**Elective VII (A): (Electronics)**

**Semester –VI**

**Elective Paper –VII-(A) :Analog and Digital Electronics**

**No. of Hours per week: 04 Total Lectures:60**

**Unit-I (14 Hours)**

1. FET-Construction, Working, characteristics and uses; MOSFET-enhancement MOSFET, depletion MOSFET, construction and working , drain characteristics of MOSFET, applications of MOSFET
2. Photo electric devices: Structure and operation, characteristics, spectral response and application of LDR, LEDand LCD

**Unit-II (10Hours)**

1. Operational Amplifiers: Characteristics of ideal and practical Op-Amp (IC 741), Basic differential amplifiers, Op-Amp supply voltage, IC identification, Internal blocks of Op-Amp, its parameter off set voltages and currents, CMRR, slew rate, concept of virtualground.

**Unit-III (10 Hours)**

1. Applications of Op-Amp: Op-Amp as voltage amplifier, Inverting amplifier, Non-inverting amplifier, voltage follower, summing amplifier, difference amplifier, comparator, integrator, differentiator.

**Unit-IV(14 Hours)**

1. Data processing circuits: Multiplexers, De-multiplexers, encoders, decoders, Characteristics for Digital ICs -RTL, DTL, TTL, ECL CMOS (NAND & NOR Gates).
2. IC 555 Timer -Its pin diagram,internal architecture, Application as astablemultivibrator and mono stable multivibrator.

**Unit-V (12 Hours)**

1. Sequential digital circuits:Flip-flops, RS, Clocked SR, JK, D, T, Master-Slave, Flip- flop, Conversion of Flip flops.
2. Code Converters: Design of code converter, BCD to 7 segment, binary/BCD to gray, gray to binary/BCD,design of counters using state machine.

**Reference Books**

1. Digital Electronics by G.K.Kharate Oxford University Press

2. Unified Electronics by Agarwal and Agarwal.

3. Op- Amp and Linear ICs by Ramakanth A Gayekwad, 4th edition PHI

4. Digital Principles and Applications by Malvino and Leach, TMH, 1996, 4th edition.

5. Digital Circuit design by Morris Mano,PHI

6. Switching Theory and Logic design by A.AnandKumar ,PHI

7. operations amplifier by SV Subramanyam.

**Elective Paper-VII-A : Practical: Analog and Digital Electronics 2hrs/Week**

Minimum of 6 experiments to be done and recorded

 1) Characteristics of FET

2) Characteristics of MOSFET

3) Characteristics of LDR

4) Characteristics of Op-amp.(IC741)

 5)Op-Amp as amplifier/inverting amplifier

 6) Op-Amp as integrator/differentiator

 7) Op-Amp as summing amplifier/difference amplifier

 8) IC 555 as astable multivibrator

 9) IC 555 as monostable amplifier

 10) Master slave flip-flop

 11) JK flip-flop

**Semester –VI**

**Cluster Electives VIII-A**

**Cluster Elective Paper –VIII-A-1: Introduction to Microprocessors and Microcontrollers**

**No. of Hours per week: 04 Total Lectures:60**

**Unit – I (10Hours)**

1. Introduction to microcontrollers:General purpose of computer systems,architecture of embedded system, classification, applications and purposes, challenges and designs, operational and non operational quality attributes, elemental description of embedded processors and micro controllers

**Unit –II (10Hours)**

2. Microprocessors:Organisation of microprocessorbased system, 8085 microprocessor,its pin diagram and architecture, concept of data bus, and address bus, 8085 programming, instruction classification, stacks and its implementation, hardware and software interrupts.

**Unit– III (15Hours)**

3. 8051 microcontroller:Introduction , block diagram, assembly language programming, programme counter, ROM memory, data types and directives, flag bits PSW register, jump, loop and call constructions

4. 8051 I/O Programming: Introduction to I/O port programming, pin out diagram, I/O port pin programming, bit manipulation, addressing modes, accessing memory, arithmetic and logic instructions.

**Unit – IV (13 Hours)**

5. Timers:Programming of 8051 timers, counter programming, interrupts, externalhardware interrupts**,** serial communication interrupts, interrupt priority.

6. Embedded system programming:Structure of programming, infinite loop, compiling, linking locating, down loading and debugging.

**Unit –V (12Hours)**

7. Embedded system design and development:Embedded system development environment, file type generated after cross compilation, dissembler, decompiler, simulator, emulator and debugging.

8. Embedded product life cycle:Embedded product development life cycle, trends in embedded industry.

**Reference Books**

1)Embedded Systems.. Architecture,programming and design, R Kamal, 2008, TMH

2) The 8051 micro controller and embedded systems using Assembly and C, M.A.Mazidi,

J.G.Mazidi and R.D.McKinlay, second Ed., 2007 pearson Education India

3) Introduction to embedded systems K.V. Shibu, 1st edition, 2009 McGraw Hill

4) Micro Controllers in practice, I Susnea and Mitescu,2005,springer

**Cluster Elective Paper-VIII-A-1: Practical: Introduction to Microprocessors and Microcontrollers 2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. To find that the given numbers is prime or not.

