3, 6.1, 6.2, 6.3, 6.4

2. Differential Calculus, Shantinarayan, 7^{th} Edition, S. Chand and Co. Publication Chapter 5

Reference Books :

1. A Course in Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer 2006.

2. Principles of Mathematical Analysis, W. Rudin, Third Edition, McGraw Hill, 1976

F. Y. B. Sc.	
Semester - I	
Paper No. 7	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	FUNDAMENTALS OF ENERGY SYSTEM - I	
1.	**CONVENTIONAL & NON-CONVENTIONAL ENERGY SOURCES** **1.1 Energy Sources & World Energy Status :** 1.1.1 Energy Sectors: Domestic, Transportation, Agriculture, Industry Sector 1.1.2 Energy Scenario 1.1.3 World Energy Present Situation 1.1.4 Availability of Conventional & Non-Conventional Energy Resources **1.2 Conventional Energy Sources :** 1.2.1 Fossil Fuel, Hydro Resources, Nuclear Resources, Coal, Oil, Gas, Thermal Power Stations 1.2.2 Comparison of various conventional energy systems, their prospects and limitations 1.2.3 Advantages and Disadvantages of Conventional Energy Sources **1.3 Non-Conventional Energy Sources :** 1.3.1 Solar Energy, Wind Energy, Energy from Biomass & Biogas, Ocean Thermal Energy Conversion, Tidal Energy, Geothermal Energy, Hydrogen Energy, Fuel Cell, Magneto Hydro-Dynamics Generator 1.3.2 Advantages & Limitations of Non-Conventional Energy Sources	**3** **3** **3**
2.	**FLUID MECAHNICS** **2.1 Fluid Properties and Classification of Fluid** 2.1.1 Definition of Fluid, Distinction between solids & fluid and liquid & gas fluid continuum 2.1.2 Mass density, Specific Volume 2.1.3 Viscosity, Newton's law of viscosity 2.1.4 Newtonian and Non-Newtonian Fluids 2.1.5 Ideal and Real fluids 2.1.6 Steady & Unsteady Flow	**6**

	2.1.7 Uniform & Non-Uniform Flow 2.1.8 Laminar & Turbulent Flow 2.1.9 Compressible & Incompressible Flow 2.1.10 Surface tension, Definitions, units and dimensions **2.2 Fluid Pressure & Its Measurement** 2.2.1 Definition of pressure, units and dimensions 2.2.2 Pressure at a point 2.2.3 Pascal's law 2.2.4 Hydrostatic pressure law 2.2.5 Absolute and Gauge pressure 2.2.6 Measurement of pressure, Simple Manometer & Differential Manometer theory and problems 2.2.7 Mechanical Pressure Gauges **2.3 Kinematics of Fluid Flow** 2.3.1 Description of fluid flow 2.3.2 Lagrange and Eulerian approaches 2.3.3 Definition of path line, streamline, streak line, stream tube, Acceleration of flow **2.4 Dynamics of Fluid Flow** 2.4.1 Concept of Inertia force and other forces causing motion 2.4.2 Derivation of Euler's equation and 2.4.3 Modification of Bernoulli's equation, problem on Bernoulli's equation without and with losses **2.5 Flow Measurements** 2.5.1 Flow through Orifices; classification 2.5.2 Hydraulic Co-efficient of an Orifice and relation between them 2.5.3 Equation for Co-efficient of velocity, problems 2.5.4 Flow Through Pipes 2.5.5 Venturi Meter	**6** **3** **6** **6**

REFERENCES (CONVENTIONAL & NON- CONVENTIONAL ENERGY)

1. Non-Conventional Energy Sources, **G. D. Rai, Khanna Publication**.
2. Non-Conventional Energy Resources, **B. H. Khan, The McGraw Hill Publishers**.

FLUID MECHANICS

REFERENCE BOOKS:

1. Fluid Mechanics and Fluid Power Engineering by D.S. Kumar, S. K. Kataria & Sons
2. Fluid Mechanics and Hydraulic Machines by R.K. Bansal, Laxmi Prakashan
3. Theory and Applications of Fluid Mechanics by K. Subramanya, TMH outline series, Tata McGraw Hill Publishing Company Lt

F. Y. B. Sc.	
Semester - I	
Paper No. 8	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 36**

Sr. No.	Particulars	No. of Lectures
	ENERGY CONVERSION SYSTEM - I	
1.	**ELEMENTS OF ELECTRO-MECHANICAL ENERGY CONVERSION** 1.1 Introduction 1.2 Salient aspects of conversions 1.3 Energy- Balance 1.4 Magnetic-field System; Energy and Co-energy 1.5 A Simple Electromechanical System 1.6 Energy in Terms of Electrical Parameters 1.7 Rotary Motion 1.8 Dynamic Equations and system-model of a simple system	**6**
2.	**D.C. GENERATORS** 2.1 Simple Loop Generator 2.2 Practical Generator 2.3 Yoke 2.4 Pole Cores and pole shoes 2.5 Pole Coils 2.6 Armature Core 2.7 Armature Windings 2.8 Commutator 2.9 Brushes and Bearings 2.10 Armature windings 2.11 Pole-pitch 2.12 Conductor 2.13 Types of Generators 2.13.1 Separately-excited 2.13.2 Self-excited generators : Shunt Wound, Series Wound, Compound Wound 2.14 Measurement of Generator Efficiency 2.15 Irons Loss in Armature 2.14.1 Hysteresis Loss (W_h) 2.14.2 Eddy Current Loss (W_e) 2.16 Total Loss in a D.C. Generator 2.15.1 Copper Losses	**12**

	2.15.2 Magnetic Losses 2.15.3 Mechanical Losses 2.17 Stray Losses 2.18Constant or Standing Losses	
3.	**GENERATOR CHARACTERISTICS** 3.1 Characteristics of D. C. Generators 3.2 Separately-excited Generator 3.2.1 (i) No-load Saturation Characteristic (ii) Load Saturation Curve 3.2.2 Internal and External Characteristics	**6**
4.	**D. C. MOTOR** 4.1 Motor Principle 4.2 Comparison of Generator and Motor Action 4.3 Significance of the Back e.m.f. 4.4 Voltage Equation of a Motor 4.5 Condition for Maximum power 4.6 Torque 4.7 Armature Torque of Motor 4.8 Shaft Torque 4.9 Speed of D. C. Motor 4.10 Speed Regulation 4.11 Torque and Speed of D. C. Motor 4.12 Motor Characteristics 4.13 Characteristics of Series Motors 4.14 Characteristics of Shunt Motors 4.15 Compound Motors 4.15.1 Cumulative-compound Motors 4.15.2 Differential-Compound 4.16 Performance Curves 4.16.1 Shunt Motor 4.16.2 Series Motor 4.17 Comparison of Shunt & Series Motors 4.18 Power Stages	**12**

Reference Book:

1. Text Book of **"Electrical Technology"** Vol. II, B.L. Theraja & A.K. Theraja, S. Chand Publications.

2. **"Electrical Machines" by** P. S. Bhimbra.

F. Y. B. Sc.	
Semester - II	
Paper No. 1	**Marks : 50**
PHYSICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	EMERGING PHYSICS	
1.	**History and Philosophy of Physics** 1.1 Introduction to the specific meaning of the world modern as in 'Modern Physics' 1.2 Early Modern Physics 16th century – scientific revolution, Work of Nicolus Copernicus 1.3 Physics of 17th century –work of Galileo Galilei, Huygens, Robert Hooke, Torricelli, Vernier, Tycho Brache, Pascal, Kepler and Newton. 1.4 Physics of 18th Century – Newton, Boyle and Young, Thompson, Coulomb, Amperes, Gauss, Biot – Savarts, Cavendish, Galvani, Franklin, Lagrange and Bernoulli 1.5 Physics of 19th century – Volta, Dalton, Michael Faraday, Ohm, Oerested, Hamilton, Maxwell, J. J. Thomson, Clausius, Hall, Boltzmann, Joule, Mcihelson Morley expt, Miller, Tesla, Roentgen, Pierre and Marie Curie, Becquerel 1.6 Physics of 20th century – Rutherford, Larmour, Lorentz, Einstein, Planck, Bohr, William, Bragg, Chadwick, Heisenberg, Fermi, Edwin Hubble, Karl Jansky, George Gamow, Pauli, Dirac, Max Born, Felix, Bloch, Ernest Lawrence, Shockley, Brattain, and Bardin, Fred Hoyle, Richard Feynman, Robert Mills, Murray Gell-Mann, Glashow, Abdus Salam, Steven Weinberg, K Onnes, A. Fert and Grunberg, Stephan Hawking. 1.7 Indian Scientists : Bose, Raman, Saha and Chandrasekhar	**8**
2.	**Lasers and Laser applications** 2.1 A brief history of lasers 2.2 Einstein prediction : The Three Processes 2.3 Einstein's relations (qualitative discussion only) 2.4 Pumping schemes Characteristics of Types of lasers : 1. Ruby laser, 2. He-Ne 2.5 Applications of lasers	**8**
3.	**Sensors and Transducers** 3.1 Overview – need, definition and qualities of transducers 3.2 Temperature – thermocouples, thermisters, platinum resistance thermometer, IC temperature sensors, quartz thermometer, pyrometers, cryogenic temperature measurements 3.3 Light Sensors-Photodiodes, Phototransistors, and Photomultipliers	**6**

4.	**Bioelectricity** 4.1 Electricity observed in living systems 4.2 Origin of bioelectricity 4.3 Sodium and potassium transport 4.4 Resting potential and action potential 4.5 Nernst's equation 4.6 Conduction velocity 4.7 Origin of compound action potential 4.8 Neuron structure and function 4.9 An axon as cable 4.10 Membrane resistance and capacitance	**6**
5.	**Nanomaterials** 5.1 Introduction 5.2 Reduction of dimensions 3D, 2D, 1D, 0D materials. 5.3 Surface and Interface effect 5.4 Modelling of quantum size effect 5.5 Synthesis of nano particles – Bottom Up and Top Down approach, Wet Chemical Method 5.6 Idea of Biomimicking, naturally occurring nanocrystals	**8**

SECTION – I (EMERGING PHYSICS)

Reference : History and Philosophy of Physics

1. http://en.wikipedia.org/wiki/History of Physics
2. http://en.wikipedia.org/wiki/Nobel Prizes in Physics

LASERS AND LASER APPLICATIONS

References:

1. An introduction to Lasers – Theory and Applications M. N. Avadhanalu, S. Chand and Co, Ltd.
2. Solid State Physics P. K. Palanisamy, Scitech Publications (India) Pvt. Ltd

SENSORS AND TRANSDUCERS

References:

1. Instrument measurement and Analysis by B. C. Narka and K. K. Chaudhary, Tata McGraw Hill Publishing Company 16th reprint Chapter 1.

BIOELECTRICITY

Reference :

1. From Neuron to Brain, Kuffler and Nicholas, Sinauer Associates, Inc Pub. Sunderland, Massachusetts

NANOMATERIALS

References :

1. Nanomaterial- Synthesis, Properties and Applications - Edelstein, Camarata, Institute of Physics Publishing, Bristol and Philadelphia.
2. Introduction to Nanotechnology Charles P. Poole Jr, Frank J. Owens John Wiley and Sons publications.
3. Physics Education Vol. 14, No. 4, Jan – March 1998.
4. Nanotechnology : Principles and Practices S. K. Kulkarni, Capital Publishing Company.

F. Y. B. Sc.	
Semester - II	
Paper No. 2	**Marks : 50**
PHYSICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	ELECTRICITY AND MAGNETISM	
1.	**Electrostatics** 1.1 Coulomb's law 1.1.1 Statement 1.1.2 Vector form of Coulomb's law for like and unlike charges. 1.1.3 Variation force with distance (F. vs. r graph) (Ref. 2, 21.3) 1.2 Superposition principle 1.2.1 Statement and explanation with illustration 1.2.2 Illustrations with specific configuration of three charges (triangular form) and four charges (square form) 1.2.3 Problems on superposition principle 1.3 Energy of the system of charges 1.3.1 Illustration with three charges 1.3.2 Electric potential energy (Ref. 1, 1.5 and Ref. 2, 23.1) 1.4 Concept of electric field 1.4.1 Electric field due to point charge 1.4.2 Electric field due to group of charges 1.4.3 Lines of force 1.4.4 Relation between electric intensity and electric potential 1.5 Concept of electric flux 1.5.1 Gauss's theorem in electrostatics (statement only and explanation) 1.5.2 Illustrations of Gauss law with examples	**8**
2.	**Dielectrics** 2.1 Electric Dipole 2.1.1 Electric dipole and dipole moment 2.1.2 Electric potential due to dipole 2.1.3 Electric intensity due to dipole 2.1.4 Torque on electric dipole in external electric field 2.1.5 Polar and non – polar molecules with examples 2.1.6 Effect of external electric field on polar and non – polar molecules 2.2 Dielectric materials 2.2.1 Electric polarization of dielectric material 2.2.2 Electric polarization vector 2.2.3 Strength of dielectric material and Dielectric breakdown 2.2.4 Electric displacement and Gauss law in dielectric 2.2.5 Relation between three electric vectors (E, D and P) 2.2.6 Effect of dielectric on capacitance of problems (parallel plate capacitor only)	**8**

	2.2.7 Problems	
3.	**Magnetostatics** 3.1 Concept of magnetic field: Definition and properties of magnetic field 3.2 Revision of Biot – Savart's law: 1. Long straight conductor. 2. Current carrying circular loop on the axis 3.3 Ampere's circuital law: Field of solenoid, Field of toroidal solenoid 3.4 Magnetic Field lines and Magnetic flux, Gauss's law for magnetism 3.5 Problems	**8**
4.	**Magnetic Properties Of Material** 4.1 Magnetic Materials, Bohr magneton 4.2 Magnetisation (M), Magnetic Intensity (H) and magnetic induction (B) 4.3 Magnetisation and Susceptibility and magnetic permeability 4.4 Relation between B, M and H (without derivation, qualitative discussion only) 4.5 Diamagnetic, paramagnetic and ferromagnetic. Explanation with the help of susceptibility and permeability 4.6 Hysteresis	**7**
5.	**Transient Currents** 5.1 Transient currents 5.2 Growth of current in an inductive (LR) circuit 5.3 Decay of current in an inductive circuit, Physical meaning of time constant 5.4 Charging of condenser through resistance 5.5 Discharging of condenser through resistance, Time constant	**5**

ELECTRICITY AND MAGNETISM

Reference books:

1. Berkeley Physics Course – Vol. – II Electricity and Magnetism. Edward M. Purcell.
2. University Physics – H.D. Young R. A. Freedman Pearson – Freedman.
3. Resnick and Halliday, Physics Vol. – II.
4. Electromagnetics by B.B.Laud.

