ST.ALBERT'S COLLEGE, ERNAKULAM

(Affiliated to Mahatma Gandhi University, Kottayam)

B.Voc. Renewable Energy (UGC Sponsored)

SCHEME & SYLLABUS

General Guidelines

1. ELIGIBILITY FOR ADMISSION, AND RESERVATION OF SEATS

1.1 Eligibility of admission, Norms for admission, reservation of seats for various Degree Programmes shall be according to the rules framed by the University from time to time. However, a student who has successfully completed Dilpoma / Advanced Diploma from Community Colleges in complementary programmes shall be eligible for admission to Year II(Semester III) / Year III(Semester V) respectively, according to the availability of seats and as decided by the CLMC in consultation with the ULMC.

2. DURATION AND LEVEL OF AWARDS

2.1 The duration of U.G. programmes shall be ***6 Semesters***.

2.2 The duration of odd semesters shall be from **June to October** and that of even semesters from **November to March.** There shall be three days *semester break after odd semesters and two months vacation during April and May in every academic year.*

2.3 The certification levels will lead to Diploma /Advanced Diploma /B.Voc. Degree and will be offered under the aegis of the University as outlined in the Table given below

Award	**Duration**
Diploma	**1 Year**
AdvancedDiploma	**2 Years**
B.Voc.Degree	**3 Years**

3. REGISTRATION

3.1 The strength of students for each course shall remain as per existing regulations, subject to the marginal increase.

3.2 Each student shall register for the courses in the prescribed registration form in consultation with the Faculty Advisor within two weeks from the commencement of each Level of Award. Faculty Adviser shall permit registration on the basis of the preferences of the student and availability of seats.

3.3 The number of courses/credits that a student can take in a semester is governed by the provisions pertaining to the minimum and maximum number of credits permitted.

3.4 A student can opt out of a course/courses registered subject to the minimum credits requirement, within seven days from the commencement of the semester.

3.5 Those students who possess the required minimum attendance and progress during an academic year/semester and could not register for the annual/semester examination are permitted to apply for Notional Registration to the examinations concerned enabling them to get promoted to the next class.

4. SCHEME AND SYLLABUS

4.1 The B.Voc. Programme shall include (a) General Courses (General Components) and (b) Core Courses (Skill Components).

4.2 Credit Transfer and Accumulation system can be adopted in the programme. Transfer of Credit consists of acknowledging, recognizing and accepting credits by an institution for programmes or courses completed at another institution. The Credit Transfer Scheme shall allow students pursuing a programme in one University to continue their education in another University without break.

5. PROGRAMME STRUCTURE

The B.Voc. programme shall include:

- General Education Components
- Skill Components which include Core Courses, Project, Hands-on training (HOT) and On-Job Training (OJT)

Credit Calculation

The following formula is used for conversion of time into credit hours.

- One Credit would mean equivalent of 15 periods of 60 minutes each, for theory, workshops/labs and tutorials
- For internship/field work, the credit weightage for equivalent hours shall be 50% of that for lectures/workshops

Course Structure

Year	Skill Component Credits	General Component Credits	Exit point/Award
I	36	24	Diploma
II	36	24	Advance Diploma
III	36	24	B.Voc. Degree

As per the UGC guidelines, there are multiple exit points for a candidate admitted to this course. If he/she completes all the six credits successfully, he/she will be awarded B. Voc. Degree in Renewable Energy. If he/she completes the first four semesters successfully, he/she will be awarded Advanced Diploma in Renewable Energy. If he/she is completes the first two semesters successfully, he/she will be awarded Diploma in Renewable Energy.

6. EXAMINATIONS

6.1 The evaluation of each course shall contain two parts:

(i) Internal or In-Semester Assessment (ISA)

(ii) External or End-Semester Assessment (ESA)

The internal to external assessment ratio shall be 1:4, for all courses including practical ***(Practical courses will be treated as independent courses)***. There shall be a maximum of **80** marks for external evaluation and maximum of **20** marks for internal evaluation. For all courses (theory & practical), grades are given on a 07-point scale based on the total percentage of marks. ***(ISA+ESA)*** as given below

Percentage of Marks	**Grade**	**Grade Point**
90 and above	A+ - Outstanding	10
80-89	A – Excellent	9
70-79	B - Very Good	8
60-69	C – Good	7
50-59	D – Satisfactory	6
40-49	E – Adequate	5
Below 40	F – Failure	4

Note: Decimal are to be rounded to the next whole number

7. CREDIT POINT AND CREDIT POINT AVERAGE

Credit Point (CP) of a course is calculated using the formula

CP = C × GP, where C = Credit; GP = Grade point

Credit Point Average (CPA) of a Semester/Programme is calculated using the formula

CPA = TCP/TC, where TCP = Total Credit Point; TC = Total Credit

Grades for the different semesters and overall programme are given based on the corresponding CPA as shown below:

CPA	**Grade**	
> 9	***A+***	***Outstanding***
> 8, but < or = 9	***A***	***Excellent***
> 7, but < or = 8	***B***	***Very Good***
> 6, but < or = 7	***C***	***Good***

> 5, but < or = 6	***D***	***Satisfactory***
> 4, but < or = 5	***E***	***Adequate***
4 or < 4	***F***	***Failure***

Note: A separate minimum of 30% marks each for internal and external (for both theory and practical) and aggregate minimum of 40% are required for a pass for a course. For a pass in a programme, a separate minimum of Grade E is required for all the individual courses. If a candidate secures **F** Grade for any one of the courses offered in a Semester/Programme only **F** grade will be awarded for that Semester/Programme until he/she improves this to **E** grade or above within the permitted period. Candidate who secures **E** grade and above will be eligible for higher studies.

8. MARKS DISTRIBUTION FOR EXTERNAL EXAMINATION AND INTERNAL EVALUATION

The external examination of all semesters shall be conducted by the University at the end of each semester. Internal evaluation is to be done by continuous assessment. Marks distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

Components of the internal evaluation and their marks are as below.

8.1 For all courses including practical

a) Marks of Theory-External Examination : 80

b) Marks of Theory- Internal Evaluation : 20

All the three components of the internal assessment are mandatory. For General Course-English, internal oral examination shall be conducted instead of test paper.

Components of Internal Evaluation-Theory	**MARKS**
Attendance	**5**
Assignment /Seminar/Viva	**5**
Test paper(s)(**1 or 2**) **(1x10=10; 2x5=10)**	**10**
Total	**20**

c) Marks of Practical-External Examination : 80 (Only in even semesters)

d) Marks of Internal Evaluation-Practical : 20 (Odd and even semesters combined annually)

Components of Internal evaluation- Practical	**Marks**
Attendance	4
Record*	10
Lab involvement	6
Total	**20**

***Marks awarded for Record should be related to number of experiments recorded.**

8.3 Project Evaluation: (Max. marks100)

Components of Project-Evaluation	Marks
Internal Evaluation	20
Dissertation (External)	50
Viva-Voce (External)	30
Total	**100**

8.4 Attendance Evaluation

a) For all courses including practical

% of attendance	Marks
90 and above	5
85 – 89	4
80-84	3
76-79	2
75	1

(Decimals are to be rounded to the next higher whole number)

9 ASSIGNMENTS

Assignments are to be done from 1st to 4th Semesters. At least one assignment per course per semester should be submitted for evaluation.

10 SEMINAR/VIVA

A student shall present a seminar in the 5th semester and appear for Viva-voce in the 6th semester.

11 INTERNAL ASSESSMENT TEST PAPERS

At least one internal test-paper is to be attended in each semester for each course. The evaluations of all components are to be published and are to be acknowledged by the candidates. All documents of internal assessments are to be kept in the college for two years and shall be made available for verification by the University. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teach the course.

12. EXTERNAL EXAMINATION

The external examination of all semesters shall be conducted by the University at the end of each semester.

12.1 Students having a minimum of 75% average attendance for all the courses only can register for the examination. Condonation of shortage of attendance to a maximum of 10 days or 50 hours in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the University on valid grounds. This condonation shall not be counted for internal assessment.

12.2 Benefit of attendance may be granted to students attending University/College union/Co-curricular activities by treating them as present for the days of absence, on production of participation/attendance certificates, within one week, from competent authorities and endorsed by the Head of the institution. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also.

12.3 Those students who are not eligible even with condonation of shortage of attendance shall repeat the course along with the next batch.

12.4 All students are to complete **One Hands-on training (HOT), One On-job training (OJT) and One Major Project**. The major project can be done individually or as a group of 5 students. The HOT and OJT has to be done during the second and fourth semesters of the programme. The major project has to be done in the final year of the programme. The reports of HOT and OJT (in duplicate) are to be submitted to the department in the second and fourth semesters and the report of the major project (in duplicate) is to be submitted to the department in the sixth semester. The major project report should be produced before the examiners appointed by the University.

12.5 There will be no supplementary exams. For reappearance/ improvement, the students can appear along with the next batch.

12.6 A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

12.7 A student who has completed the entire curriculum requirement, but could not register for the Semester examination can register notionally, for getting eligibility for promotion to the next semester.

12.8 A candidate who has not secured minimum marks/credits in internal examinations can re-do the same registering along with the University examination for the same semester, subsequently.

12.9 PATTERN OF QUESTIONS

Questions will be set to assess knowledge acquired, standard application of knowledge, application of knowledge in new situations, critical evaluation of knowledge and the ability to synthesize knowledge.

A question paper will comprise objective type, short answer type, short essay type /problem solving type and long essay type questions.

Pattern of questions for external examination (for all courses excluding practical).

	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Section A	10	10	1	10
Section B	12	8	2	16
Section C	9	6	4	24
Section D	4	2	15	30
	35	**26**	x	**80**

13. As per University Guidelines a **3 level monitoring** committee will monitor the conduct of the scheme

1. Department Level Monitoring Committee (DLMC), comprising HOD and two senior-most teachers as members.
2. College Level Monitoring Committee (CLMC), comprising Principal, Dept. Coordinator and A.O/Superintendent as members.
3. University Level Monitoring Committee (ULMC), headed by the Vice-Chancellor and Pro-Vice-Chancellor, Conveners of Syndicate subcommittee on Examination, Academic Affairs and Staff and Registrar as members and the Controller of Examinations as member-secretary.

SCHEME B.Voc. Renewable Energy

Year-I Semester-I

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-1T01	English-I	4	60	3	20	80
REG-1T02	Mathematics-I	4	60	3	20	80
REG-1T03	Chemistry-I : Thermodynamics and Electrochemistry	4	60	3	20	80
RES-1T04	Physics-I : Units and measurements, circuit theory and electrical fundamentals	5	75	4	20	80
RES-1T05	Renewable Energy-I : Fundamentals of sustainable energy & development	5	75	4	20	80
RES-1P01	General Physics Lab	4	60	4	20	80
RES-1P02	Computer Application Lab- MATLAB	4	60	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

Year-I Semester-II

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-2T06	English-II	4	60	3	20	80
REG-2T07	Mathematics-II	4	60	3	20	80
REG-2T08	Physics-II : Basic electronics	4	60	3	20	80
RES-2T09	Renewable Energy-II : Physico-chemical processes for water and wastewater treatment	5	75	4	20	80
RES-2T10	Renewable Energy-III : Photovoltaic module installation	5	75	4	20	80
RES-2P03	Practical- Electronics & Photovoltaic module installation	4	60	4	20	80
RES-2HOT01	HOT	4	(120)	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

Year-II Semester-III

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-3T11	Chemistry-II: Physical Chemistry	4	60	3	20	80
REG-3T12	Physics-III : Thermodynamics and Fluid Mechanics	4	60	3	20	80
REG-3T13	Renewable Energy-IV : Novel Energy Resources	4	60	3	20	80
RES-3T14	Renewable Energy-V : Solar Thermal Technology-I	5	75	4	20	80
RES-3T15	Renewable Energy-VI : Wind Energy	5	75	4	20	80
RES-3P04	Practical- Thermodynamics & Solar Thermal	4	60	4	20	80
RES-3P05	Practical- Fluid dynamics & Wind Energy	4	60	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

Year-II Semester-IV

Course Code	Course Title	Credits	Total hrs	Hrs/wk	Internal	External
REG-4T16	Renewable Energy-VII : Solar Thermal Technology-II	4	60	3	20	80
REG-4T17	Material Science	4	60	3	20	80
REG-4T18	Environmental Education	4	60	3	20	80
RES-4T19	Renewable Energy-VIII : Solar Photovoltaic Energy Conversion-I	5	75	4	20	80
RES-4T20	Renewable Energy-IX : Energy Storage Systems	5	75	4	20	80
RES-4P06	Practical- Solar Photovoltaics & Energy Storage Systems	4	60	4	20	80
RES-4OJT01	OJT	4	(120)	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