2. To find the factorial of a number.

3. Write a program to make the two numbers equal by increasing the smallest number and

decreasing the largest number.

4. Use one of the four ports of 8051 for O/P interfaced to eight LED’s. Simulate binary counter

(8 bit) on LED’s.

5. Program to glow first four LED then next four using TIMER application.

6. Program to rotate the contents of the accumulator first right and then left.

7. Program to run a countdown from 9-0 in the seven segment LED display.

8. To interface seven segment LED display with 8051 microcontroller and display ‘HELP’ in

the seven segment LED display.

 9. To toggle ‘1234’ as ‘1324’ in the seven segment LED.

10. Interface stepper motor with 8051 and write a program to move the motor through a given

angle in clock wise or counter clockwise direction.

11. Application of embedded systems: Temperature measurement, some information on LCD

display, interfacing a keyboard.

**Semester –VI**

**Cluster Elective Paper –VIII-A-2 : Computational Methods and Programming**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12hrs)**

1. Fundamentals of C language: C character set-Identifiers and Keywords-Constants -Variables-Data types-Declarations of variables-Declaration of storage class-Defining symbolic constants- Assignment statement.

2. Operators: Arithmetic operators-Relational operators-Logic operators-Assignment operators- Increment and decrement operators-Conditional operators.

**UNIT-II (12hrs)**

3. Expressions and I/O Statements: Arithmetic expressions-Precedence of arithmetic operators-Type converters in expressions-Mathematical (Library) functions - Data input and output-The getchar and putchar functions-Scanf-Printf simple programs.

4. Control statements:If -Else statements -Switch statements - The operators - GO TO - While, Do - While, FOR statements - BREAK and CONTINUE statements.

**UNIT-III (12hrs)**

5. Arrays: One dimensional and two dimensional arrays - Initialization - Type declaration - Inputting and outputting of data for arrays - Programs of matrices addition, subtraction and multiplication

6. User defined functions: The form of C functions - Return values and their types - Calling a function - Category of functions. Nesting of functions.Recursion.ANSI C functions- Function declaration. Scope and life time of variables in functions.

**UNIT-IV (12hrs)**

7. Linear and Non - Linear equations: Solution of Algebra and transcendental equations-Bisection, Falsi position and Newton-Rhapson methods-Basic principles-Formulae-algorithms

8. Simultaneous equations: Solutions of simultaneous linear equations-Guass elimination and Gauss Seidel iterative methods-Basic principles-Formulae – Algorithms.

**UNIT-V (12hrs)**

9. Interpolations: Concept of linear interpolation-Finite differences-Newton’s and Lagrange’s interpolation formulae-principles and Algorithms

10. Numerical differentiation and integration: Numerical differentiation-algorithm for evaluation of first order derivatives using formulae based on Taylor’s series-Numerical integration-Trapezoidal and Simpson’s 1/3 rule- Formulae-Algorithms.

**Reference books:**

1. Introductory methods of Numerical Analysis: Sastry

2. Numerical Methods: Balaguruswamy

3. Programming in ANSI C (TMH) : Balaguruswamy

4. Programming with ‘C’- Byron Gottafried, Tata Mc Graw Hill

**Cluster Elective Paper-VIII-A-2: Practical: Computational Methods and Programming**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Write a program that reads an alphabet from keyboard and display in the reverse order.
2. Write a program to read and display multiplication of tables.
3. Write a program for converting centigrade to Fahrenheit temperature and Fahrenheit temperature centigrade.
4. Write a program to find the largest element in an array.
5. Write a program based on percentage calculation, the grade by entering the subject marks. (If percentage > 60 I class, if percentage between 50&60 II class, if percentage between 35&50 III class, if percentage below 35 fail).
6. Write a program for generation of even and odd numbers up to 100 using while, do-while and for loop.
7. Write a program to solve the quadratic equation using Bisection method.
8. Write a program for integration of function using Trapezoidal rule.
9. Write a program for solving the differential equation using Simpson’s 1/3rd rule.

**Semester –VI**

**Cluster Elective Paper –VIII-A-3 :Electronic Instrumentation**

**No. of Hours per week: 04 Total Lectures:60**

**Unit – I (12Hours)**

1. Basic of measurements:Instruments accuracy , precision , sensitivity , resolution range, errors in measurement, Multimeter , principles of measurement of dc voltage and dc currents, ac current and resistance, specifications of multimeter and their significance.

**Unit -11 (10 Hours)**

2. Electronic Voltmeter:Advantage over conventional multimeter for voltage measurement with respect to input impedence and sensitivity, principles of voltage measurement (block diagram only), specification of an electronic voltmeter/multimeter and their significance.

**Unit– III (14 Hours)**

3. CRO :Block diagram of basic CRO, construction of CRT, electron gun, electrostatic focusing and acceleration(only explanation) , time base operation, synchronization, front panel controls, specifications of CRO and their significance.