F. Y. B. Sc.	
Semester - II	
Paper No. 3	**Marks : 50**
CHEMISTRY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	PHYSICAL & INORGANIC CHEMISTRY	
1	**Atomic structure:** 1.1 Historical Development, Dalton's atomic theory, Limitation of Daltons atomic theory, Electron, its discovery and properties. e/m ratio of electron by Thomson's method. 1.2 Charge on electron by Milliken's oil drop method, Proton- its discovery and properties, 'Thomson's Atomic model and its drawbacks. 1.3 Rutherford's alpha particles scattering experiments, Rutherford's atomic model and its drawbacks. Prouty's hypothesis, Moseley experiment and its importance. 1.4 The Neutron – its discovery and properties, atomic spectra. Ritz – combination principle. 1.5 Bohr's model of hydrogen atom, postulates, derivation for its radius and energy. Application of Bohr's theory, spectra and ionization potential of hydrogen, Limitations of Bohr's theory, spectra and ionization potential of hydrogen, Limitations of Bohr's theory, Quantum number, Pauling's Exclusion principle, Hund's principles of maximum multiplicity and Aufbau's principle**.**	**12**
2	**Colloids:-** 2.1 Preparation, purification, Optical properties. 2.2 Tyndall effect, shape and size, stability, solvation, interaction between, colloids, solution, emulsions and gels.	**6**
3	**Catalysis:** 3. 1 Catalyst and catalysis, positive and negative catalysis, 3. 2 Type of catalysis, Characteristics of catalytic reactions, promoters, Catalytic poisoning* 3. 3 Theories of catalysis, Active centre on catalyst surface, Adsorption theory and catalytic activity. 3. 4 Acid – Base catalysis, Enzyme catalysis, Mechanism of enzyme catalysis, characteristics of enzyme catalysis, application of	**6**

	catalysis in industries. 3. 5 *Autocatalysis, negative catalysis, Activation energy and catalysis.	
4	**Chemical bonding and structure:-** 4.1 Attainment of stable configuration. 4.2 Types of bonds a) ionic, b) covalent c) Coordinate d) Metallic. 4.3 Types of overlap, formulation of σ and π bonds S – S overlap, P-P overlap, p-d overlap with suitable examples. 4.4 Theories of bonding, Valence bond theory a) Hitler London theory and b) Pauling Slater theory.	**6**
5	**Concept of hybridization** 5.1 Definition, need of hybridization, steps involved in Hybridization. 5.2 Explanation of covalency of atoms in the molecules on the basis of hybridization. 5.3 Types of hybridization involving S, P orbitals and S, P, d, orbitals. 5.4 Applications of hybridization concept, geometries of molecules like BeF2 CH4, BF3, SiCl4, PCI5, IF7, SF6, [Ni (CN)4]2- 5.5 VSEPR theory Assumptions, need of theory, application of the theory to explain geometry of irregular molecules like H2O, NH3, TiCl4, ClF3, ICl2, BrF3, BrF5, OF2	**6**

Reference Books For second term.

1. University General Chemistry. By C.N. R. Rao. Mc Millan Publication.
2. Principles of Physical Chemistry. By Maron and Pruton 4th Ed. Oxford and IBH publication.
3. Physical Chemistry. By G.M. Barrow.

References:

1. Concise Inorganic Chemistry by J.D. Lee 5th Edn. (page No. 30 to 36, 90 – 96)
2. A new guide to modern valency theory by G.I. Brown (Pages 106, 114, 165 – 168)

References:

1. Consise Inorganic Chemistry by J.D. Lee 5th edn. (Page 30-36, 72-96
2. Basic Inorganic Chemistry by Cotton & Wilkison.
3. Inorganic Chemistry – Principles of structure and reactivity by J.E. Huheey, E.A. Keiter, R.L. Keiter, U.k. Medhi, 1st impression (2006) person Education Publishers (Pages 117 – 170) and (171-190)
4. New guide to modern valence Theory By G.I. Brown (Pages 106-114, 165-168).

F. Y. B. Sc.	
Semester - II	
Paper No. 4	**Marks : 50**
CHEMISTRY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	ORGANIC & INORGANIC CHEMISTRY	
1	**Alkenes, Dienes & Alkynes:-** 1.1 Alkenes: Introduction, higher alkenes, Nomenclature, physical properties, preparations, Reactions of alkenes, Analysis of Alkenes. 1.2 Dienes: Structure & Properties, Conjugated dienes, Reactions of dienes, analysis of dienes. 1.3 Alkynes:- Introduction , Nomenclature, Physical properties, preparation, Reactions & analysis of alkynes.	**6**
2	**Halogen derivatives of Alkanes:-** 2.1 Introduction & Classification of Halogen derivatives, Structure of alkyl halides, 2.2 Classification, Nomenclature, physical properties, preparation, reactions, analysis of alkyl halides.	**4**
3	**Alcohols & Ethers:-** 3. 1 Alcohols: - Introduction, physical properties, Reactions of alcohols. 3. 2 Industrial sources of ethyl alcohol, proof, spirit, denatured spirit, absolute alcohol, analysis of alcohols.	**6**
4	**Benzene & its Reactions:-** 4.1 Structure of benzene, Kekule structure, stability of benzene. 4.2 Reactions of benzene, aromatic character, Huckel rule, 4.3 Nomenclature of benzene derivatives, sulphonation, halogenation, Friedal – Crafts reactions of benzene.	**5**
5	**Phenols:-** 5.1 Structure, classification, Physical properties. 5.2 Nomenclature, Preparation of phenols, industrial source, Laboratory methods. 5.3 Reactions of Phenols Nitration, Sulphonation, Halogenation, nitrosation, carbonation (Kolbe synthesis,) Reimer –Tiemann	**3**

	reaction & analysis of phenols.	
6	**Chemistry S. Blocks Elements:-** 6.1 Position of elements in periodic Table, Electronic configuration, Periodic trends in Properties viz. size of atom, ion, oxidation state, ionization potential, & reactivity. 6.2 Anomalous behavior of Li, Be Diagonal relationship between Li & Mg. 6.3 Industrial biological and Agricultural applications of these elements & their Compounds, Crown ethers, Separation of these elements using Crown ethers. Solution of these metals in liquor NH3	**8**
7	**Chemistry of Noble Gases:-** 7.1 Position of these elements in periodic table, Electronic configuration. 7.2 Chemical Properties of Noble Gases. 7.3 Chemistry of xenon structure and bonding in xenon compounds. XeF2, XeF4, XeO6, XeO4, XeO2 F2, [XeO6]-4, XeOF4.	**4**

List of Reference Books (Organic Chemistry)

1. Ref. 1 Organic Chemistry by Clayden, Oxford uni.press.
2. Ref. 2 Organic Chemistry by Morrison & Boyd, 6th Edition.
3. Ref. 3 A guide book to Mechanism in Organic Chemistry by Peter Sykes, 6th Edition.

Text Book:- (6) – Inrganic Chemistry

1. Concise inorganic Chemistry by J.D. Lee, Chapman & Hall 5th Edn. (1996) (Page No. 273, 281, 302, 308, 325, 326, 329, 335 and 353)

Ref Books:- (7) - Inorganic Chemistry

1. Concise Inorganic Chemistry by J.D. Lee Chapman and hall 5th edn. (1996) pages (635 – 647)
2. Concepts and Models of Inorganic Chemistry by B. Douglas & D. Mc. Daniels Alexander Mohan Wiley & sons 3rd Edn. (2007) Relevant pages.
3. Inorganic Chemistry Principles of structure & reactivity By James Huheey, Keiter, Medhi (Pearson Education) Pages 342-348.

F. Y. B. Sc.	
Semester - II	
Paper No. 5	**Marks : 50**
MATHEMATICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	ALGEBRA AND GEOMETRY - II	
1.	**Analytical Geometry of Two Dimensions** 1.1 Change of axes: translation and rotation. 1.2 Conic Sections: General equation of second degree in two variables. Reduction to standard form. Centre of conic. Nature of conic.	**8**
2.	**Analytical Geometry of Three Dimensions** 2.1 Review of Co-ordinates in 3-space. Direction cosines and direction ratios. 2.2 Every linear equation in x. y. and z represents a plane. 2.3 Equations of coordinate planes. Normal form of equation of a plane. Plane passing through three non-collinear points. Intercept form of equation of a plane. Distance of a point from a plane. Distance between parallel planes. 2.4 Systems of planes. Bisector planes. 2.5 Equations of a line in various forms. Symmetric and unsymmetric forms of the equations of a line. Line passing through two points. 2.6 Angle between a line and a plane. Perpendicular distance of a point from a plane. Condition for two lines to be coplanar. 2.7 Skew lines and shortest distance between skew lines	**12**
3.	**Sphere** 3.1 Equation of a sphere in different forms, plane section of a sphere, Equation of a circle. Sphere through a given circle. Intersection of a sphere and a line. Equation of tangent plane to standard sphere and general sphere	**6**
4.	**System of Linear Equations** 4.1 System of m linear equations in n unknowns; Homogeneous systems, Non homogeneous system, Matrix form of System of Equations 4.2 Echelon form; row reduced echelon form of a matrix 4.3 Definition of rank of a matrix. Examples. 4.4 Gauss Elimination Method. 4.5 Consistency of a system of non homogeneous equations; Condition of consistency i.e. for $AX = B$, $\rho [A,B] = \rho[A]$ (without proof).	**10**

TEXT BOOKS:

1. Complex Variables and Applications: Ruel. V.Churchill; McGraw Hill Co.
2. Elementary Number Theory: David Burton; Tata McGraw Hill (Walter Rudin Series), Indian Edition.
3. Matrices : Shanti Narayan; S.Chand & Co. N. Delhi
4. Analytical Geometry of Two and Three Dimensions: Qazi Zameeruddin; Narosa Publ.

F. Y. B. Sc.	
Semester - II	
Paper No. 6	**Marks : 50**
MATHEMATICS	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
	CALCULUS - II	
1.	**Continuous Functions** 1.1 Continuous Functions 1.2 Combinations of Continuous Functions 1.3 Continuous functions on intervals	**16**
2.	**Differentiation** 2.2 The Derivative 2.3 The Mean Value Theorem 2.4 L' Hospital's Rules 2.5 Successive Differentiation 2.6 Taylor's Theorem	**20**

Text Books:

1. Introduction to Real Analysis by Robert G. Bartle and Donald R. Sherbert, Third Edition, John Wiley and Sons, 2002
   Sections:
   First Term: 2.1, 2.2, 2.3, 2.4, 3.1 to 3.7 , 4.1, 4.2, 4.3
   Second Term: 5.1, 5.2, 5.3, 6.1, 6.2, 6.3, 6.4

2. Differential Calculus, Shantinarayan, 7^{th} Edition, S. Chand and Co. Publication Chapter 5.

Reference Books:

1. A Course in Calculus and Analysis by Sudhir Ghorpade and Balmohan Limaye, Springer 2006.

2. Principles of Mathematical Analysis, W. Rudin, Third Edition, McGraw Hill, 1976.

F. Y. B. Sc.	
Semester - II	
Paper No. 7	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 36**

Sr. No.	Details	No. of Lectures
FUNDAMENTALS OF ENERGY SYSTEM - II		
1.	**THERMODYNAMICS** **1.1 Introduction & Laws of Thermodynamics (First & Second)** 1.1.1 Basic Concepts : System, Control Volume, Surrounding, Boundaries, Universe, Types of Systems, Thermodynamic Equilibrium, Property, Process 1.1.2 Cycle – Reversibility – Quasi – static Process, Irreversible Process, Types, Work and Heat, Point and Path function 1.1.3 Concept of quality of Temperature 1.1.4 Principles of Thermometry 1.1.5 Const. Volume gas Thermometer 1.1.6 Ideal Gas Scale 1.1.7 Joule's Experiments 1.1.8 Steady Flow Energy Equation 1.1.9 Limitations of First Law of Thermodynamics 1.1.10 Thermodynamic scale of Temperature, Clausius Inequality, Entropy **1.2 Perfect Gas Laws** 1.2.1 Perfect Gas Laws 1.2.2 Specific and Universal Gas Constants 1.2.3 Heat and Work Transfer, changes in Internal Energy 1.2.4 Throttling and Free Expansion Processes, Flow processes 1.2.5 Deviations from perfect Gas Model 1.2.6 Vander Waals Equation of State 1.2.7 Mixtures of perfect Gases 1.2.8 Avogadro's Laws of additive volume 1.2.9 Dalton's and Amagat's laws	**15**
2.	**HEAT TRANSFER** **2.1 Conduction Heat Transfer** 2.1.1 Various modes of Heat Transfer 2.1.2 Mechanisms of Different Modes of Heat Transfer	**15**

	2.1.3 Fourier's Law of Heat Conduction, Conductivity 2.1.4 Electrical Analogy, Concept of Thermal Resistance 2.1.5 Introduction to Newton's Law of Cooling 2.1.6 Unidirectional Heat Conduction, Heat Conduction with Convective Environment **2.2 Convection** 2.2.1 Basic Concepts: Convective Heat Transfer Coefficients, Boundary Layer Concept, Types of Convection, Forced Convection 2.2.2 Laminar and Turbulent Flow, Combined Laminar and Turbulent 2.2.3 Nusselt Theory 2.2.4 Film Wise and Drop Wise Condensation **2.3 Radiation Heat Transfer** 2.3.1 Basic Concepts, Laws of Radiation 2.3.2 Stefan Boltzmann Law, Kirchoff Law 2.3.3 Black Body Radiation **2.4 Heat Exchanger & Insulation** 2.4.1 Classification of Heat Exchangers 2.4.2 Overall Heat Transfer Coefficient 2.4.3 Fouling Factor 2.4.4 Design & Selection of Heat Exchanger 2.4.5 Practical Application of Heat Exchanger 2.4.6 Purpose of Insulation 2.4.7 Classification of Insulation 2.4.8 Types of Insulation Material 2.4.9 Economic Thickness of Insulation	
3.	**REFRIGERATION & AIR CONDITIONING** **3. 1 Introduction** : First and Second law applied to refrigerating machines, Unit of refrigeration, COP, EER **3. 2 Air Refrigeration** 3.2.1 Air refrigeration cycle 3.2.2 Reverse Carnot cycle 3.2.3 Bell-Coleman cycle 3.2.4 Thermodynamic processes 3.2.5 Types of Air refrigeration system, Simple, Boot Strap, Regeneration, Reduced Ambient **3. 3 Vapour Compression Cycle** 3.3.1 Thermodynamic processes in VCC 3.3.2 Compound vapour Compression System: Need of compound compression, Two stage compression, Three Stage Compressions: Various arrangements for improvement in C.O.P. 3.3.3 Multiple Evaporator System **3. 4 Refrigerants** 3.4.1 Desirable properties of refrigerant : R-12, R-22, R-717, R-134 3.4.2 Butane recent substitute for refrigerants	**6**

THERMODYNAMICS

TEXT BOOKS:

1. Engineering Thermodynamics / PK Nag /TMH, III Edition
2. Fundamentals of Thermodynamics – Sonntag, Borgnakke and van wylen / John Wiley & sons (ASIA) Pvt. Ltd.