Year-III Semester-V

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-5T21	Physics-IV : Laser and Optical Instrumentation	4	60	3	20	80
REG-5T22	Renewable Energy-X : Environment, Health and Safety in Industries	4	60	3	20	80
REG-5T23	Renewable Energy-XI: Project Management	4	60	3	20	80
RES-5T24	Renewable Energy-XII : Energy Conservation Techniques	5	75	4	20	80
RES-5T25	Renewable Energy-XIII : Solar Photovoltaic Energy Conversion-II or Solar Thermal Technology-III	5	75	4	20	80
RES-5P07	Practical-Advanced Solar Photovoltaic Lab	4	60	4	20	80
RES-5P08	Practical-Advanced Solar Thermal Lab-I	4	60	4	20	80

Total Credits: 30 **Skill: 18** **General: 12**

Year-III Semester-VI

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-6T26	Physics-V : Spectroscopy and experimental techniques	4	60	3	20	80
REG-6T27	Physics-VI : Power Electronics	4	60	3	20	80
REG-6T28	Renewable Energy-XIV : Fuel cell systems and hydrogen	4	60	3	20	80
RES-6T29	Renewable Energy-XV : Energy Management and Auditing	5	75	4	20	80
RES-6P09	Practical-Advanced Solar Thermal Lab-II	4	60	4	20	80
RES-6P10	Practical-Experimental Techniques & Power electronics	4	60	4	20	80
RES-6PRJ03	Final Project Report and Viva	5	(150)	4	20	80

Total Credits: 30 **Skill: 18** **General: 12**

Detailed Syllabus

Semester-I

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-1T01	English-I	4	60	3	20	80
REG-1T02	Mathematics-I	4	60	3	20	80
REG-1T03	Chemistry-I : Thermodynamics and Electrochemistry	4	60	3	20	80
RES-1T04	Physics-I : Units and Measurements, Circuit theory and Electrical fundamentals	5	75	4	20	80
RES-1T05	Renewable Energy-I : Fundamentals of Sustainable Energy & Development	5	75	4	20	80
RES-1P01	General Physics Lab	4	60	4	20	80
RES-1P02	Computer Application Lab- MATLAB	4	60	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

REG-1T01 ENGLISH-I **(Total: 60hrs)**

Module 1 **(10hrs)**

Speech Sounds

Phonemic symbols - Vowels – Consonants-Diphthongs- Syllables -Word stress - Stress in polysyllabic words – Stress in words used as different parts of speech - Sentence stress - Weak forms and strong forms – Intonation - Awareness of different accents: American, British and Indian - Influence of the mother tongue

Reference

Communication Skills in English; V Sasi Kumar; 2011; 2nd Ed.; MG University.

Module 2 **(10hrs)**

Non- Verbal Communication : introduction

Body Language : Personal Appearance – Posture - Gestures and Hand Movements - Eye Contact - Facial Expressions - Paralinguistic Features – Rate – Pauses – Volume - Pitch/ Intonation/Cadence/ Voice Modulation - Pronunciation and Articulation

Reference

Communication Skills; Sanjaya Kumar and Pushpa Latha; 2011; 1st Ed.; Oxford.

Module 3 **(20hrs)**

Paragraph Writing: Introduction

Structure of a Paragraph - Topic Sentence

Construction of a Paragraph -Narrative Description -Comparison and Contrast -Sustained Analogy - Cause and Effect - Quotation and Paraphrasing – Enumeration – Definition – Testimony - Facts, Figures, Instances - Features of a Paragraph - Unity – Coherence - Expansion and Emphasis - Descriptive Writing Techniques - Argumentative Paragraph - Analytical Paragraph

Reference

Communication Skills; Sanjaya Kumar and Pushpa Latha; 2011; 1st Ed.; Oxford.

Module 4 **(20hrs)**

Critical Thinking

Introduction to critical thinking – Benefits - Barriers – Reasoning - Arguments - Deductive and inductive arguments – Fallacies - Inferential comprehension- Critical thinking in academic writing - Clarity - Accuracy – Precision – Relevance

Reference

Critical Thinking Academic Writing and Presentation Skills; Marilyn Anderson; 2010; 1st Ed.; MG University.

REG 1T02 MATHEMATICS – I (Total: 60hrs)

Module 1 (15 hrs)

Sets and Functions

Power set of a set, Product of two sets, Equivalence relations, partitions of sets, Equivalence classes 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. Graphing of functions.

References:

1. Set Theory and Related Topics, LipSchutz, Schaum Outline Series, 2009, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi.
2. Discrete Mathematics and its Applications, K. H. Rosen, 6th Edition, Tata McGraw Hill Publishing Company, New Delhi.

Module 2 (15 hrs)

Complex Numbers

Complex numbers. Addition and multiplication of complex numbers. Modulus, Real and imaginary parts, conjugate and amplitude of a complex number. Polar form of complex number. Geometric representation of the sum and difference.

References:

Fundamentals of Complex Analysis, E. B. Staff and A. D. Snider, 2009, 3rd Edition, Pearson Education.

Module 3 (10 hrs)

Limit, Continuity and Differentiability

Limits of Functions, calculating limits using the limit laws, one sided limits and limits at infinity, Continuity, Rates of change and Differentiability, standard results, Differentiation Rules, Chain Rule.

References:

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 2.1 to 2.6 and 3.1 to 3.2)

Module 4 (20 hrs)

Statistical Methods of Analysis

Types of data:- quantitative, qualitative. Classification and Tabulation. Diagrammatic representation:- Bar diagram, pie diagram; pictogram and cartogram. Graphical representation:- histogram; frequency polygon; frequency curve; ogives. Measures of Central Tendency:- Mean; Median; Mode; Geometric Mean; Harmonic Mean and Properties.

Absolute and Relative measures of Dispersion:- Range, Quartile Deviation, Mean Deviation, Standard Deviation, Coefficient of Variation.

References:

1. S.P. Gupta: Statistical Methods (Sultan Chand & Sons Delhi).
2. S.C. Gupta and V.K. Kapoor: Fundamentals of Mathematical Statistics, Sultan Chand and Sons.
3. B.L. Agarwal: Basic Statistics, New Age International (p) Ltd.
4. Parimal Mukhopadhya: Mathematical Statistics, New Central Book Agency (p) Ltd, Calcutta
5. Murthy M.N.: Sampling theory and Methods, Statistical Publishing Society, Calcutta.

REG-1T03 CHEMISTRY-I : Thermodynamics and Electrochemistry (Total: 60hrs)

Module 1 (20 hrs)

Thermodynamics : System and Surrounding. First law of Thermodynamics: Internal energy, Significance of internal energy change, enthalpy, Second law of Thermodynamics: free energy, Entropy and Spontaneity, Statement of second law based on entropy, Entropy change in Phase transitions, entropy of fusion, entropy of vaporization, entropy of sublimation. The concept of Gibbs's free energy- Physical significance of free energy, conditions for equilibrium & spontaneity based on ΔG values. Effect of temperature on spontaneity of Reaction. Third law of Thermodynamics.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn. Chapter 13-16, Vishal Pub. Co.
2. Physical Chemistry, G. W. Castellan, 2004, 3rd edn., chapter 6-10, Narosa Publishing House, New Delhi.
3. Thermodynamics, J. Rajaram and J. C. Kuriakose, 1986, Shoban Lal Nagin Chand & Co.
4. Physical Chemistry, P. Atkins. J. Paula, 2006, 8th edn, chapter 2 & 3, Oxford University Press.

Module 2 (15 hrs)

Electrochemistry : Conductance of electrolytic solution, electrolytic conductivity (K), and molar conductivity (Λ) of solutions of electrolytes. Variation of conductivity and molar conductivity with concentration. Kohlrausch's law – application. Faraday's laws of electrolysis, electrochemical equivalent and chemical equivalent, transport number-determination by Hittorf's method. Applications of conductance measurements – K_w, K_{sp}. Ostwald's dilution law, hydrolysis of salts.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn. chapter 23, Vishal Pub. Co.
2. Introduction to Electrochemistry, S. Glasstone, 2011, chapter 2 & 3, Biblio Bazar.

Module 3 (15 hrs)

Electromotive Force : Galvanic cells, characteristics of reversible cells. Reversible electrodes – different types, electrode potential – effect of electrolyte concentration on electrode potential and emf, Nernst equation. Electrochemical series, representation of cell, EMF of cell. EMF and equilibrium constant of cell reaction, concentration cells – general discussion of electrode – concentration cell and electrolyte concentration cells. Liquid junction potential.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn., chapter 24 & 25, Vishal Pub. Co.
2. Physical Chemistry, G. W. Castellan, 2004, 3rd edn., chapter 17, Narosa Publishing House, New Delhi.
3. Introduction to Electrochemistry, S. Glasstone, 2011, chapter 6 & 7, Biblio Bazar.

Module 4 (10 hrs)

Electroanalytical methods : conductometric titration, amperometric titration, potentiometric titration, coulometry, voltammetry, polarography.

Reference

1. Fundamentals of Analytical Chemistry, D.A. Skoog, D.M. West, F.J. S.R. Holler, Crouch, 2006, 8th edn, Chapter 22 & 23, Thomson Brooks/Cole.
2. A Text Book of Quantitative Analysis including Instrumental Analysis, A.I. Vogel, 1961, John Wiley & Sons.

RES-1T04 PHYSICS-I : **Units and measurements, Circuit theory and electrical fundamentals** **(Total: 75hrs)**

Module 1 **(25hrs)**

Measurements: Units Necessity of measurement, concept of unit of a physical quantity, requirements of standard unit, Various system of units (CGS, MKS, SI, FPS), conversions, practical units, fundamental and derived physical quantities and their units, dimensions and dimensional analysis

Measuring instruments: Measurement of time – water clocks – sun dials – pendulum clocks – digital clocks – atomic clocks-Length measurements – rulers – standard meter – micro meters – screw gauges – travelling microscopes – laser range finder – sonar – GPS- Angle Measurements – Spectrometer verniers – scale and telescope – measurement of stellar parallaxes-Electrical measurements – Working principle of galvanometer – voltmeter – ammeter and digital multimeters

Reference

Fundamentals of Physics; David Halliday & Robert Resnick; 2010; John Wiley & Sons

Module 2 **(15hrs)**

Varying Currents: Growth and decay of current in an inductive circuit-charge and discharge of a capacitor through a resistance - measurement of high resistance by capacitor leakage method- DC applied to LCR series circuit(charge case)-discharging of capacitor through LR circuit(discharge case)

Reference

Basic Electronics- Solid state; BL Thereja; 2005; S. Chand & Co.

Module 3 **(20hrs)**

Alternating currents & Circuit theory: RMS and peak values-AC through series LCR(acceptor circuit) and parallel LCR circuit (rejecter circuit)-Q factor-power in AC-power factor-measurement of power in AC circuit-AC watt meter- Distribution of three phase current: star connection – delta connection -Ideal voltage and current sources-Thevenin's and Norton's theorems-Maximum power transfer theorem- Superposition Theorem

Reference

Basic Electronics- Solid state; BL Thereja; 2005; S. Chand & Co.

Module 4 **(15hrs)**

Resistors: Fixed and Variable type (preliminary ideas) - Colour Code of Standard Resistors.

Capacitors: Fixed and Variable type, Colour Coding of capacitors.

Cables/Wires: Types: flexible, hook-up, coaxial and fiber optic. Multi-core Power and Control cables.

Switches: Different Types: Slide, Toggle, Push to ON, Push to OFF, Rocker :- Their applications

Relays: Construction, rating & working principle of general purpose relay, Reed relay.

Reference

1. Basic Electronics- Solid state; BL Thereja; 2005; S. Chand & Co.
2. Instrumentation devices and systems, C.S Rangan, G.R. Sharma, V.S.V. Mani, Tata McGraw – Hill

RES-1T05 RENEWABLE ENERGY-I : FUNDAMENTALS OF SUSTAINABLE ENERGY & DEVELOPMENT (Total: 75hrs)

Module 1 (5hrs)

Introduction to Energy Sources

Energy sources and their availability- Conventional energy sources- Renewable energy sources- Need of renewable energy sources

Reference

Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers

Module 2 (25hrs)

Solar Energy

Potential of Solar Energy-solar radiation and Measurement-types of solar energy collectors-Solar water heating systems- Solar air heating and cooling systems-Solar thermal electric conversion- Solar photovoltaic system-Other applications of solar energy like distillation,pumping, furnace, green house etc.

