SUBJECT: ANU – Academic –UG Courses –CBCS –B.Sc III –Physics
VI Semester Syllabus - Approval - Orders - Issued.

ORDER:

In partial modification of the earlier Proceedings issued in the ref (2) cited, the Vice-Chancellor, after having considered letter of the Chairman in Physics UG BoS in ref (3) cited, has approved the B.Sc III Physics VI semester syllabus (Theory & Practical) under CBCS pattern for the academic year 2017-18 prepared by the Board of Studies (UG) in B.Sc Physics the titles of the Papers are mentioned below:

III B.Sc Physics VI Semester

Any one of the Elective Paper A or B or C:
1. Paper: VII (A): Analog and Digital Electronics
   OR
2. Paper: VII (B): Materials Science
   OR

Any one of the Cluster Elective Papers A or B or C:
   VIII-(A2): Computational Methods and Programming.
   VIII-(A3): Electronic Instrumentation.
   OR
5. Paper: VIII(B-1): Fundamentals of Nanoscience
   VIII(B-2): Synthesis and Characterization of Nanomaterials
   VIII(B-3): Applications of Nanomaterials and Devices
   OR
   VIII(C-2): Wind, Hydro and Ocean Energies
   VIII(C-3): Energy Storage Devices.
   (BY ORDER)

To
The Chairman and all members, Board of Studies (UG) in B.Sc Physics ANU.
All the Principals of the Affiliated Colleges under ANU area.
Copy to:
The Dean, Faculty of Physical Science  ANU.
The Dean, CDC, ANU.
The Coordinator, UG (Exams), ANU
The Addl. Controller of Examinations, ANU.
The In-Charge, ANU website.
The P.A. to Vice-Chancellor/ Registrar/Rector, ANU.
Andhra Pradesh State Council of Higher Education
B.Sc. PHYSICSSYLLUBUS UNDER CBCS
w.e.f. 2015-16 (Revised in April 2016)

First Semester
Paper I : Mechanics & Properties of Matter
Practical 1 (Lab-1)

Second Semester
Paper II: Waves & Oscillations
Practical 2 (Lab 2)

Third Semester
Paper III: Wave Optics
Practical 3 (Lab 3)

Fourth Semester
Paper IV: Thermodynamics & Radiation Physics
Practical 4 (Lab 4)

Fifth Semester
Paper V: Electricity, Magnetism & Electronics
Paper VI: Modern Physics
Practical 5 (Lab 5)
Practical 6 (Lab 6)

Sixth Semester
Paper VII: Elective (One)
Paper VIII: Cluster Electives (Three)
Practical 7 (Lab 7)
Practical 8 (Lab 8)

Proposed Electives in Semester – VI

Paper – VII (one elective is to be chosen from the following)

Paper VII-(A): Analog and Digital Electronics
Paper VII-(B): Materials Science
Paper VII-(C): Renewable Energy

Paper – VIII (one cluster of electives (A-1,2,3 or B-1,2,3 or C-1,2,3) to be chosen preferably relating to the elective chosen under paper – VII (A or B or C)

Cluster 1(A)
Paper VIII-A-1. Introduction to Microprocessors and Microcontrollers
PHYSICS - VI SEMESTER

Elective VII (A): (Electronics)
Semester - VI
Elective Paper - VII-(A) : Analog and Digital Electronics

No. of Hours per week: 03
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, LED and LCD

Unit-II (10 Hours)
3. 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

Unit-III (10 Hours)

Unit-IV (14 Hours)
5. Data processing circuits: Multiplexers, De-multiplexers, encoders, decoders
6. IC 555 Timer - Its pin diagram, internal architecture, Application as astable multivibrator and mono stable multivibrator.

Unit-V (12 Hours)
7. Sequential digital circuits: Flip-flops, RS, Clocked SR, JK, D, T, Master-Slave Flip- flops
8. Code Converters: Design of code converter, BCD to 7 segment, binary/BCD to gray, gray to binary/BCD.

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

No. of Hours per week: 03 Total Lectures: 60

Unit – I (12 Hours)
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 (12 Hours)
2. Microprocessors: Organisation of microprocessor based system, 8085 microprocessor, its pin diagram and architecture, concept of data bus, and address bus,
3. 8085 programming, instruction classification-data transfer, Arithmetic instructions, logical instructions.