REFERENCES:

1. Engineering Thermodynamics – Jones & Dugan
2. Thermodynamics – An Engineering Approach – Yunus Cengel & Boles /TMH
3. Thermodynamics – J.P.Holman / McGrawHill
4. An introduction to Thermodynamics / YVC Rao / New Age

For more details, visit Http://www.jntu.ac.in/

REFRIGERATION & AIR CONDITIONING

REFERENCES:

1. Refrigeration and Air Conditioning, Arora C. P., Tata McGraw Hill Publications.
2. Principles of Refrigeration, Dossat R. J., Prentice Hall Publications.
3. Refrigeration and Air Conditioning, Domkundwar, Dhanpat Rai Publications.
4. Refrigeration and Air Conditioning, Ballany P.L., Khanna Publications
5. Air Conditioning System design Handbook, Carrier Corporation, USA

DIGITAL REFERENCES:

1. www.science direct.com
2. www.Howstuffworks.com

www.efunda.com

HEAT & MASS TRANSFER

REFERENCES:

1. Sachdeva R C, “Fundamentals of Engineering Heat and Mass Transfer” New Age International, 1995
2. Yadav R “Heat and Mass Transfer” Central Publishing House, 1995.
3. Heat Transfer, S.P. Sukhatme.
4. Heat Transfer, P.K. Nag, Tata McGraw Hill 2002 Publications.
5. Heat Transfer, R C Sachdeva.
6. Thermal Insulation and Refractories -PCRA.
7. Insulation and Refractories - British Energy Efficiency Office.

F. Y. B. Sc.	
Semester - II	
Paper No. 8	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 36**

Sr. No.	Particulars	No. of Lectures
	ENERGY CONVERSION SYSTEM - II	
1.	**SPEED CONTROL OF D.C. MOTORS** 1.1 Factors Controlling Motor Speed 1.2 Speed Control of Shunt motors 1.2.1 Variation of flux or Flux Control Method 1.2.2 Armature or Rheostatic Control Method 1.2.3 Voltage Control Method 1.3 Speed Control or series Motors 1.3.1 Flux Control Method 1.3.2 Variable Resistance in series with motor 1.4 Measurement of Motor Efficiency	**8**
2.	**TRANSFORMER** 2. 1 Working principle of a Transformer 2. 2 Transformer Construction 2. 3 Core-type Transformers 2. 4 Shell-type Transformers 2. 5 Elementary Theory of an ideal Transformer 2. 6 D.M.F. Equation of Transformer 2. 7 Voltage Transformation Ratio (K) 2. 8 Transformer with losses but no magnetic Leakage 2. 9 Transformer on No-load 2. 10 Transformer on load 2. 11 Transformer with winding resistance but no Magnetic leakage 2. 12 Magnetic leakage 2. 13 Transformer with resistance and leakage reactance 2. 14 Estimation of Transformer Efficiency (at Full Load & Actual Load)	**8**
3.	**TRANSFORMER THREE PHASE** 3. 1 Three-phase Transformer connections 3. 2 Star/star or Y/Y Connection 3. 3 Delta-Delta or △ - △Connection 3. 4 Wye/Delta or Y/△ Connection	**8**

	3. 5 Delta / Wye or Y/ △ Connection	
4.	**INDUCTION MOTOR** 4.1 Classification of A.C. Motors 4.2 Induction Motor : General Principle 4.3 Construction 4.4 Squirrel-cage rotor 4.5 Phase-wound rotor 4.6 Production of Rotating field 4.7 Three-Phase supply 4.8 Mathematical proof 4.9 Why does the rotor rotate? 4.10 Slip 4.11 Frequency of rotor current 4.12 Starting Torque of a squirrel-cage motor 4.13 Starting Torque of a slip-ring motor 4.14 Torque/Speed Curve 4.15 Current /speed curve of on induction motor	**15**
5.	**SINGLE-PHASE MOTORS** 5.1 Types of single-phase motors 5.2 Single-phase induction motor 5.3 Double-field revolving Theory 5.4 Making single-phase induction motor self-starting 5.5 Types of capacitor-start motors 5.5.1 Single-voltage, externally-reversible motors 5.5.2 single-voltage, non-reversible type 5.5.3 single-voltage reversible and with thermostat type 5.5.4 Single-voltage, non-reversible with magnetic switch type 5.5.5 Two-voltage , non-reversible Type 5.5.6 Two-voltage, reversible type 5.5.7 single-voltage, three-lead reversible type 5.5.8 single-voltage, instantly-reversible type 5.5.9 Two-speed type 5.5.10 Two speed with two-capacitor type 5.6 Repulsion Type motors 5.7 Repulsion motor 5.8 Repulsion Principle	**14**

Reference Book:

1. Text Book of **"Electrical Technology"** Vol. II, B.L. Theraja & A.K. Theraja, S. Chand Publications.
2. **"Electrical Machines" by** P. S. Bhimbra.

S. Y. B. Sc.	
Semester - I	
Paper No. 1	**Marks : 50**
PHYSICS	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	MATHEMATICAL MEHODS IN PHYSICS	
1.	**Complex Numbers** 1.1 Introduction to complex numbers. 1.2 Algebra of complex numbers 1.3 Argand diagram, algebra of complex numbers using Argand diagram 1.4 Rectangular, polar and exponential forms of complex numbers. 1.5 De-Moivre's Theorem (statement only) 1.6 Trigonometric, hyperbolic and exponential functions. 1.7 Powers, roots and log of complex numbers. 1.8 Applications of complex numbers to determine velocity and acceleration in curved motion 1.9 Problems	**12**
2.	**Vector Algebra** 2.1 Introduction to scalars, vectors: dot product and cross product. 2.2 Scalar triple product and its geometrical interpretation. 2.3 Vector triple product and its proof. 2.4 Problems.	**4**
3.	**Vector Analysis** 3.1 Differentiation of vectors with respect to scalar 3.2 Scalar and vector fields 3.3 Vector differential operator 3.4 Gradient of scalar field and its physical significance. 3.5 Divergence of scalar field and its physical significance 3.6 Curl of vector field and its physical significance 3.7 Vector integrals: line, surface and volume integral with their examples 3.8 Statements of Gauss-Divergence theorem and Stoke's theorem 3.9 Vector identities a. $\nabla \times \nabla\phi = 0$ b. $\nabla \cdot (\nabla \times \mathbf{V}) = 0$ c. $\nabla \cdot (\nabla\phi) = \nabla^2\phi$ d. $\nabla \cdot (\phi\mathbf{A}) = \nabla\phi \cdot \mathbf{A} + \phi (\nabla \cdot \mathbf{A})$ e. $\nabla \times (\phi \mathbf{A}) = \phi(\nabla \times \mathbf{A}) + (\nabla\phi) \times \mathbf{A}$ f. $\nabla \cdot (\mathbf{A} \times \mathbf{B}) = \mathbf{B} \cdot (\nabla \times \mathbf{A}) - \mathbf{A} \cdot (\nabla \times \mathbf{B})$	**16**

	3.10 Problems	
4.	**Partial Differentiation** 4.1 Definition of partial differentiation 4.2 Successive differentiation 4.3 Total differentiation 4.4 Exact differential 4.5 Chain rule 4.6 Theorems of differentiation 4.7 Change of variables from Cartesian to polar co-ordinates. 4.8 Implicit and explicit functions 4.9 Conditions for maxima and minima (without proof) 4.10 Problems	**12**
5.	**Differential Equation** 5.1 Frequently occurring partial differential equations (Cartesian coordinates) 5.2 Degree, order, linearity and homogeneity of differential equation. 5.3 Singular points (x = 0, x = x0) of differential equation. 5.4 Problems	**4**

MATHEMATICAL MEHODS IN PHYSICS

Reference Books:

1. Methods of Mathematical Physics by Laud, Takwale and Gambhir
2. Mathematical Physics by B. D. Gupta
3. Mathematical Physics by Rajput and Gupta
4. Mathematical Methods in Physical Science by Mary and Boas
5. Vector analysis by Spiegel and Murrey
6. Mathematical Methods for Physicists by Arfken and Weber, 5th Edition, Academic Press.

S. Y. B. Sc.	
Semester - I	
Paper No. 2	**Marks : 50**
PHYSICS	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ELECTRONICS	
1.	**Basic Electronic Components** 1.1 Definitions of resistance, capacitance and inductance 1.2 Equations defining resistance, capacitance and inductance 1.3 Concept of reactance and impedance 1.4 Transformers: Centre tapped, Step-up, Step-down, Various energy losses in transformer.	**3**
2.	**Network Theorems** 2.1 Kirchhoff's laws (revision) 2.2 Voltage and current divider circuits 2.3 Thevenin's theorem 2.4 Norton's theorem 2.5 Super-position theorem 2.6 Maximum power transfer theorem (All theorems 2.3 to without proof) 2.7 Problems	**7**
3.	**Semiconductor Devices** 3.1 Revision of bipolar junction transistor, types, symbols and basic action 3.2 Configurations (Common Base, Common Emitter & Common Collector) 3.3 Definition of alpha, beta and their relations. 3.4 Input, output and transfer characteristics of CE and CB configurations. 3.5 Biasing methods 3.6 AC and DC load lines, Operating point (Q point) 3.7 Transistor as a switch, Transistor as an amplifier (only concept) 3.8 Frequency response of CE transistor amplifier 3.9 Unijunction transistor: principle, construction and operation 3.10 Problems	**12**
4.	**Operational Amplifiers and Oscillators** 4.1 Operational amplifier: IC 741- Block diagram, Characteristics: ideal and practical 4.2 Concept of virtual ground 4.3 Inverting and non-inverting operational amplifiers with concept of gain. 4.4 Operational amplifier as an adder and subtracter. 4.5 Oscillators: concept of positive and negative feedback	**12**

	4.6 Barkhausein criteria for an oscillator 4.7 Phase shift oscillator and Wien bridge oscillator (Derivation for frequency and feedback factor for both oscillators expected) 4.8 Problems	
5.	**Power Supplies** 5.1 Half wave, Full wave and Bridge rectifier, ripple factor, capacitor filter 5.2 Difference between regulated and unregulated power supply 5.3 Definition of Line and Load regulation 5.4 Series and Shunt regulators- Block diagram and circuit of regulated power supply using discrete components, Simple current limiting circuit 5.5 Problems	**6**
6.	**Digital Electronics** 6.1 Number systems: Binary, Binary coded decimal (BCD), Octal, Hexadecimal 6.2 Addition and subtraction of binary numbers and binary fractions using one's and two's complement. 6.3 Basic logic gates: OR, AND, NOT, Derived gates: NOR, NAND, EXOR, EXNOR with symbols and truth tables 6.4 Boolean Algebra, Boolean Equations 6.5 De Morgan's theorems and its verification 6.6 Problems	**8**
	INSTRUMENTATION	
1.	**Fundamentals of Measurement** 1.1 Aims of measurement 1.2 Functional elements of typical measurement system (block diagram) 1.3 Standards of measurement (mass, length, time and current) 1.4 Static characteristics (accuracy, precision, sensitivity, linearity, repeatability, reproducibility, drift, dead zone, hysteresis, resolution) 1.5 Dynamic characteristics: concept, first and second order system Example of first order: resistance transducer and thermal element Example of second order: U-tube manometer and seismic motion Speed of response, fidelity and lag. 1.6 Errors in measurements. 1.7 Transducers (Definition, classification and characteristics) 1.8 Problems.	**16**
2.	**Measurement of Displacement and Force** 2.1 Measurement of displacement (variable resistance, variable inductance, variable capacitance method.) 2.2 Measurement of force (load cell, column type devices, cantilever beam.)	**6**

	2.3 Problems	
3.	**Measurement of Pressure and Flow** 3.1 Units of pressure and concept of vacuum, Absolute gauge and differential pressure. 3.2 Elastic transducers (diaphragm, corrugated diaphragm, bellows and Bourden tube.) 3.3 Electrical type- LVDT, strain gauge, piezoelectric. 3.4 Pressure transducer calibration by dead weight tester method. 3.5 Measurement of flow (Type of flow, classification of flow meters, Bernoulli's theorem [statement only] Venturi tube, Pitot tube, rotameter, ultrasonic flow meter.) 3.6 Problems	**12**
4.	**Measurement of Magnetic Field** 4.1 Introduction to magnetic materials. 4.2 Hysterisis loop and its application. 4.3 Ballistic method for obtaining B-H curve 4.4 Measurement of magnetic field by search coil and Hall probe. 4.5 Problems	**6**
5.	**Biomedical and Environmental Instruments** 5.1 Block diagram of ECG, MRI and B.P. apparatus- full form ECG, MRI, BP. 5.2 Pyranometer for solar radiation measurement. 5.3 Acoustics measurements, characteristic of sound, sound pressure and power level, Block diagram of sound level meter. 5.4 Hair Hygrometer, Smoke density measurement. 5.5 Problems	**8**

ELECTRONICS

Reference Books

1. Electronics Principles, Malvino**,** 7th Edition TaTa Mc-Graw Hills.
2. Principles of Electronics, V. K. Mehta, S. Chand Publication New Delhi.
3. Op Amp and Linear integrated circuits, Ramakant Gaikwad, Prentice Hall of India Pub.
4. Integrated Circuts, Botkar, Khanna Publications, New Delhi
5. Digital Principles and Applications, Malvino and Leech Tata Mc-Graw Hills Pub.