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

Module 3 (25hrs)

Biomass and Biogas energy

Introduction – usable forms of biomass, their composition and fuel properties-Biomass conversion technologies- Biomethanation: Phases in biogas production, Parameters affecting biogas Production - Classification of biogas plants – Types of biogas plants- Methods for maintaining biogas production-Bio diesel

Reference

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers.
2. Solar Thermal and Biomass Energy; G. Lorenzini, C. Biserni & G. Flacco; 2010; First Edition; WIT Press, UK.

Module 4 (20hrs)

Wind Energy

Scope for Wind energy in India- Basic principles of wind energy conversion- Site selection considerations- Basic components of wind energy conversion system-Types of wind

machines- Performance of Wind machines- Application of Wind Energy- Solar wind hybrid system

Other sources of sustainable energy

Tidal Energy- Geothermal Energy- Magneto Hydro Dynamic energy- Chemical energy Sources-Hydrogen Energy

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

PRACTICALS

RES 1P01 General Physics Lab (Total: 60hrs)

1. Travelling microscope
2. Spectrometer-Angle of prism
3. Symmetric compound pendulum
4. Verification of Ohm's law
5. Conversion of Galvanometer into voltmeter
6. Determination of the end correction of a meter bridge
7. Determination of the specific resistance of the material of a wire using meter bridge
8. Measurement of average resistance per unit length of a wire using Carey Foster's bridge
9. Potentiometer-Calibration of a low range voltmeter
10. Potentiometer-Calibration of a low range ammeter
11. Potentiometer-Measurement of e.m.f. of a cell
12. Series LCR circuit-frequency response

RES-1P02 Computer Applications Lab-MATLAB (Total: 60hrs)

1. Create a structure for an employee database storing information about employee code, name, designation and salary. First create 3 records and then write command to read the second employee's designation.
2. Write a program to illustrate using menu function to select a candidate from given choices: - (Kiran, Sham, Johns, Fielder, Margret, Green Field, Tom, Mark Ryan, Alex Paul, Simson.)
3. Plot a 2-D graph with axes , $x= \cos \theta$, $y = \sin \theta$,where $0 \leq \theta \leq 2\pi$, taking 100 linearly spaced points in the given interval .Label the axes and title the graph with text string .
4. Plot a graph for 'power *v/s* time' $0< t < 10$ sec , with power on the log scale and time in linear scale for a motor whose performance equations are given as follows:
   a) Rotational speed, $\omega = 190(1 - e^{-0.15t})$
   b) Torque, $T= 8e^{-0.15t}$
   c) Power = ωT
5. Write a program to plot a bar graph to show the comparsion of average temperature in cities: - Ernakulam, Palakkad, Kollam, for months from October to May.
6. Write a program for following:
   a) To generate 100 random data points using ROSE function.
   b) To show rating of different small scale industries as per the given data , using 'pie ' function.
7. Write a program to

a) Draw the stairs to plot, to show the function $y= x^3$, where $-3 \leq x \leq 3$.
b) Draw the stem plot for the following data:

X= [0 1 2 3 4 5 6 7] Y = [3 -9 8 -7 5 3 1 3]

8. Plot a graph by dividing the figure window into four sub- windows and plot the following functions:
   a) Plot V *v/s* I , where V= 4I and I = 2,4,6,8,10.
   b) Plot Y *v/s* X, where $Y=3 X^2$ and X= 3,4,5,6,7,8.
   c) For t= 0:π/30:6π , plot tan(t) *v/s* t.
   d) For t= 0:π/60:5π ,plot cos(t) *v/s* t.
9. Write a program to find the largest of given 'n' numbers using for loop and if structure.

   Given data:45,67,10,33,50 .

10. Write a program to draw the curves for function, y=sin(3x), $y=4x^3+5x$, y=cos(4x) in a single graph figure window using single plot command .
11. Write a program using while loop to reverse the digits of a number.
12. Write a program to add two given row vectors, with the following data:

    [4 5 8] and [34 56].

Semester-II

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-2T06	English-II	4	60	3	20	80
REG-2T07	Mathematics-II	4	60	3	20	80
REG-2T08	Physics-II : Basic electronics	4	60	3	20	80
RES-2T09	Renewable Energy-II : Physico-chemical processes for water and wastewater treatment	5	75	4	20	80
RES-2T10	Renewable Energy-III : Photovoltaic module installation	5	75	4	20	80
RES-2P03	Practical- Electronics & Photovoltaic module installation	4	60	4	20	80
RES-2HOT01	HOT	4	(120)	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

REG-2T06 ENGLISH-II **(Total: 60hrs)**

Module 1 **(18hrs)**

Listening: Introduction –Listening is an Art –Listening vs. Hearing- Poor Listening vs. Effective –Listening –Important Facts about Listening – Advantages of Good Listening – Process of Listening – Types of Listening – Intensive and Extensive Listening –Barriers to Effective Listening –Forged Attention – Premature Evaluation of the Subject Matter and Speaker

Hard Listening – Poor Interpersonal Relations –Over Excitement –Different Levels of Perception – Five Steps to Listening

Reference

1. Communication Skills in English; V Sasi Kumar; 2011; 2nd Ed; MG University.
2. Communication Skills; Sanjaya Kumar and Pushpa Latha; 2011; 1st Ed; Oxford.

Module 2 **(12hrs)**

Essentials of Grammar: Introduction – Parts of Speech – Nouns – Pronouns – Adjectives – Verbs – Preposition – Connectives – Articles – Modals - Sentence and Their Types

Reference

Communication Skills; Sanjaya Kumar and Pushpa Latha; 2011; 1st Ed; Oxford.

Module 3 **(20hrs)**

Art of Small Talk – Participating in Conversations – Making a Short Formal Speech – Group Discussion

Public Speaking-Introduction - Choosing and Appropriate Pattern - Selecting an Appropriate Method -Art Persuasion - Making Speeches Interesting - Delivering Different Types of Speeches.

Reference

Communication Skills in English; V Sasi Kumar; 2011; 2nd Ed; MG University.

Module 4 **(10hrs)**

Email Writing-Introduction - Email Writings- Reasons for popularity -Email Writings- Some Common Pitfalls - Email Writing- Guiding Principles for Composition - Email Writing- Maintaining common etiquette

Reference

1. Communication Skills; Sanjaya Kumar and Pushpa Latha; 2011; 1st Ed; Oxford.
2. Critical Thinking Academic Writing and Presentation Skills; Marilyn Anderson; 2010; 1st Ed.; MG University.

REG-2T07 MATHEMATICS-II **(Total: 60hrs)**

Module 1 **(15hrs)**

Applications of Derivatives:

Extreme values of functions, The Mean Value Theorem, Monotonic functions and the first derivative test. (Proofs Excluded)

Reference

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 4.1 to 4.3)

Module 2 **(15hrs)**

Partial Derivatives:

Functions of several variables (Definition only), Partial derivatives, The Chain Rule.

Reference

Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 14.3 to 14.4)

Module 3 **(15hrs)**

Theory of Matrices:

Definition, Types of Matrices, Operations on Matrices, Transpose of a Matrix, Elementary Tranformations of a Matrix, Invertible Matrices, Finding Rank and Inverse of a Matrix using elementary row transformations.

References:

1. Matrices: Schaum's Outline Series, Frank Ayres Jr., TMH Edition.
2. A Text Book of Matrices, Shanthi Narayanan and P. K. Mittal, S. Chand Publications.
3. Matrix Theory, David W. Lewis, Allied Publications.

Module 4 **(15hrs)**

Numerical Analysis:

Bisection Method, Method of False Position, Iteration Method, Newton-Raphson Method.

References:

Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Edition, PHI (Sections 2.2 to 2.5)

REG-2T08 PHYSICS-II : Basic Electronics **(Total: 60hrs)**

Module 1 **(10hrs)**

Electronics- Atomic structure-structure of elements-The electron-Energy of an electron-valance electrons-free electrons- Voltage source-Constant voltage source-constant current source.

Bohr's atom model- Energy levels- Energy bands in solids – Classification of solids –metals insulators and semi-conductors

Reference

Principles of Electronics; V. K. Mehta; 2006; Tenth Edition; S. Chand & Co.

Module 2 **(15hrs)**

Semiconductors- bonds in semiconductors-crystals- commonly used semiconductors – Effect of temperature on semiconductors – hole current –intrinsic semiconductor – extrinsic semiconductor – charge on n type and p type semiconductors – majority and minority carriers – pn junction – current flow in forward biased pn junction – VI characteristics of pn junction – Important terms –limitations in the operating conditions of a pn junction

Reference

Principles of Electronics; V. K. Mehta; 2006; Tenth Edition; S. Chand & Co.

Module 3 **(20hrs)**

Semiconductor diode and transistors:

Semiconductor diode-crystal diode as a rectifier- resistance of a crystal diode- equivalent circuit of a crystal diode-half wave rectifiers and full wave rectifiers (Centre tap and bridge) -- nature of rectifier output-ripple factor-Comparison of rectifiers- filter circuits- types of filter circuits - Voltage stabilization – zener diode- zener diode as voltage stabilizer.

Transistors-Bipolar junction transistors- naming of transistor terminals – transistor action transistor symbols – Common emitter, common base and common collector configurations-their characteristics.

Reference

Principles of Electronics; V. K. Mehta; 2006; Tenth Edition; S. Chand & Co.

Module 4 **(15hrs)**

Opto-electronic devices

Radiation Sources- LED - Principle - characteristics (V-I and light-current) applications, advantages

Photodetectors: Introduction – classification of detectors – qualitative idea of each type – photodiode, phototransistor, PIN photodiode- opto-isolators, APD

Solar Cells: Principles- I-V Characteristics – Fill factor – Conversion efficiency (qualitative study)

Reference

1. Optoelectronic Engineering, S.N. Biswass, Dhanpat Rai Publications
2. Photonics Elements and Devices, V. V. Rampal , Wheeler Publishing Co
3. Semiconductor optoelectronic devices – Pallab Bhattacharya

Additional Reading

1. Basic Electronics-B.L.Theraja: S.Chand Co.
2. Elements of electronics- M.K. Bagde, S.P. Sngh and K. Singh (S. Chand and Co.)
3. Optoelectronics, Wilson and Hawkes
4. Optoelectronics, Jasprit Singh
5. Semiconductor Physics and Devices – Donald A Neamen, Tata McGraw-Hill
6. Semiconductor Physics and Optoelectronis, V. Rajendran et al, Vikas Publishing House
7. Physics of Semiconductor devices, Dilip K Roy, University Press.
8. Physics of Semiconductor devices, S M Sze, Wiley Eastern Limited

RES-2T09 RENEWABLE ENERGY-II: Physico-Chemical Processes for Water and Wastewater Treatment (Total: 75hrs)

Module 1 (22 hrs)

Water Quality and Purification

Physical, chemical and biological parameters of water- Water Quality requirement – Potable water standards -Wastewater Effluent standards -Water quality indices.

Physical processes-chemical processes and biological processes-Primary, Secondary and Tertiary treatment-Unit operations-unit processes.

Reference

1. Physicochemical processes for water quality control,Weber, W.J., John Wiley and sons, New York, 1983
2. American Public Health Association, 1998. Standard Methods for the Examination of Water and Waste water, APHA, Washington D.C. (chapter 2, 3 & 4)

Module 2 (23 hrs)

Sedimentation and Disinfection

Types, Aeration and gas transfer, Coagulation and flocculation, coagulation processes - stability of colloids - destabilization of colloids transport of colloidal particles, Clariflocculation.

Theory of Disinfection - Factors affecting disinfection, Disinfection - chlorine dioxide; chloramines; ozonation; UV radiation.

Reference

1. Wastewater Engineering, Treatment and Reuse , Metcalf and Eddy, Tata McGraw- Hill Publication, New Delhi, 2003 .
2. Water and Wastewater Treatment: A Guide for the Nonengineering Professional, Joanne E. Drinan, Frank Spellman. (Chapter 6 & 8). CRC Press , Taylor and Francis.

Module 3 (18hrs)

Filtration

Theory of granular media filtration; Classification of filters; slow sand filter and rapid sand filter; mechanism of filtration; modes of operation and operational problems; negative head and air binding; dual and multimedia filtration, pressure filters, principle of working and design.