Applications CRO: Measurement of voltage ,dc and ac frequency , time period, special features of dual trace, digital storage oscilloscope, block diagram and principle of working.

**Unit – IV (12 Hours)**

4. Digital Multimeter:Block diagram,working, frequency and period measurement using universal counter, frequency counter ,accuracy and resolution.

5. Digital instruments:Principle and working of digitalinstruments, characteristics of a digital meter, working principle of digital voltmeter.

**Unit – V (12 Hours)**

6. Signal generators:Block diagram explanation, specifications of low frequency signal generators, pulse generator, function generator-working, Brief idea for testing, specifications. Distortion factor meter, wave analysis.

7. Bridges:Block diagram, working of basic LCR bridge – specifications – block diagram and working.

**Reference Books**

1. A text book in electrical technology by B.L.Thereja (S.Chand&Co)
2. Digital circuits and systems by Venugopal 2011 (Tata Mcgraw Hill)
3. Digital Electronics by SubrathaGhoshal 2012 (Cengage Learning)

**Cluster Elective Paper-VIII-A-3: Practical: Electronic Instrumentation**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Study the loading effect of a multimeter by measuring voltage across alow and high resistance.

2. Study the limitations of a multimeter for measuring high frequency voltageand currents.

3. Measurement of voltage, frequency, time period and phase angle using CRO.

4. Measurement of time period and frequency using universal counter/frequency counter.

5. Measurement of rise, fall and delay times using a CRO.

6. Measurement of distortion of a RF signal generator using distortion factor meter.

7. Measurement of R, L and C using a LCR bridge/ universal bridge.

**Elective VII-(B): (Materials Science)**

**Semester –VI**

**Elective Paper – VII-(B): Materials Science**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12 hrs)**

1.Materials and **Crystal Bonding:** Materials, Classification, Crystalline, Amorphous, Glasses; Metals, Alloys, Semiconductors, Polymers, Ceramics, Plastics, Bio-materials, Composites, Bulk and nanomaterials. Review of atomic structure – Interatomic forces – Different types of chemical bonds – Ioniccovalent bond or homopolar bond – Metallic bond – Dispersion bond – Dipole bond – Hydrogenbond – Binding energy of a crystal.

**UNIT-II (12 hrs)**

2. Defects and Diffusion in Materials: Introduction – Types of defects - Point defects- Line defects- Surface defects- Volume defects- Production and removal ofdefects- Deformation- irradiation- quenching- annealing- recovery - recrystallization andgrain growth. Diffusion in solids- Fick’s laws of diffusion.

**UNIT-III(12 hrs)**

3. Mechanical Behavior of Materials: Different mechanical properties of engineering materials – Creep – Fracture – Technologicalproperties – Factors affecting mechanical properties of a material – Heat treatment - Cold andhot working – Types of mechanical tests – Metal forming process – Powder – Misaligning – Deformation of metals.

**UNIT-IV (12 hrs)**

4. Magnetic Materials:Dia-, Para-, Ferri- and Ferromagnetic materials, Classical Langevin theory of dia magnetism, Quantum mechanical treatment of paramagnetism. Curie’s law, Weiss’s theory of ferromagnetism, Ferromagnetic domains.Discussion of B-H Curve.Hysteresis and energy Loss.

**UNIT-V (12 hrs)**

5. Dielectric Materials:Dielectric constant, dielectric strength and dielectric loss, polarizability, mechanism of polarization,factors affecting polarization, polarization curve and hysteresis loop, types of dielectric materials, applications; ferroelectric, piezoelectric and pyroelectric materials, Clausius -Mosotti equation.

**Reference books**

1. Materials Science by M.Arumugam, Anuradha Publishers. 1990, Kumbakonam.

2.Materials Science and Engineering V.Raghavan, Printice Hall India Ed. V 2004. New Delhi.

3. Elementary Solid State Physics, 1/e M. Ali Omar, 1999, Pearson India

4. Solid State Physics, M.A. Wahab, 2011, Narosa Publications

**Elective Paper-VII-B: Practical: Materials Science**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Measurement of susceptibility of paramagnetic solution (Quinck`s Tube Method)

2. Measurement of magnetic susceptibility of solids.

3. Determination of coupling coefficient of a piezoelectric crystal.

4. Measurement of the dielectric constant of a dielectric Materials

5. Study the complex dielectric constant and plasma frequency of metal using surface plasmon

resonance (SPR)

7. Study the hysteresis loop of a Ferroelectric Crystal.

8. Study the B-H curve of ‘Fe’ using solenoid and determine energy loss from hysteresis.

**Semester –VI**

**Cluster Electives VIII-B**

**Cluster Elective Paper –VIII-B-1 :Fundamentals of Nanoscience**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12hrs)**

**1. Background and history:** Emergence of Nanoscience with special reference to Feynman and Drexler; Role of particle size; Spatial and temporal scale; Concept of confinement, strong and weak confinement with suitable example; Development of quantum structures, Basic concept of quantum well, quantum wire and quantum dot.