OR

Reference Books: INSTRUMENTATION

1. Instrumentation Device and System, Rangan, Mani Sharma, Tata Mc Graw Hill
2. Instrumentation Measurement and Analysis, Nakra, Choudhari, Tata Mc Graw Hill
3. Solar Energy, S.P. Sukhatme, Mc Graw Hill
4. Electricity & Magnetism, Khare, Shrivastav
5. Medical Instrumentation, Karr-Brown
6. Air pollution, M.N.Rao, H.V. Rao, Tata Mc Graw Hill
7. Hand Book of Biomedical Instrumentation, R.S.Kandpur, Tata Mc Graw Hill

S. Y. B. Sc.	
Semester - I	
Paper No. 3	**Marks : 50**
CHEMISTRY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	PHYSICAL CHEMISTRY	
1	**Thermodynamics:-** 1.1 Recapitulation of entropy, Thermodynamics of mixing, Entropy change or mixing of ideal gases 1.2 Third law of thermodynamics, Statement, Limitation, Importance of third law, evaluation of absolute entropies, use of absolute entropies	**8**
2	**Free energy and equilibrium:-** 2.1 Introduction, Helmholtz free energy, variation of Helmholtz free energy with volume and temperature, Helmholtz free energy change for chemical reaction. 2.2 Gibb's free energy, Variation of Gibb's free energy with pressure and temperature, Gibb's free energy change for chemical reaction. 2.3 Gibb's – Helmholtz equation, properties and significance of Gibb's free energy change, free energy change for ideal gas, Standard free energy change, Vant Hoff's reaction isotherm. 2.4 The thermodynamic equilibrium constant, Relation between Kp and Kc for gaseous reactions, Variation of equilibrium constant with temperature, Criteria of chemical equilibrium, physical equilibria, Clapeyron equation and Clausius – Clapeyron equation, Applications of Clapeyron and Clausius – Clapeyron equation, numericals. 2.5 Le chatelier – Braun principle, Application of Le chatelier – Braun principle to the formation of ammonia and phosgene.	**16**
3	**Colligative properties of solutions:-** 3.1 Introduction, Solution, electrolytes and nonelectrolytes, Meaning of term colligative property, lowering of vapour pressure of solvent in solution, elevation of B.P. of solvent in solution. 3.2 Landberger's method, freezing point depression, Beckmann's method, Osmosis and Osmotic pressure, Berkeley and Hertley method, Modern osmometer, application of colligative properties to determine molecular weight of nonelectrolyte,	**12**

	abnormal molecular weight. 3.3 Relation between Vant Hoff's factor and degree of dissociation of electrolyte by Colligative property, Numericals.	
4	**Solutions of liquids in liquids:-** 4.1 Types of solution, Ideal solution, Rault's law, Ideal dilute solution, Henry's law, 4.2 Application of Henry's law, Vapour pressure – composition diagram of ideal and non ideal solution. 4.3 Temperature – composition diagram of miscible binary solution, Distillation from temperature – composition diagram. 4.4 Azeotropes, partially miscible liquid, immiscible liquids, distillation immiscible liquids, determination of molecular weight by steam distillation, Numericals.	**9**
5	**Distribution Law** 5.1 Nernst distribution law, Statement and thermodynamic proof for Nernst distribution law, 5.2 Association and dissociation of solute in solvent, application of distribution law, Numericals.	**3**

Reference books:

1. Principles of Physical Chemistry by S. H. Maron and C. Prutton 4th edition
2. Physical Chemistry by W. J. Moore 5th edition
3. Physical Chemistry by P. W. Atkin 4th edition
4. Physical Chemistry by D. Alberty

S. Y. B. Sc.	
Semester - I	
Paper No. 4	**Marks : 50**
CHEMISTRY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ORGANIC CHEMISTRY	
1	**Stereoisomerism : (Three dimensional aspects of sp3 hybridised carbon):-** 1.1 Introduction – optical isomerism, chirality and optical activity. Three dimensional representation of chiral centre, enantiomers, Absolute configuration, R/S system and D/L Nomenclature. 1.2 Optical isomer with two chiral centers (AA and AB type) Erythro, threo, meso, diastereromers. 1.3 Stereoisomerism in cycloalkanes- Baeyer's strain theory, Heats of combustion and relative stability of cycloalkanes, factors affecting the stability of conformation, conformations of cyclohexane, Equatorial and axial bonds in cyclohexane. Monosubstituted cyclohexanes. 1.4 Stability of – Cl, Br, I, –OH, –CH3, –C(CH3)3 substituted cyclohexanes.	**8**
2	**Chemistry of Aldehydes and Ketones:-** 2.1 Structure of carbonyl groups. 2.2 Nomenclature of Aldehyde and ketones 2.3 Physical properties of aldehydes and ketones 2.4 Preparations of aldehydes from primary alcohol, methyl benzenes, acid chlorides, phenols 2.5 Preparation of ketones from – secondary alcohols, Friedel Craft acylation, nitriles 2.6 Reaction of aldehydes and ketones – (i) Oxidation (ii) reduction – catalytic reduction, metal hydrides – LiAlH4, NaBH4. Clemmenson's reduction, Wolf kishner, Thioketal reduction, (iii) Addition of cyanides (iv) Addition of derivatives of ammonia (v) Addition of alcohols (vi) Cannizzaro reaction (vii) Addition or Grignard reagent (viii) Aldol condensation (ix) Perkins reaction (x) haloform reactions g) Analysis of aldehyde and ketones	**6**

3	**Chemistry of Natural and Unnatural carboxylic acids and their derivatives:-** 3.1 Introduction – Natural and unnatural carboxylic acid with example 3.2 Structure of simple carboxylic acid 3.3 Classification 3.4 Nomenclature 3.5 Physical properties 3.6 Preparation of carboxylic acid from – primary alcohol, oxidation of alkyl benzenes, carboxylation of Grignard reagent, hydrolysis of nitriles, Kolbe's reaction 3.7 Reaction of carboxylic acids, acidity, salt formation, conversion into acid chlorides, esters, amides, acid anhydrides 3.8 Hell-Volhard Zelinsky reaction (halogenation of aliphatic acids). 3.9 Analysis of carboxylic acids 3.10 Acid derivatives – structure nomenclature, preparations, properties of acid chloride, amides, ester and acid anhydrides.	**4**
4	**Aliphatic and Aromatic amines:-** 4.1 Structure 4.2 Classification 4.3 Nomenclature 4.4 Physical Properties – salt of amine 4.5 Preparation of amine from – reduction of nitro compounds, reductive amination, reduction of nitriles, Hoffmann degradation of amides 4.6 Reactions of amines - basicity, salt formation, alkylation, conversion into amides, ring substitution in aromatic amines, Hoffmann elimination, reactions with nitrous acid 4.7 Diazonimum salts – preparation and reactions h) Sandmeyer reaction 4.8 Replacement of nuclear 'H' by – I, −OH and H− 4.9 Analysis of amines.	**4**
5	**Functional Group Inter conversion C-C and C-heteroatom bonds:-** 5.1 Functional groups inter conversion (FGI) - involving C-C and C-heteroatom bonds. 5.2 Converting the given molecule into another molecule with	**7**

	more or less number of carbon atoms (Step up and step down reactions) 5.3 Suggesting synthetic routes to the given target molecules. 5.4 Suggesting the set of reagents to bring about the conversion. 5.5 Predict the products if the reactant and conditions are given, including the major and minor products.	
6	**Chemistry of Homocyclic and Heterocyclic compounds:-** 6.1 Naphthalene and Anthracene. Numbering of carbon atoms, nomenclature of derivatives, preparation and reactions of naphthalene and anthracene. 6.2 Heterocyclic compounds – Definition, classification, nomenclature of heterocyclic compounds. 6.3 Five membered heterocyclic compounds - furan, pyrrole, Thiophene, nomenclature, preparation dorm 1, 4-diketones, reactions sulphonation, F. C. Acylation, Diazocoupling, Riemer – Tiemann reaction, catalytic hydrogenations. 6.4 Six membered heterocyclic compounds, Pyridine, structure, preparation from picoline, acetylene, acrolein, reactions nitration, sulphonation, bromination, catalytic hydrogenation.	**4**
7	**Introduction to Biomolecules:-** 7.1 Introduction: What are different Biomolecules found in and associated with living system? How is biochemistry directly concern to life i.e. what is the scope and impact of biochemistry on living system? Importance of biochemistry. Ref. 2 Relevant pages. 7.2 Carbohydrates : Definition, classification, reactions of carbohydrates – oxidation, reduction osazone formation, ester formation, isomerization, Killiani Fischer synthesis, Ruff degradation, D/L configuration, configuration of D(+) Glucose, Fischer proof and mutarotation, cyclic structure of glucose-Fischer Haworth and chair configuration. Brief account of maltose, sucrose, lactose, cellobiose, polysaccharides - starch, cellobiose 7.3 Amino acids, proteins, enzymes : i) αααα-amino acids : Fischer projection, relative configuration, classification, structure of amino acid, properties and reactions of α-amino acids. ii) Proteins : Formation of peptide linkage, feature of peptide linkage, α-helical conformation, β-plated structure, primary, secondary, tertiary and quaternary structure of proteins. iii) Enzymes : General information, co-enzymes, and vitamins hormones, prosthetic groups and their role, enzymes specificity, classification of enzymes with examples. d) Nucleic acids : Structure of RNA and DNA e) Lipids : General introduction, classification with examples.	**15**

Reference Books:

1. Organic Chemistry - 6h Ed. Morrison and Boyd Prentice Hall of India Pvt Ltd, New Delhi - 2001.
2. Outline of Biochemistry 5h Ed., Conn, Sumpf, Bruening and Roy Doi John wiley 1987.
3. Sterochemistry by Eliel

S. Y. B. Sc.	
Semester - I	
Paper No. 5	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	SOLAR PHOTOVOLTAIC ENERGY CONVERSION - I	
1.	**INTRODUCTION**	**3**
2.	**SOLAR CELL FUNDAMENTALS** 2.1 Semiconductors 2.2 p-n Junction 2.3 Generation of Electron-Hole Pair by Photon Absorption 2.4 Photoconduction	**8**
3.	**SOLAR CELL CHARACERISTICS** 3.1 I-V Characteristics 3.2 Effect of Variation of Insolation and Temperature 3.3 Energy Losses and Efficiency 3.4 Maximizing the Performances 3.5 Cell size 3.6 Energy Payback Period (EPP)	**8**
4.	**CLASSIFICATION OF SOLAR CELL** 4.1 On the Basis of Thickness of Active Material 4.2 On the Basis of Junction Structure 4.3 On the Basis of Type of Active Material 4.3.1 Single Crystal Silicon Solar Cell 4.3.2 Multicrystalline Silicon Solar Cell 4.3.3 Gallium Arsenide Cell 4.3.4 Copper Indium Diselenide Cell 4.3.5 Amorphous Solar Cell	**14**
5.	**SOLAR CELL, MODULE, PANEL, AND ARRAY CONSTRUCTION** 5.1 Solar Cell 5.2 Solar PV Module 5.3 Solar PV Panel 5.4 Solar PV Array	**14**

TEXT-BOOKS:

1. Non-Conventional Energy Resources, B. H. Khan, The McGraw Hill Publications.
2. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications.
3. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.
4. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, Prentice-Hall.
5. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill.
6. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London, 1991.
7. C.S. Solanki, Solar Photovoltaics: Fundamental, Technologies and Applications, Prentice Hall of India, 2011.
8. Antonio Luque, Steven Hegedus; Handbook of Photovoltaic Science and Engineering; John Wiley and Sons, 2002.
9. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
10. Jean Claude Sabonnadiere, Nouredine Hadjsaid, "Smart Grids", Wiley Balackwell.

REFERENCES:

1. Kreith F. and Kreider J.F., 'Principles of Solar Engineering', McGrawhill Book Co.
2. H.A. Kiehne (ed), Battery Technology Handbook; Marcel and Dekker, New York, 1989.
3. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011.

S. Y. B. Sc.	
Semester - I	
Paper No. 6	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
BIO-ENERGY – I (BIOCHEMICAL CONVERSION SYSTEMS)		
1	**BASICS IN BIOMASS STUDY** 1.1 Biomass- types and its advantages and drawbacks 1.2 Indian scenario 1.3 Characteristics 1.4 Conversion Mechanisms 1.5 Fuel Assessment Studies	**4**
2	**BIOMETHANATION** 2.1 Microbial systems, Phases in Biogas Production 2.2 Parameters Affecting Gas Production 2.3 Biogas Plants: Types, Design, Constructional Details and Comparison 2.4 Factors Affecting the Design	**5**
3	**METHODS FOR MAINTAINING BIOGAS PRODUCTION** 3.1 Insulating the Gas Plant 3.2 Composting 3.3 Hot Water circulation 3.4 Use of Chemicals 3.5 Solar energy systems	**5**
4	**COMMISSIONING AND MANAGEMENT OF BIOGAS PLANT** 4.1 Commissioning and Management of Biogas Plant, Community Plant 4.2 Biogas Appliances 4.3 Effect of Biogas on Engine Performance 4.4 Socio-Economic Aspects of Biogas 4.5 Cost-Benefit Analysis of Biogas Plant	**5**
5	**REACTORS** 5.1 Immobilized Reactors 5.2 UASB Reactor- 5.2.1 Fixed Film	**4**

	5.2.2 Hybrid 5.2.3 Bi-Phasic Reactor	
6	**ECONOMICS AND ENVIRONMENTAL ASPECTS** 6.1 Energy Effectives and Cost Effectiveness 6.2 History of Energy Consumption and Cost 6.3 Economic and competitive issues for biogas energy 6.4 Policy and market interventions (subsidies, credits, carbon markets etc.) 6.5 Environmental Aspects of Bio-Energy Conversion	**5**
7	**MUNCIPAL & INDUSTRIAL WASTE TO ENERGY CONVERSION** **7.1 SOLID WASTE** 7.3.1 Definition of Solid Waste 7.3.2 Sources, Types & Composition of Solid waste 7.3.3 Properties of Solid Waste **7.2 MUNCIPAL SOLID WASTE** 7.5.1 Physical, Chemical & Biological Properties 7.5.2 Waste Minimization and Recycling of Municipal Waste 7.5.3 Waste Treatment & Disposal Size Reduction *a Aerobic Composting* b *Incineration* : Measures of mitigate environmental effects due to incineration **7.3 WASTE DISPOSAL** 7.3.1 Land Fill Method of Solid Waste Disposal a Land Fill Classification b Types & Methods of Land Fill 7.3.2 Layout & Preliminary Design of Land Fill 7.3.3 Composition, Characteristics, Generation, Movement and Control of Landfill Leachate & Gases 7.3.4 Environmental Monitoring System for Land Fill Gases **7.4 INDUSTRIAL SOLID WASTES** 7.4.1 Composition of Industrial Solid Waste 7.4.2 Biodegradable & Non-Biodegradable Hazardous 7.4.3 Methods of Detoxification 7.4.4 Legal Aspects of Municipal Solid Waste	**15**

	Collection **7.5 HAZARDOUS WASTE MANAGEMENT** 7.5.1 Definition & Identification of Hazardous Waste 7.5.2 Sources and Nature of Hazardous Waste 7.5.3 Hazardous Waste Control 7.5.4 Impact on Environment 7.5.5 Assessment of Hazardous Waste Sites 7.5.6 Underground Storage Tanks Construction, Installation & Closure	
8	**BIOFUEL** 8.1 Ethanol and Methanol production from Cellulosic Biomass 8.2 Biodiesel Production from Non-Edible Oil Seeds	**5**

Text Book

1. David Boyles, Bio Energy Technology Thermodynamics and costs, Ellis Hoknood, Chichester, 1984.
2. Non-Conventional Energy Sources, **G. D. Ray, Khanna Publications**.
3. Non-Conventional Energy Resources, **B.H. Khan, The McGraw Hill Publications**.

References

1. Khandelwal, K.C., Mahdi, S.S., Biogas Technology – A Practical Handbook, Tata McGraw-Hill, 1986.
2. R. C. Mahaeswari, Bio Energy for Rural Energisation, Concepts Publication, 1997.
3. Tom, B. Reed, Biomass Gasification – Principles and Technology, Noyce Data Corporation, 1981
4. Best Practises Manual for Biomass Briquetting, I R E D A, 1997.
5. S. Eriksson and M. Prior, The briquetting of Agricultural wastes for fuel, FAO Energy and Environment paper, 1990.
6. “Energy conversion systems” by Rakosh das Begamudre, New age international publishers, New Delhi - 2000.
7. “Renewable Energy Resources” by John Twidell and Tony Weir, 2nd edition, Fspon & Co.
8. Parker, Colin & Roberts, Energy from Waste – An Evaluation of Conversion Technologies, Elsevier Applied Science, London, 1985
9. Shah, Kanti L., Basics of Solid & Hazardous Waste Management Technology, Printice Hall, 2000.
10. Manoj Datta, Waste Disposal in engineered Landfills, Narosa Publishing

House, 1997
11. Rich, Gerald et. al., Hazardous Waste Management Technology, Podvan Publishers, 1987
12. Bhide AD., Sundaresan BB., Solid Waste Management in Developing Countries, INSDOC New Delhi, 1983.
13. Mathur, A.N., and Rathore, N.S., "Renewable Energy and Environment" – Proceedings of the National Solar Energy, Himanshu Publications, Udaipur
14. Rao and Parulekar B.B., (19)

Websites

1 http://www.bio-energy.at

2 http://www.abchansen.dk.