Unit – III (12 Hours)
4. 8051 microcontroller: Introduction, block diagram, assembly language programming programme counter , ROM Memory , Jump , loop and Call instructions

Unit – IV (12 Hours)
5. 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 –V (12)
6. Embedded system programming: Structure of programming, infinite loop, compiling, linking locating, down loading and debugging

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

1. S. G. S. Sankar
2. Dr. McCormick
3. Dr. V. Laghulam

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: 03

Total Lectures: 60

UNIT-I (10hrs)

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 (10hrs)

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 (10hrs)

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

UNIT-IV (12hrs)

6. Linear and Non - Linear equations: Solution of Algebra and transcendental equations- Bisection and Newton-Rhapson methods-Basic principles-Formulae-algorithms

UNIT-V

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

Reference books:
1. Introductory methods of Numerical Analysis: Sastry
2. Numerical Methods: Balaguruswamy
3. Programming in ANSI C (TMH): Balaguruswamy
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.
<table>
<thead>
<tr>
<th>Unit</th>
<th>Hours</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>II</td>
<td>10</td>
<td>Electronic Voltmeter: Advantage over conventional multimeter for voltage measurement with respect to input impedance and sensitivity. Principles of voltage measurement (block diagram only). Specifications of an electronic voltmeter/multimeter and their significance.</td>
</tr>
<tr>
<td>III</td>
<td>14</td>
<td>CRO: Block diagram of basic CRO, construction of CRT, electron gun, electrostatic focusing and acceleration (only explanation). Time base operation, synchronization. Applications CRO: Measurement of voltage, dc and ac frequency, time period.</td>
</tr>
<tr>
<td>IV</td>
<td>12</td>
<td>Digital Multimeter: Block diagram, working, frequency and period measurement using universal counter, frequency counter, accuracy and resolution. Digital instruments: Principle and working of digital instruments, characteristics of a digital meter, working principle of a digital voltmeter.</td>
</tr>
<tr>
<td>V</td>
<td>12</td>
<td>Signal generators: Block diagram explanation, specifications of low frequency signal generators, pulse generator, function generator-working. Bridges: Block diagram, working of basic LCR bridge - specifications.</td>
</tr>
</tbody>
</table>

Reference Books
4. A textbook in electrical technology by B.L. Thereja (S.Chand&Co)
5. Digital circuits and systems by Venugopal 2011 (Tata McGraw Hill)
6. Digital Electronics by Subratha Ghoshal 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 a low and high resistance.
2. Study the limitations of a multimeter for measuring high frequency voltage and currents.
3. Measurement of voltage, frequency, time period and phase angle using CRO.
5. Measurement of rise, fall, and delay times using a CRO.
Paper VIII-A-3. Electronic Instrumentation

Cluster 2
- Paper VIII-B-1. Fundamentals of Nanoscience
- Paper VIII-B-2. Synthesis and Characterization of Nanomaterials
- Paper VIII-B-3. Applications of Nanomaterials and Devices

Cluster 3
- Paper VIII-C-1. Solar Thermal and Photovoltaic Aspects
- Paper VIII-C-2. Wind, Hydro and Ocean Energies
- Paper VIII-C-3. Energy Storage Devices

NOTE: Problems should be solved at the end of every chapter of all Units.

1. Each theory paper is of 100 marks and practical paper is also of 50 marks.
   Each theory paper is 75 marks University Exam (external) + 25 marks mid Semester Exam (internal). Each practical paper is 50 marks external.
2. The teaching work load per week for semesters I to VI is 4 hours per paper for theory and 2 hours for all laboratory (practical) work.
3. The duration of the examination for each theory paper is 3.00 hrs.
4. The duration of each practical examination is 3 hrs with 50 marks, which are to be distributed as 30 marks for experiment:
   - 10 marks for viva
   - 10 marks for record