Reference

1. Water & Waste Water Engineering by Fair and Gayer.
2. Water and Wastewater Treatment: A Guide for the Nonengineering Professional, Joanne E. Drinan, Frank Spellman. (Chapter 7). CRC Press , Taylor and Francis.

Module 4 **(12hrs)**

Miscellaneous Methods

Ion Exchange-processes, Application of Membrane Processes, Reverse Osmosis, Microfiltration, Nano-filtration, Ultrafiltration and Electrodialysis.

Reference

1. C.A.Sastry, Water Treatment Plants, Narosa Publishing House, Bombay, 1996 .
2. Handbook of Water and Wastewater Treatment Technologies. Nicholas P. Cheremisin (Chapter 10)

RES-2T10 RENEWABLE ENERGY-III: Photovoltaic Module Installation

(Total: 75hrs)

Module 1 **(15hrs)**

Solar Cells and PV modules: Solar cell types-Equivalent circuit diagrams of solar cells -Spectral sensitivity -Efficiency of solar cells and PV modules-Types of modules-Design options for PV modules -Module cable outlets and junction boxes -Wiring symbols -Characteristic I-V curves for modules -Irradiance dependence and temperature characteristics -Hot spots, bypass diodes and shading-Quality certification for modules

Text-book:

Planning and installing photovoltaic systems-A guide for installers, architects and engineers; The German Energy Society; 2008; Second Edition; Earthscan, UK.

Module 2 **(20hrs)**

PV array combiner/junction boxes, string diodes and fuses -Grid-connected inverters -Wiring symbol and method of operation -Grid-controlled inverters -Self-commutated inverters -characteristic curves and properties of grid-connected inverters-Further developments in grid-connected inverter technology Cabling, wiring and connection systems - Module and string cables -Connection systems -DC main cable -AC connection cable -Direct current load switch (DC main switch) -AC switch disconnector

Text-book:

Planning and installing photovoltaic systems-A guide for installers, architects and engineers; The German Energy Society; 2008; Second Edition; Earthscan, UK.

Module 3 **(20hrs)**

Site Surveys and Shading Analysis: On-site visit and site survey -Consulting with the customer Shadow types-Temporary shading -Shading resulting from the location -Shading resulting from the building -Shading analysis-Using a site plan and sun path diagram-Using a sun path diagram on acetate Shade analysis tools using software-Shading, PV-array configuration and system concept -Connection in series -& in parallel-Comparison of connection concepts Shading with free-standing/rack-mounted PV arrays -Reducing the mutual shading losses of rack-mounted PV modules -Checklists for building survey

Text-book:

Planning and installing photovoltaic systems-A guide for installers, architects and engineers; The German Energy Society; 2008; Second Edition; Earthscan, UK.

Module 4 **(20hrs)**

Planning and Sizing Grid-Connected Photovoltaic Systems-System size and module choice -System concepts -Central inverter, Sub-array and string, module inverter-Inverter installation site- Sizing the inverter -Choosing the number and power rating of inverters -Determining the number of strings -Sizing using simulation programs-Selecting and sizing cables for grid-tied PV systems -Cable voltage ratings -Cable current carrying capacity -Minimizing the cable losses/voltage drops – Sizing the module and string cabling -Sizing the DC main cable-Sizing the AC connection cable 171 Selection and sizing of the PV array combiner/junction box and the DC main disconnect/isolator switch -Lightning protection, earthing/grounding and surge protection

Text-book:

Planning and installing photovoltaic systems-A guide for installers, architects and engineers; The German Energy Society; 2008; Second Edition; Earthscan, UK.

PRACTICALS

RES-2P03 Practical Electronics and Photovoltaic Module Installation

(Total: 60hrs)

1. Multimeter-Familiarization
2. Diode Characteristics
3. Half wave rectifier with and without filter-ripple factor and load regulation
4. Characteristics of Zener diode
5. LED characteristics
6. Solar cell I-V characteristics in the dark and under illumination
7. Familiarize appropriate access equipments and basic roofing techniques for PV module installation
8. Positioning, fixing and installing
9. Connecting PV system to the grid through a domestic distribution board
10. Carry out measurement within modules and array
11. Fault diagnosis on modules and array
12. Operational testing for an inverter

Semester-III

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-3T11	Chemistry-II : Physical Chemistry	4	60	3	20	80
REG-3T12	Physics-III : Thermodynamics and fluid Mechanics	4	60	3	20	80
REG-3T13	Renewable Energy-IV : Novel Energy Resources	4	60	3	20	80
RES-3T14	Renewable Energy-V : Solar Thermal Technology-I	5	75	4	20	80
RES-3T15	Renewable Energy-VI : Wind Energy	5	75	4	20	80
RES-3P04	Practical- Thermodynamics and Solar Thermal	4	60	4	20	80
RES-3P05	Practical- Fluid dynamics and Wind Energy	4	60	4	20	80

Total Credit: 30 **Skill: 18** **General: 12**

REG-3T11 CHEMISTRY-II : PHYSICAL CHEMISTRY (Total: 60 hrs)

Module 1 (15hrs)

Chemical Kinetics

Rate of reaction, rate law, order of reaction, molecularity of reaction. Integrated rate expression for first order reaction, half life, determination of order of reactions. Influence of temperature on reaction rate – Arrhenius equation, concept of activation energy, importance of activated complex. Catalysis: Homogeneous catalysis, enzyme catalysis – Michaelis-Menten equation. Heterogeneous catalysis – surface catalysis, uni and bi molecular reactions on surface. Elementary idea about autocatalysis.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn. Chapter 28 & 30, Vishal Pub. Co.
2. Physical Chemistry, G. W. Castellan, 2004, 3rd edn., chapter 32-34, Narosa Publishing House, New Delhi.
3. Physical Chemistry, P. Atkins. J. Paula, 2006, 8th edn, chapter 22-23, Oxford University Press.

Module 2 (18hrs)

Solid State

Classification: amorphous, crystalline – differences. Lattice, lattice energy, unit cell, examples of simple cubic, bcc and fcc lattices, calculation of number of molecules in a unit cell, calculation of lattice parameters of cubic unit cell. Weiss and Miller indices, crystal systems, Bravaice lattices, X-ray diffraction – Bragg's equation, structure determination of NaCl by X-ray diffraction. Theories of Solid: metallic bond, band theory, conductors, semiconductors and insulators, mention of super conductors. Magnetic Properties: classification - diamagnetic, paramagnetic, antiferromagnetic, ferro and ferrimagnetic, permanent and temporary magnets.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn. Chapter 31, Vishal Pub. Co.
2. Introduction to Solids, L.V. Azaroff, 1984, Mc Graw Hill,.

Module 3 (12hrs)

Photochemistry

Basic interaction of radiation with matter: Laws of photochemistry – Grothus-Draper law, Stark-Einstein law, examples of photochemical reactions. Beer law and Beer-Lambert's law. Jablonsky diagram, qualitative description of fluorescence, phosphorescence, non-radiative processes (internal conversion, intersystem crossing). Quantum yield , primary and

secondary processes. Concepts of Photosensitized reactions, flash photolysis and chemiluminescene. Photosynthesis, photosystem– 1 and 2. Chemistry of Ru(bpy)2 complexes in charge transfer reactions.

Reference

1. Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46th edn. Chapter 29, Vishal Pub. Co.
2. Fundamentals of Photochemistry, K.K. Rohatgi-Mukherjee, 1986, 2nd Edn., New Age, International.

Module 4 (15hrs)

Nuclear Chemistry

Stability of Nucleus:- binding energy, magic number, packing fraction, n/p ratio. Radioactivity: detection, GM counter, units of radioactivity.Nuclear Processes: natural radioactivity, induced radioactivity, fertile and fissile isotopes.Nuclear Reactions: fission and fusion, chain reactions, disposal of nuclear wastes.Applications: Reactors – conventional and breeder, energy generation, rock dating and radiocarbon dating, neutron activation analysis; medical, agricultural and industrial applications.

Reference

1. Principles of Inorganic Chemistry, B. R. Puri, L. R. Sharma, K. C. Kalia,1998, Chapter 38 Milestone Publishers, New Delhi.
2. Essentials of Nuclear Chemistry, H. J. Arnikar,2000, New Age International Pub.

REG-3T12 PHYSICS-III : Thermodynamics and Fluid Mechanics (Total: 60hrs)

Module 1 (10hrs)

Laws of thermodynamics:- First law of thermodynamics- second law of thermodynamics-claussius and kelvin statement-thermodynamic processes-reversible and irreversible-Isothermal and adiabatic changes-Workdone during adiabatic and isothermal expansion-Heat engine and efficiency-Carnots cycle- efficiency- Difference between heat pump and refrigerator.

Reference

1. Thermodynamics- Zemansky and Dittmann (Tata McGraw-Hill)
2. Heat and Thermodynamics- Brijlal and Subrahmanyam (S. Chand &Co)

Module 2 (15hrs)

Transmission of Heat:- Conduction-Convection-Radiation-Thermal conductivity-Units-Rectilinear flow of heat through a rod- flow of heat through compound media- Radial flow of heat through spherical shell-flow of heat through cylindrical tube-Determination of thermal conductivity- Searle's method-Lees Method-Lee's Disc method-Conductivity of Glass.

Reference

1. Thermodynamics- Zemansky and Dittmann (Tata McGraw-Hill)
2. Heat and Thermodynamics- Brijlal and Subrahmanyam (S. Chand &Co)

Module 3 (15hrs)

Fluid Mechanics:-Definition of Fluid-Distinction between solids & fluid and liquid & gas fluid continuum-Mass density-Specific Volume-Viscosity- Newton’s law of viscosity-Newtonian and Non-Newtonian Fluids-Flow of fluids-Steady & Unsteady Flow Uniform & Non-Uniform Flow- Laminar & Turbulent Flow-Compressible & Incompressible Flow-Determination of coefficient of viscosity by Poiseuilles method-determination of viscocity by Stockes method-Surface tension- Definitions, units and dimensions

Reference

1. Fluid Mechanics and Fluid Power Engineering; D .S. Kumar; 1997; S. K. Kataria &Sons.
2. A Textbook of Fluid Mechanics and Hydraulic Machines; R.K. Bansal; 2005; Ninth Edition; Laxmi Prakashan.
3. Theory and Applications of Fluid Mechanics; K. Subramanya; 1993; First Edition; Tata McGraw Hill Publishing Company Ltd.

Module 4 **(20hrs)**

Description of fluid flow-Lagrange and Eulerian approaches-Definition of path line, streamline, streak line, stream tube, Acceleration of flow- Concept of Inertia force and other forces causing motion-Derivation of Euler's equation-Modification of Bernoulli's equation-problem on Bernoulli's equation without and with losses -Flow through Orifices; classification-Hydraulic Co-efficient of an Orifice and relation between them-Equation for Co-efficient of velocity, problems-Flow Through Pipes-Venturi Meter

Reference

1. Fluid Mechanics and Fluid Power Engineering; D .S. Kumar; 1997; S. K. Kataria &Sons.
2. A Textbook of Fluid Mechanics and Hydraulic Machines; R.K. Bansal; 2005; Ninth Edition; Laxmi Prakashan.
3. Theory and Applications of Fluid Mechanics; K. Subramanya; 1993; First Edition; Tata McGraw Hill Publishing Company Ltd.

REG-3T13 RENEWABLE ENERGY-IV : Novel Renewable Energy Sources

(Total: 60hrs)

Module 1 **(15hrs)**

Hydrogen Energy: Basics of Hydrogen Energy - Production methods - Storage and transportation – Applications

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

Module 2 **(15hrs)**

Fuel Cell: Principle of working -Basic thermodynamic and electrochemical principles – Classifications-Applications for power generations

Electrochemical Energy Storage System: Batteries – Types - Working principles - Role of carbon nanotubes in electrode

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

Module 3 **(15hrs)**

Ocean Energy: Ocean energy resources - Ocean energy routes - Ocean thermal energy conversion - Wave energy conversion - Tidal energy conversion

Geothermal Energy: Origin - Types of geothermal energy sites - Geothermal Power plants

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

Module 4 **(15hrs)**

Magnetohydrodynamic (MHD) energy conversion: Principle of operation - Classifications - Features of MHD Systems

Magnetic and Electric Storage System: Super conducting magnetic energy storage (SMES) systems - Capacitor and super capacitor

References

1. Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
2. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.

RES-3T14 RENEWABLE ENERGY-V : Solar Thermal Technology-I (Total: 75hrs)

Module 1 (15hrs)

Solar radiation: The sun as the source of radiation-Solar constant-Spectral distribution of extraterrestrial radiation and its variation-Basic Earth Sun angles-Diffuse radiation-Availability of solar radiation-measurement of diffuse and direct radiation

Reference

Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.