3 www.soest.hawaii.edu/csf

4 http://www.bical.net

5 http://www.volund.dk

6 http://www.iswa.org

S. Y. B. Sc.	
Semester - II	
Paper No. 1	**Marks : 50**
PHYSICS	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	OSCILLATIONS, WAVES AND SOUND	
1.	**Undamped Free Oscillations** 1.1 Different types of equilibria (stable, unstable, and neutral equilibrium) 1.2 Potential well and periodic oscillations, Approximation of a general potential well V(x) to a parabola for small oscillations 1.3 Definition of linear and angular S.H.M. 1.4 Differential equation of S.H.M. and its solution (exponential form) 1.5 Composition of two perpendicular linear S.H.Ms. for frequencies 1:1 and 1:2 (analytical method) 1.6 Lissajous's figures and its uses, Applications (mechanical, electrical and optical) 1.7 Problems	**9**
2.	**Damped Oscillations** 2.1 Introduction 2.2 Differential equation of damped harmonic oscillator and its solution, discussion of different cases. 2.3 Logarithmic decrement 2.4 Energy equation of damped oscillations 2.5 Power dissipation 2.6 Quality factor 2.7 Application: LCR series circuit 2.8 Problems	**9**
3.	**Forced Oscillations** 3.1 Forced oscillation with one degree of freedom 3.2 Differential equation of forced oscillation and its solution (transient and steady state) Amplitude of forced oscillation 3.3 Resonance and its examples: mechanical (Barton's pendulum), optical (sodium vapor lamp), electrical (LCR Circuit) 3.4 Velocity and Amplitude resonance 3.5 Sharpness of resonance 3.6 Energy of forced oscillations 3.7 Power dissipation 3.8 Quality factor and Bandwidth 3.9 Application of forced oscillations (LCR circuit) 3.10 Equation of coupled oscillations, electrically coupled	**10**

	oscillations 3.11 Problems	
4.	**Wave Motion** 4.1 Differential equations of wave motion in continuous media 4.2 Equations for longitudinal waves and it's solution (one dimension only) 4.3 Equation for transverse waves and its solution (one dimension only) 4.4 Energy density and intensity of a wave 4.5 Discussion of seismic waves 4.6 Problems	**8**
5.	**Doppler Effect** 5.1 Explanation of Doppler effect in sound 5.2 Expression for apparent frequency in different cases. 5.3 Asymmetric nature of Doppler effect in sound 5.4 Doppler effect in light, symmetric nature of Doppler effect in light. 5.5 Applications: Red shift, Violet shift, Radar, Speed trap, Width of a spectral line. 5.6 Problems	**6**
6.	**Sound** 6.1 Definition of sound intensity, loudness, pitch, quality and timber 6.2 Acoustic intensity level measurement 6.3 Acoustic pressure and it's measurement 6.4 Reverberation time and Reverberation of a hall 6.5 Sabine's formula (without derivation) 6.6 Stroboscope 6.7 Problems	**6**

OSCILLATIONS, WAVES AND SOUND

Reference Books:

1. Waves and Oscillations, Stephenson
2. The physics of waves and oscillations, N. K. Bajaj, Tata McGraw- Hill, Publishing co. ltd.
3. Fundamentals of vibration and waves, S. P. Puri, Tata McGraw- Hill, Publishing co. ltd.
4. A text book of sound, Subramanyam and Brijlal, Vikas Prakashan
5. Sound, Mee, Heinmann, Edition – London
6. Waves and Oscillations, R. N. Chaudhari, New age international (p) ltd.

S. Y. B. Sc.	
Semester - II	
Paper No. 2	**Marks : 50**
PHYSICS	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	OPTICS	
1	**Geometrical Optics** 1.1 Introduction to development of Optics 1.2 Lenses: thin and thick lenses 1.3 Lens equation 1.4 Lens maker's formula 1.5 Cardinal points of an optical system 1.6 Combination of two thin lenses (equivalent lenses) (including derivation for focal length and cardinal points). 1.7 Problems	**8**
2.	**Lens Aberrations** 2.1 Introduction 2.2 Types of aberrations: monochromatic and chromatic aberration 2.3 Types of monochromatic aberration and their reduction 2.3.1 Spherical aberration 2.3.2 Coma 2.3.3 Astigmatism 2.3.4 Curvature of field 2.3.5 Distortion 2.4 Types of chromatic aberration: Achromatism (lenses in contact and separated by finite distance) 2.5 Problems	**8**
3.	**Optical Instruments** 3.1 Simple microscope and Compound microscope 3.2 Telescopes, Reflection and transmission type of telescope 3.3 Eyepieces: Huygens's eyepiece, Ramsden's eyepiece, Gauss's eyepiece 3.4 Constant deviation spectrometer 3.5 Problems	**10**
4.	**Interference and Diffraction** 4.1 Classification of interference of thin films, Interference by division of amplitude 4.2 Interference by wedge shaped film: Interference due to reflected light and transmitted light. 4.3 Fringes of equal inclination, equal thickness, equal chromatic order (FECO fringes), colors of thin films 4.4 Interferometry: Michelson's interferometer and Fabry-Perot	**12**

	interferometer 4.5 Types of diffraction: Fresenel's diffraction and Fraunhoffer's diffraction 4.6 Fraunhoffer's diffraction at double slit and its analytical treatment, Fraunhoffer's diffraction at N slits 4.7 Plane diffraction grating 4.8 Rayleigh's criterian for resolution 4.9 Resolving power of a grating 4.10 Problems	
5	**Polarization** 5.1 Introduction to polarization 5.2 Types of polarization- plane, circular, elliptical 5.3 Polarization by reflection of light 5.4 Brewster's law 5.5 Law of Malus 5.6 Polarisation by double refracting uniaxial crystals 5.7 Linear polarizer (Polaroid) 5.8 Fabrication of linear polarizer by Nicol prism 5.9 Problems	**10**

Reference Books:

1. Optics, fourth edition, Pearson education, E. Hetch, A. R. Genesan
2. A Text book of Optics, N.Subhramanyam, Brijlal, M. N. Avadhanulu, S. Chand publication.
3. Introduction to Optics, Third Edition, F.L. Pedrotti, Pearson Education
4. Physical Optics by A.K.Ghatak, McMillan, New Delhi
5. Fundamental of Optics, F.A.Jenkins, H.E.White, McGraw-Hill international Edition.
6. Principles of optics, D.S. Mathur, Gopal Press, Kanpur
7. Optics and Atomic physics, D.P.Khandhelwal, Himalaya Publication Bombay.
8. Fundamentals of optics- Francies A Jenking, Harvey E.White, Tata McGraw Hill

S. Y. B. Sc.	
Semester - II	
Paper No. 3	**Marks : 50**
CHEMISTRY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	INORGANIC CHEMISTRY	
1	**General Principles of Metallurgy:-** 1.1 Introduction occurrence of metals, ores and minerals, types of ores, operations involved in metallurgy, crushing, connentaion, various methods of concentration such as hand picking, gravity separation, magnetic separation. 1.2 Froth flotation, Calcinations, Roasting etc. Reduction, various methods of reduction such as smelting, Aluminothermic process and electrolytic reduction, Refining of metals, various methods of refining such as poling, liquation, electrolytic and vapour phase refining.	**5**
2	**Metallurgy of Aluminium (Electrometallurgy) :-** 2.1 Occurrence, physiochemical principles, Extraction of Aluminium 2.2 Purification of bauxite by Bayer's process, Electrolysis of alumina, application of aluminum and its alloys.	**4**
3	**Metallurgy of Iron and Steel (Pyrometallurgy)** 3.1 Occurrence, concentration, calcination, smelting physio-chemical principles, reactions in the blast furnace, wrought iron. 3.2 Manufacture of steel by Bessemer and L.D. process, its composition and applications.	**6**
4	**Chemistry of p-block Elements (III A to VII A groups):-** 4.1 Position of elements in the periodic table, electronic configuration of elements, Reasoning of anomalous behavior of first member of each group. Trends in the properties of the elements with respect to following points - size of atoms and ions, ionization potential, electron negativity, oxidation state, reactivity. 4.2 Bonding and shapes of following molecules – B_2H_6, PCl_5, Al_2Br_6, CO_2, SF_6, H_2SO_4, Allotropes of carbon diamond,	**6**

	graphite and fullerene.	
5	**Chemistry of d-block elements:-** 5.1 Position of d-block in periodic table, trends in properties of these elements w.r.t. (a) size of atoms & ions (b) reactivity (c) catalytic activity (d) oxidation state (e) complex formation ability (f) colour (g) magnetic properties (h) Non-Stoichiometry (i) density, melting & boiling points.	**7**
6	**Chemical Toxicology:-** 6.1 Toxic chemicals in the environment. 6.2 Impact of toxic chemistry on enzymes. 6.3 Biochemical effect of Arsenic. 6.4 Biochemical effect of cadmium. 6.5 Biochemical effect of Lead. 6.6 Biochemical effect of Mercury. 6.7 Biological methylation.	**5**
7	**Acids Bases, Solvents and Reactions in non-aqueous solvents :-** 7.1 Definition of acids and bases, Arrhenius theory, Lowry bronsted theory (in brief). 7.2 Lewis concept, Lux-flood theory, strength of acids and bases. Trends in strength of hydracids and oxacids, properties of solvents - M. P., B. P. dipole-moments, dielectric constant, Lewis acid-base character, protonic acidity, 7.3 Types of solvents. Hard & soft acids and bases	**8**
8	**Corrosion and passivity**	**7**

Reference :

1. Introduction to electrochemistry by S. Glasstone 2nd Ed. pages 491-503.

S. Y. B. Sc.	
Semester - II	
Paper No. 4	**Marks : 50**
CHEMISTRY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ANALYTICAL CHEMISTRY	
1	**Introduction to Analytical chemistry:-** 1.1 Importance, the analytical process, sampling (solid liquid and gases), 1.2 Hazards in sampling, sample treatment (aqueous acid, fluxes, ashing)	**3**
2	**Inorganic Qualitative Analysis** 2.1 Basic principles, common ion effect, solubility, solubility product, preparation of original solution, classification of basic radicals in groups, separation of basic radicals. 2.2 Removal of interfering anions (phosphate and borate) Detection of acidic	**7**
3	**Analysis of Organic Compounds (Qualitative & Quantitative)** 3.1 Types of organic compounds. Characters tests and reactions of different functional groups. 3.2 Analysis - Estimation of C, H(O) by combustion tube, Detection of nitrogen, sulphur, 3.3 Halogen and phosphorus by Lassaigen's test. 3.4 Estamation of nitrogen by Duma's Kjeldahl's method. Estimation of Halogen, Sulphur and phosphorus by Carious method. 3.5 Determination of empirical and molecular formula, Numerical problems.	**8**
4	**Errors in Qualitative Analysis:-** 4.1 Accuracy and precision, methods of expressing accuracy, methods of expressing precision, 4.2 Classification of errors, minimization of errors, significant figures and computations, 4.3 Numerical problems.	**5**

5	**Volumetric Analysis:-** 5.1 Introduction to volumetric analysis, calibration of apparatus (burette, pipette and volumetric flask) standard solution and their preparation. Various methods of expressing the concentration of solutions. Equivalent weight in different types of reactions, primary and secondary standard solutions, Numerical problems. 5.2 **Classification of volumetric analysis** a) Acid base (neutralization) titrations : Theory of indicators, theory of acid base indicators, mixed and universal indicators, neutralization curves for strong acid - strong base, weak acid - strong base, weak base - strong acid, weak acid - weak base, polybasic acid with strong base. Displacement titrations, choice of indicators, numerical problems. b) **Oxidation-Reduction Titration :** Principle, titration curves with reference to Fe (II) and Ce (IV) reactions , detection of end points, Numerical problems. c) **Complexomatric Titration:-** Principal, Mg- EDTA complex, Standardisation, d) **Iodometry and Iodimetry** General discussion, detection of end point, difference between idometry and iodimetry. Standardisation of sodium thiosulphate solution with potassium dichromate and iodine method. Applications – Estimation of copper in crystalline copper sulphate, Estimation of available chlorine in bleaching powder.	**18**
6	**Solvent Extraction :-** 6.1 Introduction, Principle of solvent extration, Distribution coefficient, distribution retio, relation between Distribution coefficient and distribution retio, factors affecting solvent extraction, percentage extracted, 6.2 Solvent exration method, sepration factor, batch extraction, counters current extraction, application of solvent extraction, numerical problems.	**7**

Reference Books

1. Analytical chemistry by G. D. Christain, John Weiley and sons, 5th Edition.
2. Fundamentals of Analytical chemistry by D. A. Skoog, D. M. West and F. J. Holler, 6th Edn.
3. A text book of macro and semi micro Qualitative analysis by A. I. Vogel, 5th Edition
4. Vogel's text book of Quantitative Inorganic Analysis revised Edn. J. Barret, R. C. Danney, G.H. Jeffery and J. Mendham ELBS.
5. Quantitative organic Analysis 4th Ed. A. I. Vogel ELBS
6. Quantitative Inorganic Analysis 4th Ed A. I. Vogel ELBS
7. Instrumental methods of chemical Analysis by Chatwal and Anand 6th Edition
8. A text book of Quantitative Inorganic Analysis A. I. Vogel 3rd Edition.
9. Basic concept of analytical chemistry- S. M. Khopkar.
10. Instrumental methods of chemical analysis-Willard, Deen & Merrit-6th Edition.
11. Analytical chemistry by Skoog.