Finite size Zero, One and Two Dimensional Nanostructures, Concept of Surface and Interfacial Energies. Physics of the solid state – size dependence of properties, crystal structures, Lattice vibrations, Energy bands:- Insulators Semiconductors and conductors.

**UNIT-II (12hrs)**

**2. Classification of Nanomaterials:** Inorganic nanomaterials: carbon nanotubes and cones, Organic nanomaterials: dendrimers, micelles, liposomes, block copolymers; Bionanomaterials: Biomimtric, bioceramic and nanotherapeutics; Nanomaterials for molecular electronics and optoelectronics.

**UNITS-III (12hrs)**

**3. Macromolecules:** Classification of polymers, chemistry of polymerization, chain polymerization, step polymerization, coordination polymerization. Molecular weight of polymers-number average and weight average molecular weight, degree of polymerization, determination of molecular weight of polymers by viscometry, Osmometry and light scattering methods.Kinetics of free radical polymerization, derivation of rate law.Preparation and application of polyethylene, PVC, Teflon.

**UNIT-IV (12hrs)**

**4. Molecular & Nanoelectronics:**Semiconductors, Transition from crystal technology to nanotechnology. Tiny motors, Gyroscopes and accelerometers. Nano particle embedded wrinkle resistant cloth, Transparent Zinc Oxide sun screens.Bio-systems, Nanoscale processes in environment. Nanoscale structures, Novel phenomena and Quantum control and quantum computing. Single electron transistors, Quantum dots, Quantum wires.

**UNIT-V (12hrs)**

**5. Biomaterials:** Implant materials: Stainless steels and its alloys, Ti and Ti based alloys, Ceramic implant materials; Hydroxyapatite glass ceramics, Carbon Implant materials, Polymeric Implant materials, Soft tissue replacement implants, Sutures, Surgical tapes and adhesives, heart valve implants, Artificial organs, Hard Tissue replacement Implants, Internal Fracture Fixation Devices, Wires, Pins, and Screws, Fracture Plates.

**Reference Books**

1. T. Pradeep: Textbook of Nanoscience and Nanotechnology Chapter (McGraw-Hill Professional, 2012), Access Engineering.

2. C. N. R. Rao, A. Mu¨ller, A. K. Cheetham, “The Chemistry of Nanomaterials :Synthesis, Properties and Applications”, Wiley-VCH, 2006.

3. C. Breachignac P. Houdy M. Lahmani, “Nanomaterials and Nanochemistry”, Springer, 2006.

4. Guozhong Cao, “Nanostructures and Nanomaterials: Synthesis, Properties, and Applications”, World Scientific Publishing Private, Ltd., 2011.

5. Zhong Lin Wang, “Characterization of Nanophase Materials”, Wiley-VCH, 2004.

6. Carl C. Koch, “Nanostructured Materials: Processing, Properties and Potential Applications”, William Andrew Publishing Norwich, 2006.

**Elective Paper- VIII-B-1: Practical: Fundamentals of Nanoscience**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Determination of the Band Gap of Semiconductor Nanoparticles.

2. [Surface Enhanced Raman Scattering Activity of Silver Nanoparticles](http://accessengineeringlibrary.com/browse/textbook-of-nanoscience-and-nanotechnology/apx05)

3. [Conversion of Gold Nanorods into Gold Nanoparticles](http://accessengineeringlibrary.com/browse/textbook-of-nanoscience-and-nanotechnology/apx06)

4. [Bimetallic Nanoparticles](http://accessengineeringlibrary.com/browse/textbook-of-nanoscience-and-nanotechnology/apx09)

5. Processing and Development of Nanoparticle gas sensor

6. Magnetic separation/identification studies of nanoparticles

7. Harvesting light using nano-solar cells

8. Nano-Forensic analysis to identify, individualize and evaluate evidence using nanophase materials

9. Comparison of the performance of nanoparticles based conductive adhesives and conventional non conductive adhesives.

10. Electrodeposition and corrosion behavior of nanostructured composite film

11. Photocatalytic activity of nanomaterials

**Semester –VI**

**Cluster Elective Paper –VIII-B-2 :Synthesis and Characterization of Nanomaterials**

**No. of Hours per week: 04 Total Lectures:60**

**Unit-I (12 hrs)**

**1. Nanomaterials synthesis**: Synthesis and nanofabrication, Bottom-Up and Top-Down approach with examples. Chemical precipitation methods, sol-gel method, chemical reduction, hydrothermal, process. Physical Mehtods- ball milling, Physical Vapour deposition (PVD), Sputtering, ChemicalVapor deposition (CVD), pray pyrolysis, Biological methods- Synthesis using micro organisms and bacteria, Synthesis using plant extract, use of proteins and DNA templates.

**Unit-II (12 hrs)**

**2. Classification of materials:** Types of materials, Metals, Ceramics (Sand glasses) polymers, composites, semiconductors.Metals and alloys- Phase diagrams of single component, binary and ternary systems, diffusion, nucleation and growth. Diffusional and diffusionless transformations.Mechanical properties.Metallic glasses. Preparation, structure and properties like electrical, magnetic, thermal and mechanical, applications.