Module 2 (20hrs)

Flat Plate Collectors: Liquid Flat Plate Collector- Materials for flat plate collector-Efficiency of flat plate collectors-Flat plate air heating collectors-Types and novel designs-Solar ponds

Reference

Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.

Module 3 (20hrs)

Solar Concentrating Collectors: Parameters characterizing solar concentrators-Classification of solar concentrators- Thermodynamic limits to concentration- Solar concentrator mountings-Performance analysis of cylindrical parabolic collector- Compound parabolic collector- Point focusing solar concentrators- Materials for solar concentrators

Reference

Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.

Module 4 (20hrs)

Solar Thermal Applications: Solar water heater-Natural and forced circulation type- Solar cookers-Types-Solar Still- Solar drying of food-Basics- Types-Solar heating of buildings-active and passive-Solar cooling of buildings-refrigeration and air conditioning- Solar furnaces-Solar thermal energy storage

Reference

Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.

RES-3T15 RENEWABLE ENERGY-VI : Wind Energy (Total: 75hrs)

Module 1 (30hrs)

Basics of Wind Energy Conversion- History of wind energy, Current status and future prospects, Wind Energy in India- Power available in the wind- Wind Turbine power and torque characteristics-Types of rotors: Horizontal and Vertical axis wind turbine-Characteristics of wind rotor-Analysis of wind regimes- Local effects, wind shear, Turbulence and acceleration effects- Measurement of wind: Ecological indicator, Anemometers-wind direction-Wind speed statistics: Time and Frequency distribution, Mean wind speed and-distribution of wind velocity- Statistical model for wind data analysis : Weibull distribution-Energy estimation of wind regimes.

Reference

Wind Energy: Fundamentals, Resource Analysis and Economics; Mathew Sathyajith; 2006; Springer

Module 2 (15hrs)

Aerodynamics of wind turbine:

Airfoil, lift and drag characteristics- Aerodynamic theories- Axial momentum theory- Blade element theory- Strip theory- Power coefficient and tip speed ratio characteristics-Rotor design and Performance analysis

Reference

Wind Energy: Fundamentals, Resource Analysis and Economics; Mathew Sathyajith; 2006; Springer

Module 3 (20hrs)

Wind energy conversion systems: Wind electric generators- Tower, rotor, gearbox, power regulation, safety mechanisms- Generator: Induction and synchronous generator-Grid integration- Wind pumps- Wind driven piston pumps, limitations and performance analysis

Reference

Wind Energy: Fundamentals, Resource Analysis and Economics; Mathew Sathyajith; 2006; Springer

Module 4 (10hrs)

Wind Energy and Environment: Environmental benefits and problems of wind energy

Economics of wind energy: Factors influencing the wind energy economics- Site specific parameters-machine parameters- Life cycle cost analysis

Reference

Wind Energy: Fundamentals, Resource Analysis and Economics; Mathew Sathyajith; 2006; Springer

Additional reading

1. Johnson GL. Wind Energy Systems, (Electronic Edition), Prentice Hall Inc, 2006
2. Burton T. Sharpe D. Jenkins N. Bossanyi E. Wind Energy Handbook. John Wiley, 2001
3. Jha AR. Wind Turbine Technology, CRC Press, Taylor & Francis, 2011
4. Jain P. Wind Energy Engineering. McGraw-Hill 2011

RES-3P04 Practical-Thermodynamics and Solar Thermal (Total: 60hrs)

1. Thermal conductivity of bad solid conductor- Lee's Disc
2. Thermal conductivity of powder samples- Lee's Disc
3. Thermal conductivity of rubber
4. Specific latent heat of steam-using condenser
5. Specific heat of liquid –Newton's law of cooling
6. Specific heat capacity of a solid
7. Operational experience on Pyranometer
8. Familiarization of Sunshine recorder
9. Measurement of temperature using Infrared Thermometer and Thermocouple
10. Evaluation of different parameters of Flat-Plate Collector in thermosyphonic mode of flow with fixed input parameters
11. Evaluation of different parameters of Flat-Plate Collector in thermosyphonic mode of flow with different radiation level
12. Evaluation of different parameters of Flat-Plate Collector in thermosyphonic mode of flow with different inlet water temperature

RES-3P05 Practical- Fluid dynamics and Wind Energy (Total: 60hrs)

1. Surface tension - Capillary rise method
2. Density of a liquid - U-Tube and Hare's apparatus
3. Measurement of wind speed
4. Evaluation of cut-in speed and cut-off speed
5. I-V characteristics of wind turbine at different wind speed
6. Characteristics of wind turbine with electrolysis and water pump
7. P, V and F measurement of output of wind generator
8. Demonstration of system with charge controller
9. Demonstration of system with charge controller and inverter
10. Power quality of AC output of system.
11. Impact of wind speed on power output and its quality
12. Impact of load on power output and its quality

Semester-IV

Course Code	Course Title	Credits	Total hrs	Hrs/wk	Internal	External
REG-4T16	Renewable Energy-VII: Solar Thermal-II	4	60	3	20	80
REG-4T17	Material Science	4	60	3	20	80
REG-4T18	Environmental Education	4	60	3	20	80
RES-4T19	Renewable Energy-VIII: Solar Photovoltaic Energy Conversion-I	5	75	4	20	80
RES-4T20	Renewable Energy-IX : Energy Storage Systems	5	75	4	20	80
RES-4P06	Practical- Solar Photovoltaics & Energy Storage Systems	4	60	4	20	80
RES-4OJT01	OJT	4	(120)	4	20	80

Total Credits: 30 **Skill: 18** **General: 12**

REG-4T16 RENEWABLE ENERGY-VII: Solar Thermal Technology-II (Total: 60hrs)

Module 1 (10hrs)

Heat Transfer: Concepts and Definitions

Introduction-Conduction-Boundary Conditions-Overall Heat Transfer-Dimensionless Heat-Conduction Parameters-Convection-Radiation-Heat and Mass Transfer

Reference

1. Solar Energy: Fundamentals, Design, Modeling and Applications; G. N. Tiwari; 2002; Alpha Science.
2. Solar Energy Engineering; A. A. M. Sayigh; 1977; Academic Press, UK.

Module 2 (20hrs)

Flat-Plate Collectors: Performance and Testing

Introduction-Testing of Collector-Heat Transfer Coefficients-Optimization of Heat Losses-Determination of Fin Efficiency-Thermal Analysis of Flat-Plate Collectors-Configuration of flat plate collector connection- Effect of Heat Capacity in Flat-Plate Collector-Optimum Inclination of Flat-Plate Collector-Effect of Dust in Flat-Plate Collector

Reference

Solar Energy: Fundamentals, Design, Modeling and Applications; G. N. Tiwari; 2002; Alpha Science.

Module 3 (15hrs)

Evacuated solar collector

Introduction-Evacuated-Tube Cover Collector-Evacuated-Tubular Collector-Analysis of Owens-Illinois Collector-Evacuated-Tube Collector with Heat Pipe

Reference

Solar Energy: Fundamentals, Design, Modeling and Applications; G. N. Tiwari; 2002; Alpha Science.

Module 4 (15hrs)

Economic Analysis

Initial and Annual costs-Definitions-Present worth calculation-Repayment of loan in equal annual installments-Annual savings-Cumulative Savings and Life Cycle Savings-Economic analysis of add-on solar systems-Payback period-Clean development mechanism

Reference

Solar Energy: Principles of Thermal Collection and Storage; S. P. Sukhatme and J. K. Nayak; 2008; Tata McGraw-Hill.

REG-4T17 MATERIAL SCIENCE **(Total: 60hrs)**

Module 1 **(18 hrs)**

Nanomaterials and Nanoscience: terminology- scales of nanosystems- nanoparticles : introduction-atoms to molecules-quantum dots-shrinking of bulk materials to quantum dots. Different types of nanoparticles: metal nanoparticles and monolayer substituted nanoparticles-fullerenes: synthesis and characterization- carbon nanotubes: synthesis and characterization-various approaches in nanoparticle synthesis : self-assembled monolayers, monolayer protected metal nanoparticles. electrical and optical properties of nanoparticles- electrical and optical properties of carbon nanotubes.

References

1. Nano: The Essentials, T. Pradeep, 2007, Mc Graw Hill Publishing Company, New Delhi.
2. Nanosciece and nanotechnology, V. S. Muraleedharan and A. Subramania, 2009, Ane Books Pvt. Ltd. New Delhi.
3. Nanotubes and Nanowires, C. N. R. Rao and A.Govindraj, 2005, Royal Society of Chemistry.
4. Nanotechnology, R. Booker and , E. Boysen, 2008, Wiley India Pvt Ltd
5. Nanoscale materials in chemistry, K. J. Klabunde, 2004, John Wiley and Sons.

Module 2 **(15hrs)**

Applications of nanomaterials: nanocatalysis- nanolithography- nanochemical devices-optoelectronic devices- photodetectors- LEDs and lasers. nanocrystals- immunogold labeling-applications in medical diagnosis- nanobased drug delivery- nanosensors- nanomedicines-destructive applications of nanomaterials- nanomaterials in war.

References

1. Nano: The Essentials, T. Pradeep, 2007, Mc Graw Hill Publishing Company, New Delhi.
2. Nanosciece and nanotechnology, V. S. Muraleedharan and A. Subramania, 2009, Ane Books Pvt. Ltd. New Delhi.
3. Nanotubes and Nanowires, C. N. R. Rao and A.Govindraj, 2005, Royal Society of Chemistry.
4. Nanotechnology, R. Booker and , E. Boysen, 2008, Wiley India Pvt Ltd
5. Nanoscale materials in chemistry, K. J. Klabunde, 2004, John Wiley and Sons.
6. Introduction to nanotechnology, C. P. Poole Jr and F J Owens, 2009, Wiley IndiaPvt Ltd.
7. Nanotechnology: Science, Innovation and Opportunity, L. E. Foster, 2008, Pearson Education

Module 3 **(15hrs)**

Natural and Synthetic Polymers

Classification of polymers: Natural, synthetic; linear, cross-linked and network; plastics, elastomers, fibres; homopolymers and copolymers. Polymerization reactions, typical examples-polyethene, polypropylene, PVC, phenol-formaldehyde and melamine- formaldehyde resins,

polyamides (nylons) and polyester. Natural rubber: structure, vulcanization. Synthetic rubbers-SBR, nitrile rubber, neoprene. Biodegradability of polymers, environmental hazards.

References

1. Polymer Science, V. R. Gowariker, 2010, NewAge International.
2. Text book of polymer science, Billmeyer F.W., 1994, Jr.John Wiley and Sons.

Module 4 (12hrs)

Thin Film Fabrication Methods

Thin film preparation-Physical methods-Vacuum Evaporation-Electron Beam evaporation-Flash Evaporation-Sputtering-DC sputtering-Ion Beam sputtering-Chemical methods-Electro deposition-electro plating-Chemical bath-Spray Pyrolysis.

References

1. Thin film Phenomena; K L Chopra; 1969; McGraw Hill.
2. Handbook of Thin film technology; L. I. Meissel & R. Glang; 1970; McGraw Hill.

REG-4T18 ENVIRONMENTAL EDUCATION (Total: 60hrs)

Module 1 (15hrs)

Objectives, Scope and Nature of Environmental Education

Meaning, definition and characteristics of environmental education – content; Importance, objectives and scope of environmental education; Factors of degradation of environment – adverse socio – economic impacts of degradation of environment. Environmental education at Primary, Secondary and Higher Education level. Contraints for implementation. National resource center for environmental education. Impact of Science and technology on environment – degradation of resources – Role of individual in conservation of natural resources- Role of information technology in environmental and human health.

References

1. Sharma, R. A. (2008). Environmental Education. Meerut: R.Lall Books Depot.
2. Sharma, B. L., & Maheswari, B. K. (2008). Education for Environmental and Human value. Meerut: R.Lall Books Depot.
3. Singh,Y. K. (2009). Teaching of environmental science. New Delhi: APH Publishing Corporation.
4. Sharma, V. S. (2005). Environmental education. New Delhi: Anmol publication.
5. Reddy, P. K., & Reddy, N. D. (2001). Environmental Education. Hyerabad: Neelkamal publications.
6. Kelu, P. (2000). Environmental education: A conceptual analysis. Calicut: Calicut University.
7. Joy, P., & Neal, P. (1994). The handbook of environmental education: London, New Fetter Lane
8. Sharma, R. G. (1986). Environmental Education. New Delhi : Metropolitan Book Co., Pvt. Ltd.