S. Y. B. Sc.	
Semester - II	
Paper No. 5	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	SOLAR PHOTOVOLTAIC ENERGY CONVERSION - II	
1.	**SOLAR CELL FABRICATION TECHNOLOGY** 1.1 Preparation of Metallurgical, Electronic & Solar Grade Silicon 1.2 Production of Single Crystal, Multicrystalline, Gallium Arsenide, Copper Indium Diselenide, Amorphous Solar Cell 1.3 Wafering & Doping 1.4 Thin-Film Modules-method of Manufacture 1.5 Procedure of Masking 1.6 Photolithography & Etching 1.7 Role of Nano-Technology in Solar Cell 1.8 Module Lamination & Fabrication	**9**
2.	**SOLAR PV SYSTEM** 2.1 Classification 2.2 Stand-Alone Solar PV System 2.3 Grid Interactive Solar PV System 2.4 Hybrid Solar PV System 2.5 Battery technology 2.5.1 Introduction : Basic Concepts, Components of Battery, Operation of Battery 2.5.2 Battery Characteristics 2.5.3 Classification of Batteries 2.5.4 Classical batteries : Lead Acid, Nickel Cadmium, Zinc Manganese dioxide 2.6 Inverter 2.6.1 Introduction 2.6.2 Classification of Inverter 2.6.3 Single Phase Series Inverter 2.6.4 Single Phase Full Bridge Inverter 2.6.5 Single Phase Inverter Output Voltage Control	**14**

	2.6.6 Single Pulse Width Modulation 2.6.7 Multiple Pulse Width Modulation	
3.	**SMART GRID TECHNOLOGY** 3.1 Evolution of Electric Grid 3.1.1 Concept of Smart Grid 3.1.2 Definition of Smart Grid 3.1.3 Need of Smart Grid 3.1.4 Functions Smart Grid 3.1.5 Opportunities and Barriers Smart Grid 3.1.6 Difference between Conventional Grid and Smart Grid 3.1.7 Concept of Resilient Grid and Smart Grid 3.2 Role of Smart Meter in Smart Grid 8.2.1 Real Time Prizing 3.3 Smart Appliances 3.4 Automatic Meter Reading(AMR) 3.5 Smart Sensors 3.6 Smart Grid Life Cycle 3.6.1 Regulatory & Cost Recovery 3.6.2 Strategy & Planning 3.6.3 Technology Integration 3.6.4 Business Process Readiness 3.6.5 Compliance & Risk Management	**15**
4.	**SOLAR PV APPLICATIONS** 4.1 Grid Interactive PV Power Generation 4.2 Water Pumping 4.3 Lighting 4.4 Medical Refrigeration 4.5 Village Power 4.6 Telecommunication and Signalling	**10**

TEXT-BOOKS:

1. Non-Conventional Energy Resources, B. H. Khan, The McGraw Hill Publications.
2. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications.
3. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principles of Thermal Collection and Storage, Tata McGraw-Hill, New Delhi.

4. Gilbert M. Masters, Renewable and Efficient Electric Power Systems, Prentice-Hall.
5. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill.
6. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London, 1991.
7. C.S. Solanki, Solar Photovoltaics: Fundamental, Technologies and Applications, Prentice Hall of India, 2011.
8. Antonio Luque, Steven Hegedus; Handbook of Photovoltaic Science and Engineering; John Wiley and Sons, 2002.
9. Clark W. Gellings, "The Smart Grid: Enabling Energy Efficiency and Demand Response", CRC Press.
10. Jean Claude Sabonnadiere, Nouredine Hadjsaid, "Smart Grids", Wiley Balackwell.

REFERENCES:

1. Kreith F. and Kreider J.F., 'Principles of Solar Engineering', McGrawhill Book Co.
2. H.A. Kiehne (ed), Battery Technology Handbook; Marcel and Dekker, New York, 1989.
3. Andres Carvallo, John Cooper, "The Advanced Smart Grid: Edge Power Driving Sustainability: 1", Artech House Publishers July 2011.

S. Y. B. Sc.	
Semester - II	
Paper No. 6	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
BIO-ENERGY - II (THERMOCHEMICAL CONVERSION OF BIOMASS)		
1	**INTRODUCTION** 1.1 Introduction to Biomass Conversion 1.2 Biomass Composition 1.3 Properties of Biomass 1.1 Thermal degradation : Steps, Arrhenius law, Kinetics 1.2 Gas Producers	**4**
2	**GASIFICATION** 2.1 Principles of Gasification 2.2 Pre-Treatment of Biomass 2.2.1 Physical Treatment : Mechanically Grinding & Chipping 2.2.2 Moisture Removing or Adding 2.2.3 Application of Binding Agent 2.2.4 Steaming 2.2.5 Torrefaction 2.3 Chemistry of Gasification 2.4 Types of Gasifiers and Zones 2.5 Updraft Gasifier – Principles – Design – Application 2.6 Downdraft Gasifier - Principles – Design – Application 2.7 Cross Draft Gasifier - Principles – Design – Application 2.8 Open core Gasifier - Principles – Design – Application 2.9 Fluidized Bed Gasifier - Principles – Design – Application – Models	**15**
3	**GASIFIER APPLICATIONS** 3.1 Engine system : Requirements 3.2 Thermal application : System, Requirements	**4**
4	**COMBUSTOR** 4.1 Wood Burning Stoves 4.2 Principle of Wood Burning Stoves 4.3 Design : Wood Burning Stoves	**5**
5	**PYROLYSIS** 5.1 Pyrolysis Plants	**5**

	5.2 Principle of Pyrolysis Plants 5.3 Products Recovery from Pyrolysis Plants	
6	**COGENERATION** 6.1 Principle & Classification (Topping Cycle, Bottoming Cycle, Combined cycle, Rankine Cycle) of Cogeneration 6.2 Layout of Cogeneration system 6.3 Cogeneration Technologies 6.3.1 Steam Turbine Cogeneration Systems 6.3.2 Gas Turbine Cogeneration Systems 6.3.3 Combined Cycles Cogeneration Systems 6.3.4 Advanced Cogeneration Systems 6.4 Issues & Applications of Cogeneration Technologies 6.4.1 Applications: Utility Sector, Industrial Sector, Building Sector, Rural Sector 6.4.2 Impacts of Cogeneration plants on Fuel, Electricity and Environment 6.5 Technical Parameters for Cogeneration: Heat – to – Power Ratio, Quality of Thermal Energy Needed, Load Pattern, Fuels Available, System Reliability, Grid Dependent System Versus Independent System, Retrofit versus New Installation, Electricity Buy-Back, Local Environmental Regulation 6.6 Instruments related to Gasifiers studies	**15**

REFERENCES:

1. Vimal, O.P. and Tyagi P.D. 1985. Fuel wood from waste land. Agricole publishing Academy, New Delhi.
2. Glass, D.L. and Emert M. 1985. Fuels from Biomasss waste Ann Arbor Science publishing Inc. Michigan.
3. Tilman D.A. Progress in Biomass Conversion Vol. I to V., Academic Press, London.
4. Kjellstorm N. 1980. Producer Gas – Local Electricity Generation from wood and agricultural residues. FAO Publication.
5. Kaupp A. 1984. Gasification of Rice Hulls - Theory and Practice. Publication of GATE, Gmbh, Germany.

Book:

1. Non-Conventional Energy Sources. **G.D. Ray, Khanna Publications.**
2. Non-Conventional Energy Resources, **B.H. Khan, The McGraw Hill Publications**.

T. Y. B. Sc.	
Semester - I	
Paper No. 1	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	SOLAR THERMAL ENERGY CONVERSION - I	
1	**BASICS IN SOLAR ENERGY SYSTEMS** 1.1 Different types of Renewable Energy Sources 1.2 Sun as a Source of Energy 1.3 Solar Radiation 1.4 Extra Terrestrial at Earth's Surface – Horizontal, Tilted Surface 1.5 Estimation of Radiation 1.6 Alternation of Solar Radiation by Atmosphere 1.7 Effect of Orientation of Receiving Surface	**4**
2	**BASIC SUNS-EARTH ANGLES** 2.1 Angle of Latitude 2.2 Declination Angle 2.3 Hour Angle 2.4 Inclination Angle (Altitude) 2.5 Zenith Angle 2.6 Solar Azimuth Angle 2.7 Tilt Angle (Slope) 2.8 Surface Azimuth Angle 2.9 Angle of Incidence 2.10 Local Solar Time	**8**
3	**SOLAR RADIATION** 3.1 Solar Radiation Data 3.2 Estimation of Monthly Average, Daily Total Radiation on Horizontal Surface 3.3 Estimation of Monthly Average, Daily Diffuse Radiation on Horizontal Surface 3.4 Monthly Average, Daily Global Radiation on Tilted Surface	**6**

4	**MEASUREMENT OF SOLAR RADIATION** 4.1 Measurement of Solar Radiation 4.1.1 Pyranometer 4.1.2 Pyrheliometer 4.1.3 Sunshine Recorder 4.2 Radiation Characteristics of Opaque Materials 4.3 Radiation Transmission through covers and Absorption of Collectors	**5**
5	**THE SOLAR ENERGY OPTION: AN OVERVIEW OF THERMAL APPLICATIONS** 5.1 Devices for Thermal Collection and Storage 5.2 Thermal applications	**5**
6	**LIQUID FLAT-PLATE COLLECTORS (FPC)** 6.1 Definition 6.2 Characteristic Features of FPC 6.3 Performance Analysis 6.4 Transmissivity - Absorptivity Product 6.5 Overall Loss Coefficient and Heat Transfer Correlations 6.6 Collector Efficiency Factor 6.7 Effects of Various Parameters on Performance 6.8 Advantages of Flat plate Collector 6.9 Alternatives to the Conventional Collector	**10**
7	**SOLAR AIR HEATERS & WATER HEATER** 7.1 Introduction 7.2 Performance Analysis of Solar Air Heater 7.3 Types of Air Heaters 7.3.1 Collector with Non-Porous Absorber 7.3.2 Collector with Porous Absorber 7.4 Testing Procedure of Solar Air Heater 7.5 Application of Solar Air Heater 7.6 Solar Water Heating System : Thermosiphon & Forced Flow	**10**

TEXT BOOKS:

1. Non-Conventional Energy Sources, **G.D. Rai, Khanna Publishers**.
2. Non-Conventional Energy Resources, **B.H. Khan, The McGraw-Hill Publications**.
3. S.P. Sukhatme and J.K. Nayak, Solar Energy – Priniciples of thermal collection and storage; Tata McGraw-Hill, New Delhi
4. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
5. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London, 1991.
6. M.S. Sodha, N.K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986
7. M.A.S. Malik, G.N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon Press, New York, 1982.
8. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principes of thermal collection and storage, Tate McGraw-Hill, New Delhi
9. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
10. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
11. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, Johm Wiley, London, 1991.
12. C.S. Solanki, Solar Photovoltaics: Fundamental, technologies and applications, Prentice Hall of India, 2011.

REFERENCES:

1. Kreith F and Kreider J.F., ‘Principles of Solar Engineering’, McGraw Hill Book Co.,
2. A. Rabl, Active Solar Collectors and Their Applications, Oxford University Press, New York, 1985.
3. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall

4. Kreith F and Kreider J.F., ‘Principles of Solar Engineering’, McGrawHill Book Co.

Text Book

1. J. A. Duffie and W. A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London, 1991.
2. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications.
3. Non-Conventional Energy Resources, B.H. Khan, The McGraw Hill Publications.

References

1. Sukhatme, S. P., Solar Energy Principles of Thermal Collection and Storage, Tata McGraw Hill Publishing Co., 1996.
2. Kreith, F., and Kreider J. F., Principles of Solar Engineering, McGraw hill Book Co., 1978.
3. Garg, H.P., Treatise on Solar Energy, Volume 1, 2 and 3, John Wiley and Sons, 1982.
4. Seshadri et.al. Climatological and Solar Data for India, Sarita Prakashan, 1969.

T. Y. B. Sc.	
Semester - I	
Paper No. 2	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	WIND ENERGY - I	
1.	**BASICS OF WIND** 1.1 Introduction 1.2 Causes of wind 1.3 Types of Winds 1.3.1 Planetary or Permanent Winds 1.3.2 Trade Winds 1.3.3 Westerlies Winds 1.3.4 Polar Winds 1.3.5 Periodic Winds 1.3.6 Sea Breeze Winds 1.3.7 Land Breeze Winds 1.3.8 Monsoon Winds : Summer, Winter, Local 1.4 Local & Regional Wind System 1.5 Meteorology of Wind: Global Circulation 1.6 Forces influencing Wind – Pressure Gradient Force & Coriolis Force 1.7 Power in the Wind	**6**
2.	**WIND MEASUREMENT TECHNIQUIES** 2.1 Measurement & Instrumentation 2.2 Wind Data Presentation 2.3 Power Law Index, Betz Constant, Terrain value 2.4 Wind data Characterization 2.4.1 Mean Wind Speed 2.4.2 Wind Speed Distribution : Diurnal Pattern, Depression & Anti-Cyclones and Annual Pattern 2.4.3 Wind Turbulence Characteristics : Short-term fluctuations & Long-term fluctuations 2.4.4 Wind Direction Distribution 2.4.5 Wind Shear 2.4 Wind Data Statics, Weibull, Rayleigh & Normal Distributions	**8**

3.	**WIND RESOURCE ASSESSMENT** 3.1 Atmospheric Boundary Layer, Atmospheric Stability 3.2 Wind Power Conversion 3.3 Wind Power Estimation 3.4 Site Survey & Analysis	**5**
4.	**WIND MILL SITE SELECTION & MICRO SITING** ***4.1 Site Selection*** 4.1.1 Anemometric wind data: Wind speed, Wind direction 4.1.2 Site Topography a. Availability of wind $V_{(t)}$ curve at the proposed site b. Wind structure at the proposed site 4.1.3 Terrain 4.1.4 Altitude 4.1.5 Local Ecology 4.1.6 Project Accessibility a. Distance to Roads or Railways b. Nearness of site to local centre/users c. Nature of ground 4.1.7 Land cost ***4.2 Micrositing*** 4.2.1 Necessary Parameters a. Building Requirements (e.g. distances to residences) b. Distances between the individual turbines in a park 4.2.2 Environmental Aspects a Wind Condition (wind speed & Direction) b Influence of WTG on the environment (e.g. shadow flickering, noise emission) 4.2.3 Prevailing Conditions	**12**
5.	**AERODYNAMICS & WIND MILL BLADE** 5.1 Theory of Aerodynamics 5.1.1 Basic Equation: Continuity, Momentum & Energy Equation, Application of Momentum Equation 5.1.2 Calculation of Drag on Two-Dimensional body 5.2 Blade Element Theory & Aerofoil 5.2.1 Aerofoil Nomenclature & Characteristics 5.2.2 Incompressible flow over Aerofoil 5.2.3 Kutta Condition 5.2.4 Kelvin's Circulation Theorem 5.2.5 Classical Thin Aerofoil Theory	**5**

	5.2.6 Symmetric & Cambered Aerofoil 5.2.7 Prandt's Lifting Line Theory	
6.	**WIND ENERGY CONVERSION** 6.1 Wind Mill 6.2 Basic Components of Wind Mill Conversion System 6.3 Types of Wind Mills – Based on: 6.3.1 Application 6.3.2 Wind Flow Direction 6.3.3 Tower Type & Height 6.3.4 Rotor 6.3.5 Controls 6.3.6 Axis 6.3.7 Number & Types of Blades 6.3.8 Speed 6.3.9 Inventor & Make 6.4 Development of Wind Turbine 6.5 Wind Turbine Terminology 6.5.1 Tip Speed Ratio 6.5.2 Tip Loss 6.5.3 Lift / Drag / Axial Thrust 6.5.4 Slip Stream Theory 6.5.5 Rotor Solidity 6.5.6 Power & Torque co-efficient 6.5.7 Co-efficient of Performance 6.5.8 Efficiency 6.6 Wind Turbine Performance Analysis	**12**

TEXT BOOKS

1. E. I. Walil "Power Plant Technology", McGraw Hill Publishers, New York
2. G. D. Rai "Non-Conventional Energy Sources", Khanna Publishers, New Delhi.
3. B. H. Khan "Non-Conventional Energy Resources", McGraw Hill Publishers, New Delhi.
4. Meteorological Aspects of the Utilization of Wind as an Energy Source, Technical Note No. 175, World Meteorological Organization.
5. Wind Turbines – Fundamentals: Technologies, Application, Economics. Erich Hau, Springer – Verlag Berlin – Heidelbeg, 2000.
6. Gary L. Johnson, Wind Energy System", Printice Hall Inc, New Jersy, 1985.
7. E.H. Lysen, Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983.