**UNITS-III (12 hrs)**

**3. Glasses**: The glass transition - theories for the glass transition, Factors that determine the glass-transition temperature. Glass forming systems and ease of glass formation, preparation of glass materials.Applications of Glasses: Introduction: Electronic applications, Electrochemical applications, optical applications, Magnetic applications.

**UNITS-IV (12 hrs)**

**4. Liquid Crystals**: Mesomorphism of anisotropic systems, Different liquid crystalline phase and phase transitions, Thermal and electrical properties of liquid crystals, Types Liquid Crystals displays, few applications of liquid crystals.

**UNITS-V (12 hrs)**

**5. Characterization Methods:** XRD, SEM, TEM, AFM, XPS and PL characterization techniques for nano materials.Electrical and mechanical properties, Optical properties by IR and Raman Spectroscopy.

**References books**

1. Encyclopedia of Nanotechnology by M.Balakrishna Rao and K.Krishna Reddy, Vol.I to X, Campus books.

2. Nano: The Essentials-Understanding Nanoscinece & Nanotechnology by T.Pradeep; Tata Mc. Graw Hill

3. Nanotechnology in Microelectronics & Optoelectronics, J.M Martine Duart, R.J Martin Palma, F. Agullo Rueda, Elsevier

4. Nanoelectronic Circuit Design, N.K Jha, D Chen, Springer

5. Handbook of Nanophysics- Nanoelectronics & Nanophotonics, K.D Sattler, CRC Press

6. Organic Electronics-Sensors & Biotechnology- R. Shinar & J. Shinar, McGraw-Hill

**Cluster Elective Paper-VIII-B-2: Practical: Synthesis and Characterization of Nanomaterials**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Synthesis of nanocrystalline films of II-VI compounds doped with rare earths by chemical process.

2. Synthesis of Alkaline earth aluminates in nanocrystalline form by combustion synthesis.

3. Preparation of surface conducting glass plate by spray pyrolysis method

4. Preparation of surface conducting glass plate by chemical route

5. Fabrication of micro fluidic nanofilter by polymerisation reaction

6. Absorption studies on the nanocrystalline films and determination of absorption coefficient.

7. Determination of band gap from the absorption spectra using Tauc’s plots.

8. Study of Hall effect in semiconductors and its application in nanotechnology.

9. Measurement of electrical conductivity of semiconductor film by Four Probe method and study of temperature variation of electrical conductivity.

**Semester –VI**

**Cluster Elective Paper –VIII-B-3 :Applications of Nanomaterials and Devices**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12 hrs)**

**1. Optical properties:** Coulomb interaction in nanostructures. Concept of dielectric constant for nanostructures and charging of nanostructure.Quasi-particles and excitons. Excitons in direct and indirect band gap semiconductor nanocrystals. Quantitative treatment of quasi-particles and excitons, charging effects. Radiative processes: General formalization-absorption, emission and luminescence. Optical properties of heterostrctures and nanostructures.

**UNIT-II (12 hrs)**

**2. Electrical transport:**

Carrier transport in nanostrcutures.Hall effect, etermination of carrier mobility and carrier concentration; Coulomb blockade effect, thermionic emission, tunneling and hoping conductivity. Defects and impurities: Deep level and surface defects.

**UNIT-III (12 hrs)**

**3. Applications:**Applications of nanoparticles, quantum dots, nanowires and thin films for photonic devices (LED, solar cells). Single electron transfer devices (no derivation). CNT based transistors. Nanomaterial Devices: Quantum dots heterostructures lasers, optical switching and optical data storage. Magnetic quantum well; magnetic dots - magnetic data storage.Micro Electromechanical Systems (MEMS), Nano Electromechanical Systems (NEMS).

**UNIT-IV(12 hrs)**

**4. Nanoelectronics:**Introduction, Electronic structure of Nanocrystals,Tuning the Band gap of Nanoscale semiconductors, Excitons, Quantumdot, Single electron devices, Nanostructured ferromagnetism,Effect of bulk nanostructuring of magnetic properties, Dynamics of nanomagnets, Nanocarbon ferromagnets, Giant and colossal magneto-resistance, Introduction of spintronics, Spintronics devices and applications.

**UNIT-V (12 hrs)**

**5. Nanobiotechnology and Medical application:**Introduction, Biological building blocks- size of building blocks and nanostructures, Peptide nanowires and protein nanoparticles, DNA double nanowires, Nanomaterials in drug delivery and therapy, Nanomedicine, Targeted gold nanoparticles for imaging and therapy.

**Reference books:**

 1.C.P. Poole, Jr. Frank J. Owens, Introduction to Nanotechnology (Wiley India Pvt. Ltd.).

 2.S.K. Kulkarni, Nanotechnology: Principles & Practices (Capital Publishing Company).