Module 2 (15hrs)

Environmental Pollution, Management and Protection

Meaning and definition of Environmental hazards and pollution – Types of environmental hazards and disaster – Types of pollution: Land, Air, Water, Noise, and Radiation- Green house effect- Ozone layer depletion. Need for environmental management – function and characteristics of environmental management – dimensions of environmental management.

Factors responsible for flora and fauna extinction – Measures to conserve flora and fauna.- causes for forest fire- measures of prevention

References

1. Harrison R.M. 1993. Pollution: Causes, Effects and Control. Royal Society of Chemistry.
2. Marquata K. Hill. 1997. Understanding Environmental pollution. Cambridge University Press.

Module 3 **(15hrs)**

India and Environmental Issues, Policies and Movements

Major environmental problems in India – Environmental protection and polices inIndia – Need and objectives of conservation – Environmental conservation measures taken in India – Constitutional amendments made and Environmental laws. Environmental movements in India. Strategies for sustainable development in India.

References

1. Kumar, A. (2009). A text book of environmental science. New Delhi: APH Publishing Corporation.
2. Singh,Y. K. (2009). Teaching of environmental science. New Delhi: APH Publishing Corporation.
3. Sharma, V. S. (2005). Environmental education. New Delhi: Anmol publication.
4. Reddy, P. K., & Reddy, N. D. (2001). Environmental Education. Hyerabad: Neelkamal publications.

Module 4 **(15hrs)**

International Efforts for Environmental Protection

The Stockholm conference 1972 – Brundtland commission 1983 – Nairobi conference 1982 – The Rio Summit 1992 – the Rio Declaration at the earth charter – Major achievements of the Rio Summit – Main features of the Rio Declaration – Kyoto conference and part on Global Warming 1997.

References

1. Ian Paulford., Hugh Flowers., 2006. Environmental Chemistry at a Glance. Blackwell.
2. Marquata K. Hill. 1997. Understanding Environmental pollution. Cambridge University Press.
3. Harrison R.M. 1993. Pollution: Causes, Effects and Control. Royal Society of Chemistry.
4. Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management. Himalaya Publishing House.

RES-4T19 RENEWABLE ENERGY-VIII : Solar Photovoltaic Energy Conversion-I

(Total: 75hrs)

Module 1 (15hrs)

Solar Cell Fundamentals

Introduction- semiconductors- p-n junction- generation of electron-hole pair by photon absorption- photoconduction

Reference

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.
3. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 2 (20hrs)

Solar Cell characteristics

I-V characteristics- solar cell parameters- open circuit voltage, short circuit current, fill factor, efficiency- effect of variation of insolation and temperature- energy losses and efficiency- maximizing the performances- cell size- Energy Payback Period (EPP)

Reference

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.
3. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 3 (20hrs)

Classification of Solar Cells

On the basis of thickness of active material- On the basis of Junction structure- On the basis of type of active material- single crystal silicon solar cell- multicrystalline silicon solar cell- gallium arsenide solar cell- amorphous silicon solar cell- copper sulfide, cadmium telluride and copper indium selenide based solar cell- Dye Sensitised Solar Cells (DSSCs)- Polymer solar cells

Reference

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.
3. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 4 **(20hrs)**

Solar photovoltaic (PV) module, panel and array construction

Solar PV modules- solar PV modules from solar cells, series and parallel connection, mismatch in cell/module, design and structure of PV modules, number of cells in a module, Wattage of modules, fabrication of PV modules, rating of PV modules- construction of solar PV panels and arrays from modules

Reference

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Solar Energy: Fundamentals and Applications; H. P. Garg & J. Prakash; 2000; Tata McGraw-Hill.
3. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

RES-4T20 RENEWABLE ENERGY-IX : Energy Storage Systems (Total: 75hrs)

Module 1 (15hrs)

Energy Storage

Need of energy storage- Different modes of Energy Storage- Mechanical Energy Storage- Electrical Storage- Chemical Storage- Electromagnetic energy storage- Thermal Energy Storage

Reference

Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers

Module 2 (25hrs)

Electrochemical, electrical and magnetic energy storage systems

Primary & Secondary Batteries- Solid-State and Molten Solvent Batteries- Lead acid batteries- Nickel Cadmium Batteries, Advanced Batteries-Superconducting Magnet Energy Storage (SMES) Systems- Capacitors-Super capacitor-Electrochemical Double Layer Capacitor (EDLC)

Reference

Handbook of batteries; David Linden& Thomas B. Reddy; 2002; Third Edition; McGraw-Hill Companies, Inc.

Energy Storage; Robert A. Huggins; 2010; Springer

Module 3 (15hrs)

Sensible heat storage (SHS)

Mediums for SHS- Stratified storage systems- Rock-bed storage systems- Thermal storage in buildings- Energy storage in aquifers

Reference

Solar Thermal Energy Storage; H.P. Garg, S.C. Mullick and A. K. Bhargava; 1985; Springer

Module 4 (20hrs)

Latent Heat Thermal Energy Storage (LHTES)

Phase Change Materials (PCMs) : Selection criteria of PCMs- Solar thermal LHTES systems- Energy conservation through LHTES systems- LHTES systems in refrigeration and air conditioning systems

Reference

Solar Thermal Energy Storage; H.P. Garg, S.C. Mullick and A. K. Bhargava; 1985; Springer

RES-4P06 Practical- Solar Photovoltaics &Energy Storage Systems (Total: 60hrs)

1. Temperature dependent conductivity of semiconductor
2. Lux meter and Power meter familiarization
3. Illuminated I-V characteristics of a solar cell-Calculation of Fill Factor and Efficiency
4. Comparison of the illuminated I-V characteristics of a photodiode with that of a solar cell.
5. Battery charging and discharging characteristics.
6. Combine AC and DC load system with battery
7. Evaluation of heat transfer during charging and discharging of Phase Change Material (PCM)
8. Inspection of temperature distribution inside the PCM
9. Calculation of LMTD of the heat exchangers
10. Evaluation of system thermal efficiency during charging storing and discharging the PCM
11. Evaluation of overall system thermal efficiency
12. Calculation FOM of the system

Semester-V

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-5T21	Physics-IV : Lasers and Optical Instrumentation	4	60	3	20	80
REG-5T22	Renewable Energy-X: Environment, Health and Safety in Industries	4	60	3	20	80
REG-5T23	Renewable Energy-XI: Project Management	4	60	3	20	80
RES-5T24	Renewable Energy-XII : Energy Conservation Techniques	5	75	4	20	80
RES-5T25	Renewable Energy-XIII : Solar Photovoltaic Energy Conversion-II or Solar Thermal Technology-III	5	75	4	20	80
RES-5P07	Practical- Advanced Solar Photovoltaic Lab	4	60	4	20	80
RES-5P08	Practical- Advanced Solar Thermal Lab-I	4	60	4	20	80

Total Credits: 30 **Skill: 18** **General: 12**

REG-5T21 PHYSICS-IV : Lasers and Optical Instrumentation (Total: 60hrs)

Module 1 (15hrs)

Lasers

Absorption and emission of light-Absorption-spontaneous emission and stimulated emission-light amplification by stimulated emission-Einstein's relations-condition for light amplification –population inversion-pumping-pumping methods –optical pumping – electrical pumping -direct conversion. Active medium-metastable states-pumping schemes (two level, three level and four level) Optical resonator (theory not required) Threshold condition. Types of lasers-ruby laser, Nd-YAG laser, He-Ne laser, semi-conductor laser.

Reference

1. An introduction to lasers theory and applications; M N Avadhanulu; 2012; S.Chand & Co
2. Introduction to lasers and Applications; D.C. O'shea and W. R. Callen; 1978; Addision Wesley.

Module 2 (15hrs)

Applications of Lasers

Laser for measurement of distance, length, atmospheric effect and pollutants-material processing-laser heating, melting, scribing, trimming, welding, material removal and vaporization-Calculation of power requirements of laser for material processing-Holography-Basic principles-Holography for non-destructive testing-Medical application of lasers.

Reference

1. An introduction to lasers theory and applications; M N Avadhanulu; 2012; S.Chand & Co
2. Introduction to lasers and Applications; D.C. O'shea and W. R. Callen; 1978; Addision Wesley.

Module 3 (15hrs)

Fibre Optics and Optical Communication

Optical fibre- Critical angle of propagation-modes of propagation- Acceptance angle-Fractional refractive index change- Numerical Aperture- Types of Optical fibers-Normalized Frequency- pulse dispersion Attenuation-Applications- Fibre optic communication system-Advantages of Optical fibers.

Reference

A textbook of optics; N. Subramanayam, Brijlal and M. N. Avadhanalu; 2004; S.Chand & Co.

Module 4 **(15hrs)**

Optical components and their characteristics

Plane mirrors, curved mirrors, achromatic prisms, direct vision prisms, right angle prisms, roof prisms, erecting prisms, cube corner prisms, beam splitter prisms, lenses, and ophthalmic lenses. Optical materials and fabrication techniques: optical glasses and their characteristics, crystalline materials.

Reference

Optics and optical instruments, Johnson, Dover

REG-5T22 RENEWABLE ENERGY-X : Environment, Health and Safety in Industries

(Total: 60hrs)

Module 1 (17hrs)

Occupational Health and Hygiene

Need for developing Environment, Health and Safety systems in work places. Status and relationship of Acts, Regulations and Codes of Practice. Role of trade union safety representatives. International initiatives. Ergonomics and work place. Categories of health hazards. Exposure pathways and human responses to hazardous and toxic substances. Advantages and limitations of environmental monitoring and occupational exposure limits. Hierarchy of control measures for occupational health risks. Role of personal protective equipment and the selection criteria. Effects on humans, control methods and reduction strategies for noise, radiation and excessive stress.

References

1. Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management; Himalaya Publishing House.
2. Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services 2005
3. Kumar R. (Editor)., 1997. Environmental pollution and health hazards in India. Ashish Publication.
4. Ghosh G.K., 1987. Environmental pollution: a scientific dimension. Ashish Publication.

Module 2 (17hrs)

Workplace Safety and Safety Systems

Features of the satisfactory design of work premises HVAC, ventilation. Safe installation and use of electrical supplies. Fire safety and first aid provision. Significance of human factors in the establishment and effectiveness of safe systems. Safe systems of work for manual handling operations. Control methods to eliminate or reduce the risks arising from the use of work equipment. Requirements for the safe use of display screen equipment. Procedures and precautionary measures necessary when handling hazardous substances. Contingency arrangements for events of serious and imminent danger.

References

1. Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management. Himalaya Publishing House.
2. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
3. Ian Paulford., Hugh Flowers., 2006. Environmental Chemistry at a Glance. Blackwell.
4. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant,

Module 3 (16hrs)

Techniques of Environmental Safety

Elements of a health and safety policy and methods of its effective implementation and review. Functions and techniques of risk assessment, inspections and audits. Investigation of accidents- Principles of quality management systems in health and safety management. Relationship between quality manuals, safety policies and written risk assessments. Records and other documentation required by an organisation for health and safety. Industry specific EHS issues.

References

1. Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995
2. The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ., 2007.
3. Khitoliya R.K., 2004, Environmental pollution management and control for sustainable development. S. Chand publication.
4. Bhattiya S.C., 2003. Managing industrial pollution. Mc Millan India Ltd.
5. Trivedi R.K. (Editor). Pollution and Bio monitoring of Indian Rivers. ABD publication.

Module 4 (10hrs)

Education and Training

Requirements for and benefits of the provision of information, instruction, training and supervision. Factors to be considered in the development of effective training programmes. Principles and methods of effective training. Feedback and evaluation mechanism.

References

1. Reddy, P. K., & Reddy, N. D. (2001). Environmental Education. Hyerabad: Neelkamal publications.
2. Kelu, P. (2000). Environmental education: A conceptual analysis. Calicut: Calicut University.
3. Agarwal, S.P. and Aggarwal, J.C. (1996) Environmental Protection, Education and Development. New Delhi: New Concepts.