8. DNV-Riso Guidelines for Design of Wind Turbines, Second Edition, Riso National Laboratory, Denmark, 2002.
9. Hansen, Martin,
10.
11. O., L., Aerodynamics of Wind Turbine, James & James (Science Publishers) Ltd., London 2000.
12. **J.F. Manwell, J.G. McGowan and A.L. Rogers Wind Energy Explained, John Willy & Sons 2003**
13. **A report by the EWEA The Economics of Wind Energy, March 2009**
14. **Paul Gipe, Wind Power for Home and Business, Chelsea Green Publishing Company, Vermont, Totnes, England, 1993**
15. Lysen, E.H., Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983.
16. T. Burton et al, Wind Energy Handbook, John Wiley and Sons, 2004.
17. G L Johnson, Wind Energy System, Manhattan, KS, 2004.
18. T. Burton, Handbook of Wind Energy, John Wiley and Sons, 2005.
19. R. Harrison, E. Hau, and H. Snel, Large wind turbines. John Wiley & Sons, Chichester, 2000
20. Thomas Ackermann (Ed), Wing power in Power Systems, John Wiley & Sons, Ltd, 2005
21. DNV-Riso Guidelines for Design of Wind Turbines, Second Edition, Riso National Laboratory, Denmark, 2002
22. T. Burton et al, Wind Energy Handbook, John Wiley and Sons, 2004.
23. I.J. Nagarath and D.P. Kothari, Electric Machines, Tata McGraw Hill, 2nd Ed. 2003.
24. IEC 61400 Wind Turbine Generator Systems
25. S. A. Nasar, I Boldea and L.E. Unnewehr, Permanent Magnet, Reluctance and Self-synchronous motors, CRC Press, London, 1993
26. S.N. Bhadra, D. Kastha and S. Banerjee, Wind Electrical Systems, Oxford Univ Press 2005.

REFERENCES

1. S. Rao & B. B. Parulekar, "Energy Technology", 3rd edition, Khanna Publishers, New Delhi, 1995.
2. Anna Mani & Dr. Nooley, "Wind Energy Data for India", 1983.
3. Logan (EARL), "Turbo Machinery Basic theory and applications", 1981.

T. Y. B. Sc.	
Semester - I	
Paper No. 3	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ENERGY STORAGE SYSTEMS - I	
1	**ENERGY STORAGE** 1.1 Need of energy storage 1.2 Different modes of Energy Storage 1.2.1 Potential Energy 1.2.2 Kinetic Energy & Compressed Gas System 1.2.3 Electrical and magnetic energy storage 1.2.4 Chemical Energy storage 1.2.5 Hydrogen for energy storage 1.2.6 Solar Ponds for energy storage	**18**
2	**ELECTROCHEMICAL ENERGY STORAGE SYSTEMS** 2.1 Primary & Secondary Batteries 2.2 Solid-State and Molten Solvent Batteries 2.3 Lead acid batteries 2.4 Nickel Cadmium Batteries, Advanced Batteries	**20**
3	**MAGNETIC AND ELECTRIC ENERGY STORAGE SYSTEMS** 3.1 Superconducting Magnet Energy Storage (SMES) Systems 3.2 Capacitor and Batteries	**10**

References:

1. Fuel cell technology handbook, edited by Gregor Hoogers, CRC Press 2003.
2. Handbook of Batteries and Fuel cell, David Linden, McGraw-Hill Book Company.
3. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications.
4. Non-Conventional Energy Resources, B.H. Khan, The McGraw Hill Publications.
5. High-temperature Solid Oxide Fuel Cells: Fundamentals, Design and Applications, S.C. Singhal, Elsevier Publications, 2003.
6. Fuel Cells for automotive applications – professional engineering publishing UK. ISBN 1-86058 4233, 2004.

T. Y. B. Sc.	
Semester - I	
Paper No. 4	Marks : 50
RENEWABLE ENERGY	No. of Lectures : 48

Sr. No.	Details	No. of Lectures
	OTHER RENEWABLE ENERGY SOURCES - I	
PART - A HYDROGEN ENERGY		
1	**INTRODUCTION**	**4**
2	**HYDROGEN PRODUCTION** 2.1 Electrolysis 2.2 Catalytic Methods 2.3 Thermo-chemical Methods 2.4 Fossil Fuel Methods 2.5 Solar Energy Method	**10**
3	**HYDROGEN STORAGE** 3.1 Hydrogen Storage Methods 3.2 Utilization of Hydrogen Gas 3.3 Hydrogen as an Alternative Fuel 3.4 Hydrogen Transportation 3.5 Utilization of Hydrogen Gas	**10**
PART-B	**NUCLEAR ENERGY**	
4	**NUCLEAR REACTIONS** 4.1 Mechanism of Nuclear Fission: Nuclides - Radioactivity – Decay Chains 4.2 Fission Process 4.3 Reactors 4.4 Reactor Materials 4.4.1 Characteristics of Nuclear Fuels 4.4.2 Nuclear Fuels	**10**
5	**REPROCESSING** 5.1 Nuclear Fuel Cycles 5.2 Spent Fuel Characteristics 5.3 Role of Solvent Extraction in Reprocessing & their	**4**

	Equipments	
6	**SEPARATION OF REACTOR PRODUCTS** 6.1 'Fuel Element' Dissolution 6.2 Precipitation Process 6.3 Ion Exchange 6.4 TBP and Thorax Processes 6.5 Isotopes : Principles of Isotope Separation	**5**
7	**WASTE DISPOSAL AND RADIATION PROTECTION** 7.1 Types of Nuclear Wastes 7.2 Safety Control and Pollution Control and Abatement 7.3 International Convention on Safety Aspects 7.4 Radiation Hazards Prevention	**5**

Reference Books:

1. Non-Conventional Energy Sources. **G. D. Ray, Khanna Publications.**
2. Non-Conventional Energy Resources, **B. H. Khan, The McGraw Hill Publications**.

T. Y. B. Sc.	
Semester - I	
Paper No. 5	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
ENERGY EFFICIENCY IN BUILDINGS & ECBC		
1	**ENERGY CONSERVATION IN BUILDINGS** 1.1 Introduction, Definition and concepts 1.2 Criticality of resources (Energy & Water) 1.3 Heat Loss and Heat Gain and its evaluation 1.4 Thermal Comfort Improvement Methods 1.5 IAQ Requirements 1.6 Electrical Energy Conservation 1.7 Opportunities and Techniques for energy conservation in Buildings	**12**
2	**THERMAL BEHAVIOUR OF BUILDING** 2.1 Orientation and Planning for Environment 2.2 Principles of Heat, Thermal Insulation, Humidity and Condensation, Humidity and Condensation 2.3 Admittance Method 2.4 Building energy Simulation 2.5 Load Calculation	**8**
3	**EFFICIENT LIGHTING AND DAYLIGHTING** 3.1 Principles of Lights, Artificial Lighting, Natural Lighting 3.2 Lighting and Visual ability 3.3 Light sources and Luminaries 3.4 Lighting System Design 3.5 Impacts of Lighting efficiency 3.6 Installed Interior and Exterior Lighting Power	**6**
4	**ENERGY CONSERVATION IN AIR CONDITIONING SYSTEM** 4.1 Energy Conservation in pumps/fan/blowers 4.2 Refrigerating machines 4.3 Heat Rejection Equipment 4.4 Energy efficient motors 4.5 Insulation	**8**

5	**INDOOR ENVIRONMENTAL REQUIREMENT AND MANAGEMENT** 5.1 Thermal Comfort of Building 5.2 Air Conditioning Requirement 5.3 Illumination Requirement 5.4 Auditory Requirement 5.5 Energy Management Options	**6**
6	**SERVICE HOT WATER & PUMPING** 6.1 Mandatory Requirements of Service Hot Water 6.2 Solar Water Heating 6.3 Equipment Efficiency 6.4 Supplementary Water Heating System 6.5 Piping Insulation 6.6 Swimming Pools	**8**

Reference Books:

1. J. Krieder and A. Rabi (1994): Heating and Cooling of Buildings: Design for Efficiency McGraw-Hill.
2. M. S. Sodha, N.K. Bansal, P.K. Bansal, A. Kumar and M.A.S. Malik, Solar Passive Building, Science and Design, Pergamon Press (1986).
3. J. R. Williams, Passive Solar Heating, Ann Arbar Science (1983).
4. R.W. Jones, J.D. Balcomb, C.E. Kosiewiez, G.S. Lazarus, R.D. Mc Farland and W.O. Waray (1982), Passive Solar Design Handbook, Vol 3, Report of U.S. Department of Energy (DOE/CS 0127/3)
5. J. L. Thrikeld, Thermal Environmental Engineering, Prentice Hall (1976).
6. (1993): IES Lighting Handbook, Reference and Application Volume, IESNA.
7. Thumann (1992): Lighting Efficiency Applications, Fairmont Press.

Websites:

1. http : //www.climat.arch.ucl.ac.be
2. http ://www.21design.com
3. http ://www.ashrae.org

www.log-one.com

T. Y. B. Sc.	
Semester - I	
Paper No. 6	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ENERGY MANAGEMENT	
1	**INTRODUCTION** 1.1 Energy & Sources of energy 1.2 Energy consumption and GDP 1.3 Costs of exploration and utilization of depletable resources, energy pricing, National energy plan	**4**
2	**ENERGY AUDIT** 2.1 Energy audit concepts 2.2 Energy audit based on $_1$st law and $_2$nd law of thermodynamics 2.3 Mass and Energy balances, 2.4 Availability analysis, 2.5 Evaluation of energy conserving opportunities, 2.6 Economic analysis and life cycle costing.	**12**
3	**ENERGY CONSERVATION** 3.1 Energy conservation areas 3.2 Energy transmission and storage, 3.3 Plant wide energy optimization Models, 3.4 Data base for energy management , 3.5 Energy conservation through controls, 3.6 Computer aided energy management, 3.7 Program organization and methodology.	**12**
4	**ENERGY USES** 4.1 Electrical energy conservation in building lighting, heating, ventilating and air conditioning, 4.2 Energy efficient motor, 4.3 power factor improvement in power systems, 4.4 Energy audit of Combustion process, 4.5 Boilers, 4.6 Turbines, 4.7 compressors, 4.8 Pumps,	**10**

	4.9 Heat exchangers, 4.10 Condensers, 4.11 Use of industrial, wastes.	
5	**ENERGY & ENVIRONMENT** 5.1 Energy environment interaction, 5.2 Environmental issues, 5.3 Global Warming, 5.4 Carbon dioxide emissions, 5.5 Depletion of ozone layer, 5.6 Govt.'s Regulations, 5.7 Energy Economy interaction	**10**

BOOKS:

1. Energy Management and condevtion, by Clive Beggs, Butterwoth- Heinemann Elsevier Science.
2. Optimising Energy Efficiency in the Industry, By Rajan, Tata Mc Graw Hill Publishers. 3. Guide to energy Management , By C.L Capehart, Fairmont Press.
3. Renewable Energy Sources and their Environment Impact, by Abbasi & Abbasi, Prentice Hall of India.
4. Environmental Risks and Hazards by Cutter, Prentice Hall of India.
5. Energy and Power Risk Management: New Developments in Modeling, Pricing and Hedging, buy Alexander Eydeland, John Wiley & Sons.
6. Energy Management Handbook by, Wayne C. Turner.
7. Thermodynamics, By Kenneth Wark, Tata Mc Graw Hill Publishers.
8. Exergy Analysis of Thermal, Chemical and Metallurgical Process, By Jan Szargut, David R. Morris, Frank R. Steward, Hemisphere Pub, Springer Verlag Publisher

S. Y. B. Sc.	
Semester - II	
Paper No. 1	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	SOLAR ENERGY THERMAL CONVERSION - II	
1	**CONCENTRATING COLLECTORS** 1.1 Introduction 1.2 Flat-plate Collectors with Plane Reflectors 1.3 Tracking lodes & Analysis of Cylindrical Parabolic Collector 1.4 Compound Parabolic Collector (CPC) 1.5 Paraboloid Dish Collector 1.6 Central Receiver Collector	**15**
2	**OTHER SOLAR THERMAL DEVICES** 2.1 Solar still basin & multiple effect 2.2 Solar Cookers 2.2.1 Box Type 2.2.2 Paraboloid Dish 2.2.3 Scheffler Type 2.3 Solar Dryers : Cabinet Type Dryer & Indirect Driers 2.4 Solar Ponds & its Analysis	**10**
3	**OTHER APPLICATIONS OF SOLAR ENERGY** 3.1 Solar Distillation 3.2 Solar Pumping 3.3 Solar Cooking 3.4 Solar Cooling & Refrigeration	**6**
4	**THERMAL ENERGY STORAGE** 4.1 Introduction 4.2 Sensible Heat Storage 4.3 Latent Heat Storage 4.4 Thermo Chemical Storage	**8**
5	**APPLICATIONS** 5.1 Thermal energy storage : various methods and applications 5.2 Solar ponds : thermal applications 5.3 Thermal Power Conversion 5.4 Solar Cooling and Heating 5.5 Solar Desalination, Drying, Solar Pumping	**9**

TEXT BOOKS:

1. Non-Conventional Energy Sources, **G.D. Rai, Khanna Publishers**.
2. Non-Conventional Energy Resources, **B.H. Khan, The McGraw-Hill Publications**.
3. S.P. Sukhatme and J.K. Nayak, Solar Energy – Priniciples of thermal collection and storage; Tata McGraw-Hill, New Delhi
4. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
5. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, John Wiley, London, 1991.
6. M.S. Sodha, N.K. Bansal, A. Kumar and M. A. S. Malik, Solar Passive Building: science and design, Pergamon Press, New York, 1986
7. M.A.S. Malik, G.N. Tiwari, A. Kumar and M.S. Sodha, Solar Distillation. Pergamon Press, New York, 1982.
8. S. P. Sukhatme and J.K. Nayak, Solar Energy – Principes of thermal collection and storage, Tate McGraw-Hill, New Delhi
9. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
10. Solar Energy, Fundamentals and Applications, Garg, Prakash, Tata McGraw Hill
11. J.A. Duffie and W.A. Beckmann, Solar Engineering of Thermal Processes, Johm Wiley, London, 1991.
12. C.S. Solanki, Solar Photovoltaics: Fundamental, technologies and applications, Prentice Hall of India, 2011.