### Practical Marks

<table>
<thead>
<tr>
<th>Description</th>
<th>Marks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Formula &amp; Explanation</td>
<td>6</td>
</tr>
<tr>
<td>Tabular form + graph + circuit diagram</td>
<td>6</td>
</tr>
<tr>
<td>Observations</td>
<td>12</td>
</tr>
<tr>
<td>Calculation, graph, precautions &amp; Result</td>
<td>6</td>
</tr>
<tr>
<td>Viva-Voce</td>
<td>10</td>
</tr>
<tr>
<td>Record</td>
<td>10</td>
</tr>
</tbody>
</table>

***NOTE: Practical syllabus is same for both Mathematics and Non Mathematics combinations***

B.Sc. (Physics) (Maths Combinations)
Scheme of instruction and examination to be followed w.e.f. 2015-2016

<table>
<thead>
<tr>
<th>S. No</th>
<th>Semester</th>
<th>Title of the paper</th>
<th>Instruction hrs/week</th>
<th>Duration of exam (hrs)</th>
<th>Max Marks (external)</th>
</tr>
</thead>
</table>
Model question Paper for all theory papers

Time : 3 hrs  
Max marks : 75

Section-A (Essay type)
Answer All questions with internal choice from all units  
Marks :10x5 = 50
(Two questions are to be set from each unit with either or type)

Section-B (Short answer type)
Answer any three out of 5 questions from all units (I to V)  
Marks: 5 x3 = 15
At least one question should be set from each unit.

Section-C
Answer any two out of 5 questions set from all units  
Marks: 5x2 = 10
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)

UNIT-II (12 hrs)

UNIT-III (12 hrs)

UNIT-IV (12 hrs)

UNIT-V (12 hrs)
1. 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.

Reference books

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)
3. Determination of coupling coefficient of a piezoelectric crystal.
5. Study the complex dielectric constant and plasma frequency of metal using surface plasmon resonance (SPR)
6. Study the hysteresis loop of a Ferroelectric Crystal.
7. 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: Biomimetic, bioceramic and nanotherapeutics; Nanomaterials for molecular electronics and optoelectronics.

UNITS-III (12hrs)

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.

UNIT-V (12hrs)

**Reference Books**

Elective Paper- VIII-B-1: Practical: Fundamentals of Nanoscience
2hrs/Week

Minimum of 6 experiments to be done and recorded
2. Surface Enhanced Raman Scattering Activity of Silver Nanoparticles
3. Conversion of Gold Nanorods into Gold Nanoparticles
4. Bimetallic Nanoparticles
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

No. of Hours per week: 04

Total Lectures:60

Unit-I (12 hrs)

Unit-II (12 hrs)

UNITS-III (12 hrs)
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)

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

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.
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)

UNIT-II (12 hrs)
2. Electrical transport:
Carrier transport in nanostructures. Hall effect, determination 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)

UNIT-IV (12 hrs)

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.).

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.

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, energy resources, coal, oil, natural gas, nuclear and hydroelectric power.

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

UNIT-III (12 hrs)


UNIT-IV (12 hrs)
UNIT-V (12 hrs)

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

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.
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, 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 – and pyrheliometer.
2. Radiative Properties and Characteristics of Materials: 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.

Unit-III (14 hrs)

UNIT-IV (8 hrs)

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.

Reference Books:

Cluster Elective Paper- VIII-C-1: Practical: Solar Thermal and Photovoltaic Aspects
2hrs/Week
Minimum of 6 experiments to be done and recorded
5. Performance testing of solar air dryer unit.
7. Study on solar photovoltaic panel in series and parallel combination.
Semester - VI
Cluster Elective Paper – VTH-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.

UNIT-II
2. Wind Energy Conversion System: Aerodynamic design principles; Aerodynamic theories; Axial momentum, blade element and combine theory; Rotor characteristics; Maximum power coefficient; Prandlt’s tip loss correction.

UNIT-III
3. Wind Energy Application: Wind pumps: Performance analysis, design concept and testing; Principle of wind energy generation; 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 and turbine; Selection and design criteria of pumps and turbines; Site selection; Speed and voltage regulation;

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,

Reference Books:
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.
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)

UNIT-III (12 hrs)

UNIT-IV (12 hrs)

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, applications of fuel cells.

REFERENCE BOOKS

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.