REG-5T23 RENEWABLE ENERGY-XI : Project Management (Total: 60hrs)

Module 1 (15hrs)

Introduction: Definitions- Classifications- Project Risk- Scope

Project Management: Definitions- Overview- Project Plan- Management principles applied to project management- Project management life cycles and uncertainty

Project Planning: Scope- Problem Statement- Project Goals- Objectives- Success criteria- Assumptions- Risks-Obstacles- Approval process

Reference

1. Project Management – for 21st Century-Bennet P Lientz, Kathryn Rea- Academic Press, 1995
2. The Essentials of Project Management-Dennis Lock-Gower Publishing Ltd., 2014
3. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
4. Project Management-Harvey-Maylor-Pearson Publication, 2009

Module 2 (15hrs)

Project Implementation: Project resource requirements- Types of resources: men, materials, finance

Project Monitoring: Evaluation- Control- Project network technique- Planning for monitoring and evaluation- Project audits- Project management information system- Project scheduling-PERT & CPM- Project communication- Post project reviews

Reference

1. Project Management – for 21st Century-Bennet P Lientz, Kathryn Rea- Academic Press, 1995
2. The Essentials of Project Management-Dennis Lock-Gower Publishing Ltd., 2014
3. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
4. Project Management-Harvey-Maylor-Pearson Publication, 2009

Module 3 (15hrs)

Project Team Management: Recruitment- Organizing- Human Resources- Team operating rules- Project Organization- Various forms of project organizations- Project organization charting, project contracts, principles- Compilation of contracts- Practical aspects- Legal aspects- Global tender- Negotiations- Insurance

Reference

1. Project Management – for 21st Century-Bennet P Lientz, Kathryn Rea- Academic Press, 1995
2. The Essentials of Project Management-Dennis Lock-Gower Publishing Ltd., 2014
3. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
4. Project Management-Harvey-Maylor-Pearson Publication, 2009

Module-4 **(15hrs)**

Closing the Project: Types of project termination- Strategic implications- Project in trouble- Termination strategies- Evaluation of termination possibilities- Termination procedures

Project Inventory Management: Nature of project inventory- Supply and transportation of materials- Use of PERT & CPM techniques

Reference

1. Project Management – for 21st Century-Bennet P Lientz, Kathryn Rea- Academic Press, 1995
2. The Essentials of Project Management-Dennis Lock-Gower Publishing Ltd., 2014
3. Project management - David I Cleland - Mcgraw Hill International Edition, 1999
4. Project Management-Harvey-Maylor-Pearson Publication, 2009

RES-5T24 RENEWABLE ENERGY-XII : Energy Conservation Techniques

(Total: 75hrs)

Module 1 **(20hrs)**

Introduction

Energy conservation & its importance - The Energy conservation Act 2001 & its features

Waste Minimization & Resource Conservation

Need of waste minimization - Waste minimization method & its classification - Effects of waste environment & Role of pollution control board - Case study.

References

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi
2. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
3. Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M. Dekker

Module 2 **(20hrs)**

Energy Conservation Methods in Electrical System

Motors - Power factor improvement techniques - Effects of harmonics - Star-Delta conversion techniques - Variable speed drive (VSD) - Energy conservation in electric furnaces. - Pumps, Compressors, Fans & Blowers - Lighting systems - HVAC systems

References

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi
2. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
3. Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M. Dekker

Module 3 **(20hrs)**

Energy Conservation In Thermal System

Boiler & furnace - Steam distribution system –HVAC - Waste heat recovery - Insulation of pipes - Condensate recovery - Fuel Handling - Other heat based application - Case Study

References

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi
2. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
3. Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M. Dekker

Module 4 **(15hrs)**

Energy Conservation in Housing & Commercial Building

In Lighting System - Water heating system - Optimization cooking method - Energy efficient building.

References

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi
2. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
3. Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M. Dekker

Additional Reading

1. www.bee-india.com
2. Energy Efficiency in Thermal Utilities, 2010, BEE guide book
3. Energy Efficiency in Electrical Utilities, 2010, BEE guide book

RES-5T25 RENEWABLE ENERGY-XIII (Total: 75hrs)

OPTION-A : Solar Photovoltaic Energy Conversion-II

Module 1 (15hrs)

Design of Solar Cells - Upper limits of cell parameters : Short circuit current-open circuit voltage, fill factor – Losses in Solar cells – Model of a solar cell- effect of series and shunt resistance, solar radiation and temperature on the efficiency of solar cells-Solar cell design (qualitative)

References

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 2 (20hrs)

Types of Solar Cells: c-Si Solar Cells, GaAs Solar Cells, Poly crystalline Si Solar Cells, a-Si Solar Cells

Thin Film Solar Cells: Various layers of Thin film solar cells: Absorber layer, Window layer (CdS), Transparent conducting oxides (FTO, ZnO)

Examples for thin film solar cells: CdTe, CIGS, CZTS based solar cells

Other Solar Cell technologies: organic solar cells, Dye sensitized Solar cells, Quantum Dot sensitized Solar cells (qualitative)

References

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 3 (20hrs)

Material Fabrication Technologies - Purification of silicon, zone refining and gettering, segregation coefficient. Growth of crystalline silicon, Bridgmann, Czochralski and floating zone methods.

Epitaxial growth methods, MBE, MOCVD, LPE, VPE.

Thin film deposition methods, evaporation, sputtering, wet chemical, spray pyrolysis, screen printing.

References

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Module 4 (20hrs)

Photovoltaic System Design and applications - Introduction to Solar PV systems, Stand alone PV system configuration: Type a, Type b, Type c, Type d, Type e, Type f- Hybrid PV systems : types of hybrid systems, issues -Simple Payback period – Life Cycle Costing: Time Value of money, Present worth of future one time investment, Present worth of future recurring investments, Life cycle cost-Annualised Life cycle costing-Unit cost of generated electricity

References

1. Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall of India.
2. Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley and Sons.

Additional reading

1. Physics of Solar Cells by Jenny Nelson
2. Solar Cells by Martin Green

OPTION-B : Solar Thermal Technology-III

Module 1 (20hrs)

Components of Solar Thermal Systems: How Does a Solar Thermal System Work?- Collectors- Heat Stores- Solar Circuit-Controller

Systems for Single-Family Houses: Systems for Charging/Discharging the Store - Systems for Heating Domestic Water-Systems for Heating Domestic Water and Space Heating- Planning and Dimensioning-Costs and Yields

Installation, Commissioning, Maintenance and Servicing: A Brief Study of Roofing and Materials- Installation Methods and Safety- Installation-Starting Up, Maintenance and Servicing- Information Sources for Specific Countries

Text book

Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers by German Solar Energy Society (DGS); 2010; Earthscan

Module 2 **(20hrs)**

Large-scale Systems

Systems- Control of the Systems- Heat Exchangers- Safety Technology- Economic Considerations- Solar Contracting- Solar District Heating

Solar Concentrating Systems

Concentration of Solar Radiation- Concentrating Systems Providing Process Heat- Concentrating Solar Thermal Systems for Electricity Generation

Text book

Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers by German Solar Energy Society (DGS); 2010; Earthscan

Module 3 **(20hrs)**

Solar Air Systems: Introduction- Components- Systems- Planning and Dimensioning- Installation- Costs and Yields- Examples

Solar Cooling: Theoretical Bases- Integrated Planning of Solar Cooling/Air-conditioning Systems- System Technology- System Design

Text book

Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers by German Solar Energy Society (DGS); 2010; Earthscan

Module 4 **(15hrs)**

Simulation Programs for Solar Thermal Systems

Introduction- Evaluation of Simulation Results- Simulation with Shading- Market Survey, Classification and Selection of Simulation Programs- Brief Description of Simulation Programs

Text book

Planning and Installing Solar Thermal Systems: A Guide for Installers, Architects and Engineers by German Solar Energy Society (DGS); 2010; Earthscan

RES-5P07 Practical-Advanced Solar Photovoltaic Lab (Total: 60hrs)

1. Series and Parallel connection of solar cells
2. Study the temperature dependence of open-circuit voltage (V_{oc}) and short-circuit current (I_{sc}) of a solar cell
3. Study the variation of V_{oc} and I_{sc} of a solar cell with light intensity
4. I-V characteristics of a PV module-Calculation of series and shunt resistance
5. I-V characteristics of a PV module with variation in intensity of radiation.
6. P-V characteristics of a PV module with variation in intensity of radiation.
7. I-V characteristics of a PV module at different temperatures
8. P-V characteristics of a PV module at different temperatures
9. I-V characteristics with series combination of modules.
10. I-V characteristics with parallel combination of modules.
11. P-V characteristics with series combination of modules.
12. P-V characteristics with parallel combination of modules.

RES-5P08 Practical-Advanced Solar Thermal Lab-I (Total: 60hrs)

1. Evaluation of different parameters of Flat-Plate Collector in thermosyphonic mode of flow with different tilt angle
2. Evaluation of different parameters of Flat-Plate Collector in forced mode of flow with fixed input parameters
3. Evaluation of different parameters of Flat-Plate Collector in forced mode of flow for different flow rate
4. Evaluation of different parameters of Flat-Plate Collector in forced mode of flow for different radiation level
5. Evaluation of different parameters of Flat-Plate Collector in forced mode of flow with different inlet water temperature
6. Evaluation of different parameters of Flat-Plate Collector in forced mode of flow for different tilt angle.
7. To determine the performance of the Parabolic Trough collector with fixed input parameters (Forced mode).
8. To determine the performance of the Parabolic Trough collector for different flow rates (Forced mode).
9. To determine the performance of the Parabolic Trough collector for different radiation level (Forced mode).
10. To determine the performance of the Parabolic Trough collector with different inlet water temperature (Forced mode).
11. To determine the performance of the Parabolic Trough collector for various wind speed (convection losses).
12. To determine the variation of mean water-temperature in the storage tank with different tank volumes

Semester-VI

Course code	Course title	Credits	Total Hrs	Hrs/Wk	Internal	External
REG-6T26	Physics-V : Spectroscopy- experimental techniques	4	60	3	20	80
REG-6T27	Physics-VI : Power Electronics	4	60	3	20	80
REG-6T28	Renewable Energy-XIV : Fuel cells and hydrogen	4	60	3	20	80
RES-6T29	Renewable Energy-XV : Energy Management and Auditing	5	75	4	20	80
RES-6P09	Practical-Advanced Solar Thermal Lab-II	4	60	4	20	80
RES-6P10	Practical- Experimental techniques and Power Electronics	4	60	4	20	80
RES-6PRJ01	Final Project Report	5	(150)	4	20	80

Total Credits: 30 **Skill: 18** **General: 12**

REG-6T26 PHYSICS-V : Spectroscopy and Experimental Techniques

(Total: 60hrs)

Module 1 **(15hrs)**

Spectroscopy

Atom models- Thomson's model-Rutherford's nuclear atom model-Bohr atom model-Somerfield's relativistic atom model- vector atom model- Fine structure of Hydrogen atom - Rotational and vibrational spectra of rigid diatomic molecules- Raman effect-quantum theory

Reference

Introduction to Modern Physics- H.S. Mani and G.K.Mehta

Module 2 **(15hrs)**

Spectroscopic techniques

Qualitative ideas of: Fourier Transform Infrared Spectroscopy, UV-Vis-NIR spectroscopy, Photoluminescence technique, Raman spectroscopy, X-ray Photoelectron Spectroscopy

Reference

Semiconductor material and device characterization; Dieter K. Schroder; 2006; Wiley-Interscience

Module 3 **(15hrs)**

Vacuum Techniques

Vacuum Physics: Important and fields applications of vacuum, gas properties, gas flow regimes, gas transport properties, gas conductance of apertures, elbows, tubes etc. for viscous and molecular flow regimes, principles of pumping concepts (vacuum pumps), vacuum measurement, leak detection, source of gases in vacuum system, evaluation of gas load, vacuum system design

Reference

Vacuum technology; A. Roth; 1990; Elsevier Science.

Module 4 **(15hrs)**

Qualitative ideas of: Basic optical microscopy-Electron microscopy: SEM and TEM-Probe Microscopy: STM, AFM-Diffraction techniques: XRD-Thermal analysis: Thermo-gravimetric analysis (TGA).

Reference

Semiconductor material and device characterization; Dieter K. Schroder; 2006; Wiley-Interscience

REG-6T27 PHYSICS-VI : Power Electronics **(Total: 60hrs)**

Module 1 **(15hrs)**

Field-Effect Transistors (FET)

Types of FET- Junction FET (JFET)- Formation of depletion region-Operation-Characteristics-Drain characteristics-Transfer characteristics-JFET parameters-MOSFETs-Types-Depletion type-Enhancement type-CMOS

Reference

A Text book of Applied Electronics; R.S. Sedha; 2005; S. Chand and Co.