REFERENCES:

1. Kreith F and Kreider J.F., ‘Principles of Solar Engineering’, McGraw Hill Book Co.,
2. A. Rabl, Active Solar Collectors and Their Applications, Oxford University Press, New York, 1985.
3. Gilbert M. Masters, Renewable and efficient electric power systems, Prentice-Hall
4. Kreith F and Kreider J.F., ‘Principles of Solar Engineering’, McGrawHill Book Co.

S. Y. B. Sc.	
Semester - II	
Paper No. 2	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	WIND ENERGY - II	
1	**GENERATORS USED IN WIND TURBINE** 1.1 Generator : Basics 1.2 D.C. Generator 1.3 Induction Generator 1.3.1 Construction & Principle of Operation 1.3.2 Development of Equivalent circuit 1.3.3 Power equation 1.3.4 Voltage control of self-excited generators 1.3.5 Grid connected single & double output generators 1.4 Synchronous Generators 1.4.1 Construction & Principle of operation 1.4.2 Operating characteristics power flow equations 1.4.3 Salient pole synchronous machines	**8**
2	**WIND FARM DEVELOPMENT & WIND POWER PROJECTS** 2.1 Introduction 2.2 General Principles & Basic Concepts 2.3 Techno-economic Feasibility considerations 2.4 Govt. & Private Utilities 2.5 Regulatory Affairs, Guidelines, Constraints 2.6 Land Selection, Topography & Survey Detail 2.7 Farm Layout 2.7.1 Methods & Procedure 2.7.2 Selection of Equipments 2.7.3 Transportation, Installation & Commissioning 2.7.4 Local infrastructure & Power evacuation 2.7.5 Grid quality & Reliability 2.8 Performance Analysis 2.8.1 Operation Efficiency of Wind Turbine	**12**

	2.8.2 Failure Analysis, Ageing and Rehabilitation 2.9 Effective Operation of Wind Farm 2.9.1 Central Monitoring System 2.9.2 Modern Developments & SCADA 2.10 Estimation of Energy Production, Capacity Factor, Capacity Credit & Energy Credit 2.11 Offshore Wind farm Development & Special considerations 2.12 Operation & Supervision of Wind Farm	
3	**POWER GENERATION & HYBRID SYSTEM** 3.1 Wind Energy Conversion System 3.1.1 Fixed Speed Drive Scheme 3.1.2 Variable Speed Drive Scheme 3.2 Diesel Power Generation 3.3 Photovoltaic Power Generation 3.4 Hybrid System Models 3.4.1 Wind – Diesel Hybrid System 3.4.2 Wind – Photovoltaic Hybrid System 3.4.3 Diesel – Photovoltaic Hybrid System 3.4.4 Wind – Photovoltaic – Diesel Hybrid System 3.5 Battery Banks and Power Converters	**12**
4	**COST ECONOMICS** 4.1 Cost Components of wind power project 4.2 Fixed and variable costs 4.3 Statutory provisions and polices 4.4 Economics of Wind Energy 4.4.1 Cost of energy 4.4.2 Return on Investment (ROI) 4.4.3 Life time cash flow and IRR 4.5 International Wind Energy Market	**4**
5	**ENVIRONMENTAL IMPACT & SAFETY ASPETCS** 5.1 Environmental Impact 5.1.1 Aviation interaction 5.1.2 Visual impact 5.1.3 Noise 5.1.4 Radio waves interference 5.1.5 Bird hits 5.1.6 Land use 5.1.7 Impact on flora & fauna	**12**

	5.1.8 Lightning strikes 5.2 Industry Guidelines and Govt. Regulations 5.3 Electrical Safety 5.3.1 Related to Wind Electric Generator 5.3.2 Local Utility & Electrical Inspectorate Standards 5.3.3 Earthing, Fencing, Lightning protection in wind farms 5.4 Corrosion Resistance 5.4.1 Methods & Practices 5.4.2 Selection of Corrosion Resistant Materials & Usage 5.5 Safety Hazards 5.5.1 Personal Safety i. Fire ii. Working at Heights 5.5.2 Wind Turbine Safety i Computer ii Emergency Stops iii Revolution Counters iv Wind Velocity v Parachutes vi Lightning Rods 5.5.3 Equipment Safety i Electricity Failure ii Earthquakes & Lightning iii Reptiles 5.5.4 Public Safety i Blade Throw ii Tower Failure iii Power Failure iv Shadow Flicker & Flashing 5.6 Mitigation of Safety Hazards	

TEXT BOOKS

1. E. I. Walil “Power Plant Technology”, McGraw Hill Publishers, New York
2. G. D. Rai “Non-Conventional Energy Sources”, Khanna Publishers, New Delhi.
3. B. H. Khan “Non-Conventional Energy Resources”, McGraw Hill Publishers, New Delhi.
4. Meteorological Aspects of the Utilization of Wind as an Energy Source, Technical Note No. 175, World Meteorological Organization.
5. Wind Turbines – Fundamentals: Technologies, Application, Economics. Erich Hau, Springer – Verlag Berlin – Heidelbeg, 2000.
6. Gary L. Johnson, Wind Energy System”, Printice Hall Inc, New Jersy, 1985.
7. E.H. Lysen, Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983.
8. DNV-Riso Guidelines for Design of Wind Turbines, Second Edition, Riso National Laboratory, Denmark, 2002.
9. Hansen, Martin, O., L., Aerodynamics of Wind Turbine, James & James (Science Publishers) Ltd., London 2000.
10. **J.F. Manwell, J.G. McGowan and A.L. Rogers Wind Energy Explained, John Willy & Sons 2003**
11. **A report by the EWEA The Economics of Wind Energy, March 2009**
12. **Paul Gipe, Wind Power for Home and Business, Chelsea Green Publishing Company, Vermont, Totnes, England, 1993**
13. Lysen, E.H., Introduction to Wind Energy, CWD Report 82-1, Consultancy Services Wind Energy Developing Countries, May 1983.
14. T. Burton et al, Wind Energy Handbook, John Wiley and Sons, 2004.
15. G L Johnson, Wind Energy System, Manhattan, KS, 2004.
16. T. Burton, Handbook of Wind Energy, John Wiley and Sons, 2005.
17. R. Harrison, E. Hau, and H. Snel, Large wind turbines. John Wiley & Sons, Chichester, 2000
18. Thomas Ackermann (Ed), Wing power in Power Systems, John Wiley & Sons, Ltd, 2005
19. DNV-Riso Guidelines for Design of Wind Turbines, Second Edition, Riso National Laboratory, Denmark, 2002
20. T. Burton et al, Wind Energy Handbook, John Wiley and Sons, 2004.
21. I.J. Nagarath and D.P. Kothari, Electric Machines, Tata McGraw Hill, 2nd Ed. 2003.
22. IEC 61400 Wind Turbine Generator Systems

23. S. A. Nasar, I Boldea and L.E. Unnewehr, Permanent Magnet, Reluctance and Self-synchronous motors, CRC Press, London, 1993
24. S.N. Bhadra, D. Kastha and S. Banerjee, Wind Electrical Systems, Oxford Univ Press 2005.

REFERENCES

1. S. Rao & B. B. Parulekar, "Energy Technology", 3rd edition, Khanna Publishers, New Delhi, 1995.
2. Anna Mani & Dr. Nooley, "Wind Energy Data for India", 1983.
3. Logan (EARL), "Turbo Machinery Basic theory and applications", 1981.

T. Y. B. Sc.	
Semester - II	
Paper No. 3	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ENERGY STORAGE SYSTEMS - II	
1	**SENSIBLE HEAT STORAGE (SHS)** 1.1 Mediums for SHS 1.2 Stratified storage systems 1.3 Rock-bed storage systems 1.4 Thermal storage in buildings 1.5 Energy storage in aquifers	**14**
2	**LATENT HEAT THERMAL ENERGY STORAGE PHASE** 2.1 Change Materials (PCMs) : Selection criteria of PCMs 2.2 Solar thermal LHTES systems 2.2.1. Energy conservation through LHTES systems 2.2.2. LHTES systems in refrigeration and air-conditioning systems 2.3 Areas of Application of Energy Storage 2.4 Food preservation 2.5 Waste Heat Recovery 2.6 Solar Energy Storage 2.7 Green House Heating 2.8 Power Plant Applications 2.9 Drying and Heating for Process Industries	**24**
3	**FUEL CELL** 3.1 Introduction to Technology Overview 3.2 Critical Functions of Cell Components 3.3 Fuel Cell Types 3.4 Characteristics and Advantages/Disadvantages of Fuel Cell 3.5 Fuel Cell Calculations, Fuel Processing Calculations 3.6 Applications of Fuel Cells	**10**

References:

1. Fuel cell technology handbook, edited by Gregor Hoogers, CRC Press 2003.
2. Handbook of Batteries and Fuel cell, David Linden, McGraw-Hill Book Company.
3. Non-Conventional Energy Sources, G.D. Ray, Khanna Publications.
4. Non-Conventional Energy Resources, B.H. Khan, The McGraw Hill Publications.
5. High-temperature Solid Oxide Fuel Cells: Fundamentals, Design and Applications, S.C. Singhal, Elsevier Publications, 2003.
6. Fuel Cells for automotive applications – professional engineering publishing UK. ISBN 1-86058 4233, 2004.

T. Y. B. Sc.	
Semester - II	
Paper No. 4	Marks : 50
RENEWABLE ENERGY	No. of Lectures : 48

Sr. No.	Details	No. of Lectures
	OTHER RENEWABLE ENERGY SOURCES - II	
	GEOTHERMAL & OCEAN ENERGY	
1	**INTRODUCTION TO GEOTHERMAL ENERGY**	**4**
2	**GEOTHERMAL RESOURCES** 2.1 Hydrothermal Resources 2.2 Geopressured Resources 2.3 Hot Dry Rock Resources 2.4 Magma Resources 2.5 Advantages & Disadvantages Of Geothermal Energy	**10**
3	**APPLICATIONS OF GEOTHERMAL ENERGY** 3.1 Electric Power Generation 3.2 Industrial Process Heat 3.3 Space Heating for various kinds of Buildings	**10**
4	**TIDAL ENERGY** 4.1 Introduction 4.2 Origin & Nature of Tidal Energy 4.3 Tidal Energy Technology 4.4 Advantages &Limitations of Tidal Energy 4.5 Environmental Impacts	**10**
5	**WAVE ENERGY** 5.1 Introduction 5.2 Energy & Power in Waves 5.3 Wave Energy Technology 5.3.1 Heaving Float Type 5.3.2 Pitching Type 5.3.3 Heaving & Pitching Float Type 5.3.4 Oscillating Water Column Type 5.3.5 Surge Devices	**8**

	5.4 Advantages & Disadvantages of Wave Energy	
6	**OCEAN THERMAL ENERGY** 6.1 Introduction 6.2 Ocean Thermal Conversion Technology (OTEC) 6.2.1 Open Cycle OTEC System 6.2.2 Closed or Anderson OTEC System 6.3 Environmental Impacts	**6**

Reference Books:

1. Non-Conventional Energy Sources. **G. D. Ray, Khanna Publications.**
2. Non-Conventional Energy Resources, **B. H. Khan, The McGraw Hill Publications**.

T. Y. B. Sc.	
Semester - II	
Paper No. 5	Marks : 50
RENEWABLE ENERGY	No. of Lectures : 48

Sr. No.	Details	No. of Lectures
	PROJECT MANAGEMENT	
1	**INTRODUCTION** 1.1 Definitions 1.2 Classifications 1.3 Project Risk 1.4 Scope	4
2	**PROJECT MANAGEMENT** 2.1 Definitions 2.2 Overview 2.3 Project Plan 2.4 Management principles applied to project management 2.5 Project management life cycles and uncertainty	5
3	**PROJECT PLANNING** 3.1 Scope 3.2 Problem Statement 3.3 Project Goals 3.4 Objectives 3.5 Success criteria 3.6 Assumptions 3.7 Risks 3.8 Obstacles 3.9 Approval process	8
4	**PROJECT IMPLEMENTATION** 4.1 Project resource requirements 4.2 Types of resources: men, materials, finance	5
5	**PROJECT MONITORING** 5.1 Evaluation 5.2 Control 5.3 Project network technique 5.4 Planning for monitoring and evaluation 5.5 Project audits 5.6 Project management information system	6

	5.7 Project scheduling 5.8 PERT & CPM 5.9 Project communication 5.10 Post project reviews	
6	**PROJECT TEAM MANAGEMENT** 6.1 Recruitment 6.2 Organizing 6.3 Human Resources 6.4 Team operating rules 6.5 Project Organization 6.6 Various forms of project organizations 6.7 Project organization charting – project contracts – principles 6.8 Compilation of contracts 6.9 Practical aspects 6.10 Legal aspects 6.11 Global tender 6.12 Negotiations 6.13 Insurance	**10**
7	**CLOSING THE PROJECT** 7.1 Types of project termination 7.2 Strategic implications 7.3 Project in trouble 7.4 Termination strategies 7.5 Evaluation of termination possibilities 7.6 Termination procedures	**5**
8	**PROJECT INVENTORY MANAGEMENT** 8.1 Nature of project inventory 8.2 Supply and transportation of materials 8.3 Use of PERT & CPM techniques	**5**

RECOMMENDED BOOKS:

1. Project Management – for 21st Centrury-Beenet P Lientz, Kathyn P rea- Academic Press, 1995
2. Project Management –Denislok

REFERENCE BOOKS:

1. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
2. Project Management – Gopalakrishnan – Mcmillan India Ltd.
3. Project Management-Harry-Maylor-Peason Publication

WEBSITE:

www.vtu.ac.in

T. Y. B. Sc.	
Semester - II	
Paper No. 6	**Marks : 50**
RENEWABLE ENERGY	**No. of Lectures : 48**

Sr. No.	Details	No. of Lectures
	ENERGY & ENVIRONMENT	
1	**ENERGY & ENVIRONMENT BALANCE** 1.1 Introduction to sources of energy 1.2 Overview of environmental effects 1.3 Various forms of energy extraction and consumption	**6**
2	**ENERGY** 2.1 Patterns of energy consumption 2.2 The laws of energy conversion 2.3 Work, heat, and internal energy 2.4 Qualitative presentation of thermodynamic barriers to energy use	**10**
3	**ENERGY AND THE INDUSTRIAL SOCIETY** 3.1 Energy and growth 3.2 Energy flow in an industrial society 3.3 Primary fuels: wood, coal, oil, natural gas	**8**
4	**ELECTRICAL ENERGY** 4.1 Generation of electrical energy 4.2 Transmission of electrical energy 4.3 End uses of electrical energy	**8**
5	**ENERGY AND AIR POLLUTION** 5.1 Sources of air pollution 5.2 Effects of air pollution 5.3 Controlling air pollution 5.4 Effects of energy on climate, CO_2 and the "green house	**10**

	effect" 5.5 Energy transport and the environment; pipelines, tankers, oil spills 5.6 Energy-related water demand	
6	**ENERGY AND SOCIETY** 6.1 Renewable energy flows and the problems of matching them with end use requirements 6.2 Energy inequity and energy conflicts Energy versus the environment 6.3 Roles of government and private industry	**6**

Reference:

1. Aubrecht, Gordon J., *Energy*, Second Edition, Prentice Hall, 1994.