 3. K.K. Chattopadhyay and A.N. Banerjee, Introduction to Nanoscience & Technology (PHI Learning Private Limited).

 4. Richard Booker, Earl Boysen, Nanotechnology (John Wiley and Sons).

**Elective Paper- VIII-B-3: Practical: Applications of Nanomaterials and Devices**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Synthesis of metal nanoparticles by chemical route.

2. Synthesis of semiconductor nanoparticles.

3. Surface Plasmon study of metal nanoparticles by UV-Visible spectrophotometer.

4. XRD pattern of nanomaterials and estimation of particle size.

5. To study the effect of size on color of nanomaterials.

6. Prepare a disc of ceramic of a compound using ball milling, pressing and sintering, and study its XRD.

7. Fabricate a thin film of nanoparticles by spin coating (or chemical route) and study transmittance spectra in UV-Visible region.

8. Fabricate a pn-diode by diffusing Al over the surface of n-type Si and study its I-V characteristics.

**Elective VII-(C) :(Renewable Energy)**

**Semester –VI**

**Elective Paper –VII-(C) :Renewable Energy**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12 hrs)**

**1. Introduction to Energy:** Definition and units of energy, power, Forms of energy, Conservation of energy, second law of thermodynamics, Energy flow diagram to the earth. Origin and time scale of fossil fuels, Conventional energy sources, Role of energy in economic development and social transformation.

**2. Environmental Effects:**Environmental degradation due to energy production and utilization, air and water pollution, depletion of ozone layer, global warming, biological damage due to environmental degradation. Effect of pollution due to thermal power station, nuclear power generation, hydroelectric power stations on ecology and environment.

**UNIT-II (12 hrs)**

**3. Global Energy Scenario:** Energy consumption in various sectors, projected energy consumption for the next century, exponential increase in energy consumption, energy resources, coal, oil, natural gas, nuclear and hydroelectric power, impact of exponential rise in energy usage on global economy.

**4. Indian Energy Scene:** Energy resources available in India, urban and rural energy consumption, energy consumption pattern and its variation as a function of time, nuclear energy - promise and future, energy as a factor limiting growth, need for use of new and renewable energy sources.

**UNIT-III (12 hrs)**

**5.Solar energy:** Solar energy, Spectral distribution of radiation, Flat plate collector, solar water heating system, Applications, Solar cooker. Solar cell, Types of solar cells, Solar module and array, Components of PV system, Applications of solar PV systems.

**6. Wind Energy:** Introduction, Principle of wind energy conversion, Components of wind turbines, Operation and characteristics of a wind turbine, Advantages and disadvantages of wind mills, Applications of wind energy.

**UNIT-IV (12 hrs)**

**7. Ocean Energy:** Introduction, Principle of ocean thermal energy conversion, Tidal power generation, Tidal energy technologies, Energy from waves, Wave energy conversion, Wave energy technologies, advantages and disadvantages.

**8. Hydrogen Energy:**History of hydrogen energy - Hydrogen production methods - Electrolysis of water, Hydrogen storage options – Compressed and liquefied gas tanks, Metal hydrides; Hydrogen safety - Problems of hydrogen transport and distribution - Uses of hydrogen as fuel.

**UNIT-V (12 hrs)**

**9. Bio-Energy**

Energy from biomass – Sources of biomass – Different species – Conversion of biomass into fuels – Energy through fermentation – Pyrolysis, gasification and combustion – Aerobic and anaerobic bio-conversion – Properties of biomass – Biogas plants – Types of plants – Design and operation – Properties and characteristics of biogas.

**References:**

1. Solar Energy Principles, Thermal Collection &Storage, S.P.Sukhatme: Tata McGraw Hill Pub., New Delhi.

2. Non-Conventional Energy Sources, G.D.Rai, New Delhi.

3. Renewable Energy, power for a sustainable future, Godfrey Boyle, 2004,

4. The Generation of electricity by wind, E.W. Golding.

5. Hydrogen and Fuel Cells: A comprehensive guide, Rebecca Busby, Pennwell corporation (2005)

6. Hydrogen and Fuel Cells: Emerging Technologies and Applications, B.Sorensen, Academic

Press (2012).

7. Non-Conventional Energy Resources by B.H. Khan, Tata McGraw Hill Pub., 2009.

8. Fundamentals of Renewable Energy Resources byG.N.Tiwari, M.K.Ghosal, Narosa Pub., 2007.

**Elective Paper-VII-C: Practical: Renewable Energy**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Preparation of copper oxide selective surface by chemical conversion method.

2. Performance testing of solar cooker.

3. Determination of solar constant using pyrheliometer.

4. Measurement of I-V characteristics of solar cell.

5. Study the effect of input light intensity on the performance of solar cell.

6. Study the characteristics of wind.

**Semester –VI**

**Cluster Electives VIII-C**

**Cluster Elective Paper –VIII-C-1 :Solar Thermal and Photovoltaic Aspects**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12 hrs)**

**1. Basics of Solar Radiation:** Structure of Sun, Spectral distribution of extra terrestrial radiation, Solar constant, Concept of Zenith angle and air mass, Definition of declination, hour angle, solar and surface azimuth angles; Direct, diffuse and total solar radiation, Solar intensity measurement – Thermoelectric pyranometer and pyrheliometer.

**2. Radiative Properties and Characteristics of Materials:** Reflection, absorption and transmission of solar radiation throughsingle and multi covers; Kirchoff’s law – Relation between absorptance, emittance and reflectance; Selective Surfaces - preparation and characterization, Types and applications; Anti-reflective coating.

**UNIT-II (14 hrs)**

**3. Flat Plate Collectors (FPC) :** Description of flat plate collector, Liquid heating type FPC, Energy balance equation,Efficiency, Temperature distribution in FPC, Definitions of fin efficiency and collector efficiency, Evacuated tubular collectors.

**4. Concentrating Collectors:** Classification, design and performance parameters; Definitions of aperture, rim-angle, concentration ratio and acceptance angle; Tracking systems; Parabolic trough concentrators; Concentrators with point focus.

**Unit-III (14 hrs)**

**5. Solar photovoltaic (PV) cell:** Physics of solar cell –Type of interfaces, homo, hetero andschottky interfaces, Photovoltaic Effect, Equivalent circuit of solar cell, Solar cell output parameters, Series and shunt resistances and its effect on cell efficiency; Variation of efficiency with band-gap and temperature.

**6. Solar cell fabrication:** Production of single crystal Silicon: Czokralski (CZ) and Float Zone (FZ) methods, Silicon wafer fabrication, Wafer to cell formation, Thin film solar cells, Advantages, CdTe/CdS cell formation, Multi-junction solar cell; Basic concept of Dye-sensitized solar cell, Quantum dot solar cell.

**UNIT-IV (8 hrs)**

**Solar PV systems:** Solar cell module assembly – Steps involved in the fabrication of solar module, Module performance, I-V characteristics, Modules in series and parallel, Module protection – use of Bypass and Blocking diodes, Solar PV system and its components, PV array, inverter, battery and load.

**UNIT-V (12 hrs)**

**Solar thermal applications:** Solar hot water system (SHWS), Types of SHWS, Standard method of testing the efficiency of SHWS; Passive space heating and cooling concepts, Solar desalinator and drier, Solar thermal power generation.

**Solar PV applications**: SPV systems; Stand alone, hybrid and grid connected systems, System installation, operation and maintenances; Field experience; PV market analysis and economics of SPV systems.

**Reference Books:**

1. Solar Energy Utilization, G. D. Rai, Khanna Publishers

2. Solar Energy- Fundamentals, design, modeling and applications, G.N. Tiwari, Narosa Pub., 2005.

3. Solar Energy-Principles of thermal energy collection & storage, S.P. Sukhatme, Tata Mc-Graw Hill Publishers, 1999.

4. Solar Photovoltaics- Fundamentals, technologies and applications, Chetan Singh Solanki, PHI Learning Pvt. Ltd.,

5. Science and Technology of Photovoltaics, P. Jayarama Reddy, BS Publications, 2004.

**Cluster Elective Paper- VIII-C-1: Practical: Solar Thermal and Photovoltaic Aspects**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Measurement of direct solar radiation using pyrheliometer.

2. Measurement of global and diffuse solar radiation using pyranometer.

3. Measurement of emissivity, reflectivity and transsivity.

4. Measurement of efficiency of solar flat plate collector.

5. Performance testing of solar air dryer unit.

6. Effect of tilt angle on the efficiency of solar photovoltaic panel.

7. Study on solar photovoltaic panel in series and parallel combination.

**Semester - VI**

**Cluster Elective Paper –VIII-C-2 :Wind, Hydro and Ocean Energies**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I**

**1. Introduction:** Wind generation, meteorology of wind, world distribution of wind, wind speed variation with height, wind speed statistics, Wind energy conversion principles; General introduction; Types and classification of WECS; Power, torque and speed characteristics.

2. Wind Measurements:Eolian features, biological indicators, rotational anemometers, other anemometers, wind measurements withballoons.

**UNIT-II**

3. Wind Energy Conversion System:Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element andcombine theory; Rotor characteristics; Maximum power coefficient; Prandlt’s tip losscorrection.

4. Design of Wind Turbine: Wind turbine design considerations; Methodology; Theoretical simulation of wind turbinecharacteristics; Test methods.

**UNIT-III**

5. Wind Energy Application: Wind pumps: Performance analysis, design concept and testing; Principle of wind energy generation; Standalone, grid connected and hybrid applications of wind energy conversion systems, Economics of wind energyutilization; Wind energy in India; Environmental Impacts of Wind farms.

**UNIT-IV**

6. Small Hydropower Systems: Overview of micro, mini and small hydro systems; Hydrology; Elements of pumps andturbine; Selection and design criteria of pumps and turbines; Site selection;Speed and voltage regulation; Investment issues load management and tariff collection; potential of small hydro power in India.Wind and hydro based stand-alone hybrid power systems.

**UNIT-V**

7.Ocean Thermal, Tidal and Wave Energy Systems:Ocean Thermal - Introduction, Technology process, Working principle, Resource and site requirements, Location of OCET system, Electricity generation methods from OCET,Advantages and disadvantages, Applications of OTEC,

8. Tidal Energy - Introduction, Origin and nature of tidal energy, Merits and limitations, Tidal energy technology,Tidal range power, Basic modes of operation of tidal systems.Wave Energy – Introduction, Basics of wave motion, Power in waves, Wave energy conversion devices, Advantages anddisadvantages, Applications of wave energy.

**Reference Books:**

1. Dan Charis, Mick Sagrillo, LanWoofenden, “Power from the Wind”, New Society Pub., 2009.

2. Erich Hau, “Wind Turbines-Fundaments, Technologies, Applications, Economics”, 2ndEdition, Springer Verlag, BerlinHeidelberg, NY, 2006.

3. Joshue Earnest, Tore Wizelius, Wind Power and Project Developmen”, PHI Pub., 2011.

4. T. Burton, D. Sharpe, N. Jenkins, E. Bossanyi, Wind Energy Handbook, John Wiley Pub., 2001.

5. Paul Gipe, “Wind Energy Basics”, Chelsea Green Publications, 1999.

6. Khan, B.H., “Non-Conventional Energy Resources”, TMH, 2nd Edition, New Delhi, 2009.

7. Tiwari, G.N., and Ghosal, M.K, Renewable Energy Resources – Basic Principles and applications, Narosa Publishing House,2007.

**Cluster Elective Paper- VIII-C-2: Practical: Wind, Hydro and Ocean Energies**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Estimation of wind speed using anemometer.

2. Determination of characteristics of a wind generator

3. Study the effect of number and size of blades of a wind turbine on electric power output.

4. Performance evaluation of vertical and horizontal axes wind turbine rotors.

5. Study the effect of density of water on the output power of hydroelectric generator.

6. Study the effect of wave amplitude and frequency on the wave energy generated.

**Semester - VI**

**Cluster Elective Paper –VIII-C-3 :Energy Storage Devices**

**No. of Hours per week: 04 Total Lectures:60**

**UNIT-I (12 hr)**

**1. Energy Storage:**Need of energy storage; Different modes of energy storage, Flywheel storage, Electrical and magnetic energy storage: Capacitors,electromagnets; Chemical Energy storage: Thermo-chemical, photo-chemical, bio-chemical,electro-chemical, fossil fuels and synthetic fuels. Hydrogen for energy storage.

**UNIT-II (12 hrs)**

**2. Electrochemical Energy Storage Systems:**Batteries: Primary, Secondary, Lithium, Solid-state and molten solvent batteries; Leadacid batteries; Nickel Cadmium Batteries; Advanced Batteries. Role of carbon nano-tubes inelectrodes.

**UNIT-III (12 hrs)**

**3. Magnetic and Electric Energy Storage Systems:**Superconducting Magnet Energy Storage(SMES) systems; Capacitor and battery:Comparison and application; Super capacitor: Electrochemical Double Layer Capacitor(EDLC), principle of working, structure, performance and application.

**UNIT-IV (12 hrs)**

**4. Fuel Cell:** Fuel cell definition, difference between batteries and fuel cells, fuel cell components, principle and working of fuel cell, performance characteristics,efficiency, fuel cell stack, fuel cell power plant: fuel processor, fuel cell powersection, power conditioner, Advantages and disadvantages.

**UNIT-V (12 hrs)**

**5. Types of Fuel Cells:** Alkaline fuel cell, polymer electrolyte fuel cell, phosphoric acid fuel cell,molten carbonate fuel cell; solid oxide fuel cell,proton exchange membrane fuel cell, problems with fuel cells, applications of fuel cells.

**REFERENCE BOOKS**

1. J. Jensen and B. Squrensen, Fundamentals of Energy Storage, John Wiley, NY, 1984.

2. M. Barak, Electrochemical Power Sources: Primary and Secondary Batteries by, P. Peregrinus,IEE,1980.

3.P.D.Dunn, Renewable Energies, Peter Peregrinus Ltd, London, 1986.

4. B.Viswanathan and M. A. Scibioh, Fuel Cells-Principles and Applications, University Press, 2006.

5. Hart, A.B and G.J.Womack, Fuel Cells: Theory and Application, Prentice Hall, NewYork, 1989.

**Cluster Elective Paper –VIII-C-3: Practical: Energy Storage Devices**

**2hrs/Week**

Minimum of 6 experiments to be done and recorded

1. Study of charge and discharge characteristics of storage battery.

2. Study of charging and discharging behavior of a capacitor.

3. Determination of efficiency of DC-AC inverter and DC-DC converters

4. Study of charging characteristics of a Ni-Cd battery using solar photovoltaic panel.

5. Performance estimation of a fuel cell.

6. Study of effect of temperature on the performance of fuel cell.