Module 2 **(15hrs)**

Thyristors, SCR, DIAC, TRIAC

Basic ideas and Types of Thyristors-Silicon Controlled Rectifier (SCR)-biasing-operation-equivalent circuit-Characteristics-SCR ratings-Series and parallel combination of SCR-Applications- Basic construction of Diac- V-I characteristic- Applications-TRIAC-Operation- V-I characteristics-TRIAC ratings-Applications

Reference

A Text book of Applied Electronics; R.S. Sedha; 2005; S. Chand and Co.

Module 3 **(15hrs)**

UJT and SCS

Uni Junction Transistor (UJT)-construction-equivalent circuit-intrinsic standoff ratio-Operation- V-I characteristics-Applications- Basic ideas of Silicon Controlled Switch (SCS)-operation-SCS application-Silicon Unilateral Switch (SUS)-Silicon Bilateral Switch (SBS) – Silicon Asymmetrical Switch (SAS).

Reference

A Text book of Applied Electronics; R.S. Sedha; 2005; S. Chand and Co.

Module 4 **(15hrs)**

Controlled Rectifiers

Introduction-SCR – Power control using SCR – SCR half wave rectifier – Average values of load voltage and current - 90°Variable Half Wave Rectifier - 180º Variable Half Wave Rectifier – SCR Full Wave Rectifier – UJT Triggered SCR phase control –TRIAC power control – DIAC-TRIAC Phase Control Circuit – General ideas of Inverters- Single phase inverter – Push-pull inverter.

Reference

A Text book of Applied Electronics; R.S. Sedha; 2005; S. Chand and Co.

REG-6T28 RENEWABLE ENERGY-XIV : Fuel cell systems and hydrogen

(Total: 60hrs)

Module 1 **(10hrs)**

Fuel Cells: History – Need for fuel cells- Applications- principle - working - thermodynamics and kinetics of fuel cell process –performance evaluation of fuel cell – comparison on battery Vs fuel cell

References

1. Fuel Cells: Theory and Application; Hart, A.B and G.J.Womack; 1989; First Edition; Prentice Hall.
2. Fuel Cell and Their Applications; Kordesch, K and G.Simader; 1996; First Edition; Wiley-VCH, Germany.
3. Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press, UK.
4. Hydrogen Energy: Challenges and Prospects; David Anthony James Rand and Ronald Dell; 2008; The Royal Society of Chemistry, UK.

Module 2 **(15hrs)**

Fuel Cell Types: Types of fuel cells – Alkaline Fuel Cell, Phosphoric Acid Fuel Cell, Solid Oxide Fuel Cell, Molten Carbonate Fuel Cell, Direct Methanol Fuel Cell, Proton-exchange Membrane Fuel Cell.

References

1. Fuel Cell and Their Applications; Kordesch, K and G.Simader; 1996; First Edition; Wiley-VCH, Germany.
2. Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press, UK.
3. Hydrogen Energy: Challenges and Prospects; David Anthony James Rand and Ronald Dell; 2008; The Royal Society of Chemistry, UK.

Module 3 **(15hrs)**

Hydrogen and production techniques: Hydrogen – physical and chemical properties, salient characteristics. Production of hydrogen – steam reforming – water electrolysis – gasification and woody biomass conversion – biological hydrogen production – photo dissociation– direct thermal or catalytic splitting of water.

References

1. Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press, UK.
2. Hydrogen Energy: Challenges and Prospects; David Anthony James Rand and Ronald Dell; 2008; The Royal Society of Chemistry, UK.

Module 4 **(10hrs)**

Hydrogen Storage and Applications: Hydrogen storage options – compressed gas –liquid hydrogen – Hydride – chemical Storage – comparisons. Hydrogen transmission systems. Applications of Hydrogen.

References

1. Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press, UK.
2. Hydrogen Energy: Challenges and Prospects; David Anthony James Rand and Ronald Dell; 2008; The Royal Society of Chemistry, UK.

RES-6T29 RENEWABLE ENERGY-XV : Energy Management and Auditing

(Total: 75hrs)

Module 1 **(15hrs)**

Energy Scenario – Introduction - Types of energy sources - Indian energy scenario-Energy V/s economic growth - Energy Policies, pricing & reforms. - Energy security - Energy strategy for future

Basic of energy & its various forms - Various forms of energy - Terms & definitions used in electrical energy - Terms & definitions used in thermal energy -Energy – Units & Conversion

Reference

1. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
2. General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

Module 2 **(20hrs)**

Energy Management & Audit - Definition and Objective of Energy Management **-** Principle of Energy Management - Energy Management skills - Energy Management Strategies

Energy Audit - Types & Methodology - Energy Audit Reporting format - understanding energy carts - Bench marking & energy performance - Matching energy usage to requirement - Maximizing System - Fuel & energy Substitution

Reference

1. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
2. General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

Module 3 **(20hrs)**

Initializing and Organizing - Managing Energy Management Programmers - Organizing Energy Management Programmers -Initializing Energy Management Programmers - Initializing Planning, Leading, Controlling - Promoting, Monitoring and Reporting.

Energy Action Planning - Key Elements - Force Field Analysis - Energy Policy - Organizing – Location of energy Manager - Top Management Support - Energy Manager: Responsibilities & duties to be assigned under energy conservation Act 2001 - accountability - Motivation of Employees - Requirements for Energy Action Planning - Information System - marketing & Communicating - Planning & Training.

Reference

1. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
2. General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

Module 4 **(20hrs)**

Energy Audit Instruments - Principal and working of Electrical Measuring Instruments (Voltmeter, ammeter ,Power Factor meter, Tri-vector meters for , Speedometer contact /non-contact type) - Flue gas analyzer , Principal of measurements by Chemical Methods, Electronic Methods, - Temperature Measurement Contact type methods, Non Contact type methods - Pressure and velocity Measurement (Bourdon gauge, Manometers, Anemometer) - Flow Measurement of steam, water and air -Humidity Measurement and leak Detectors

Reference

1. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press
2. General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

RES-6P09 Practical-Advanced Solar Thermal Lab-II (Total: 60hrs)

1. Installation of a flat-plate collector
2. To determine the performance of the Parabolic Trough collector with varying solar radiation
3. To determine the effect of tilt on the performance of the Parabolic Trough collector.
4. Installation of solar water heater
5. Performance analysis of a solar water heater under full sun
6. Performance analysis of a solar water heater by varying the radiation intensity
7. Construction of a solar cooker
8. Study the performance of a solar cooker using different types of raw food items
9. Assembling and installing a solar drier
10. Performance analysis of a solar drier
11. Familiarization of a solar tracker
12. Installation of solar tracker

RES-6P10 Practical – Experimental techniques and Power Electronics

(Total: 60hrs)

1. JFET characteristics (Static drain characteristics-Calculation of parameters)
2. UJT characteristics
3. SCR. Characteristics
4. DIAC Characteristics
5. TRIAC Characteristics
6. MOSFET characteristics
7. Familiarization of Pirani and Penning Gauge
8. Pumping speed of rotary pump
9. Pumping speed of diffusion pump
10. Study of degassing
11. Familiarization of thermal evaporation
12. Familiarization of radiant heater and temperature controller

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

First Semester Degree Examination - , 2015

Complementary Course – REG-1T01 ENGLISH-I

Time: 3 hours   Maximum: 80 marks

Part A

Answer **all** the questions in a sentence or two

Each question carries 1 mark

1. A valid Argument is one ……………………..
2. Why English is called unphonetic language

Transcribe the following words

3. Sugar
4. City
5. What is intonation?
6. Identify the vowel in the word “ feed”
7. Define diphthong
8. To become a good decision –maker, one has to develop………………….
9. Yes/No questions are normally spoken in …………………tone.
10. Identify the diphthong in the word “same”.

(10×1=10)

Part B

Answer **any Eight** of the following questions in about 60 words

Each carries 2 marks

11. Mention two barriers to Critical thinking.
12. Give an example for Argument.
13. Influence of Mother tongue.
14. What is Non-Verbal communication?
15. What is Intonation?
16. What are the features of a Paragraph?
17. What do you mean by Word Stress?
18. What do you mean by Fallacy?
19. What are the benefits of Critical thinking?
20. Explain Egocentrism
21. How can you recognize an Argument?

22. What is a Deductive Argument?

(8×2=16)

Part C

Answer **any Six** of the following questions in about 100 words

Each carries 4 marks

23. Write a short note on paralinguistic features.
24. Write a short note on the differences between American and British English?
25. Write a 100 word introduction for presentation on 'Corruption in Kerala'.
26. What are the barriers to effective communication?
27. What are the main differences between Deductive and Inductive arguments?
28. Write short notes on Descriptive writing techniques.
29. Write short notes on Critical thinking in Academic writing.
30. Write short notes on Quotation and paraphrasing.
31. Write short notes on Pronunciation and Articulation.

(6×4=24)

Part D

Answer **any Two** of the following questions in about 300 words

Each carries 15 marks

32. Explain Deductive and Inductive Argument.
33. Explain the features of a paragraph
34. Explain Paralinguistic features, proxemics
35. Elaborate different types of Fallacies.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

First Semester Degree Examination - , 2015

Complementary Course – REG-1T02 MATHEMATICS-I

Time: 3 hours Maximum: 80 marks

Part – A

Answer **all** the ten questions.
*Each question carries **1** mark.*

1. Define GCD of two numbers.
2. Define Convergence of a sequence.
3. What is $\lim_{n\to\infty} \frac{1}{n}$?
4. Define asymptote.
5. State quotient rule.
6. If n(A) = r and n(B) = s, find n(A×B).
7. Define partition of a set.
8. Write the conjugate of 3 + 4i.
9. Find the modulus of 5 – 8i.
10. Find domain and range of the function f(x) = $\frac{1}{x}$.

(10×1=10)

Part – B

Answer **any Eight** questions.
*Each question carries **2** marks.*

11. Find y" if y = sec x.
12. Find $\frac{dy}{dx}$ if $y^2 = x$.
13. Evaluate $\lim_{x\to 2} \frac{(x-2)^2}{x^2-4}$.
14. State order completeness property of R.
15. Find gcd(82, 172).
16. Is the sequence $\left\{\frac{(-1)^n}{n!}\right\}$ convergent? If yes, what is its limit?
17. If f : R → R and g : R → R are defined by $f(x) = x^2$ and g(x) = x + 3 find (g°f)(2).
18. Define functions and give an example.
19. Show that the function $f(x) = x^3$ is one-one.
20. Find (5 + 4i)(8 – 3i).
21. Write all partitions of the set S = {1, 2, 3}.
22. Define injective and surjective functions.

(8×2=16)

Part – C

Answer **any Six** questions.

*Each question carries **4** marks.*

23. Find the gcd(81,110) using Euclid's algorithm.
24. Find (i) $\lim_{n\to\infty} \frac{(3n+1)(n-2)}{n(n+3)}$.

    (ii) $\lim_{n\to\infty} \frac{2n^2-5}{3n^2+7n}$.
25. Show that congruence modulo n is an equivalence relation.
26. Define the absolute value function. Show that it is continuous at x = 0.
27. Find $\frac{dy}{dx}$ if $y^2 = x^2 + \sin xy$.
28. If S = {1, 2, 3} show that the relation { (1,1), (1,2), (2,1), (2,2), (3,3)} is an equivalence relation.
29. Write the modulus amplitude form of the complex number 1 + i.
30. Separate into real and imaginary parts $(5 + 3i)^3$.
31. Let the functions f and g be defined by f(x) = 2x + 1 and $g(x) = x^2 - 2$. Find $g_o f$ and $f_o g$.

(6×4=16)

Part – D

Answer **any Two** questions.

*Each question carries **15** marks.*

32. (i) Show that the point (2, 4) lies on t6he curve $x^3 + y^3 - 9xy = 0$. Then find the tangent and normal to the curve there.

    (ii)Find $\frac{dy}{dx}$ if $y = \cos(t^2 + 1)$ and $x = \tan(5 - \sin 2t)$.
33. (i) Show that f(x) has a continuous extension to x = 2 and find that extension where $f(x) = \frac{x^2+x-6}{x^2-4}, x \neq 2$.

    (ii) Evaluate the limits $\lim_{h\to 0} \frac{\cos h - 1}{h}$ and $\lim_{x\to 0} \frac{\sin 2x}{5x}$.
34. Sketch the graph of $f(x) = x^2 + x - 6$.
35. Let A be a set of non zero integers and let ≈ be the relation on A × A defined as follows: (a, b) ≈ (c, d) whenever ad = bc. Prove that ≈ is an equivalence relation on A.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

First Semester Degree Examination - , 2015

Complementary Course – REG-1T03 CHEMISTRY-I : THERMODYNAMICS AND ELECTROCHEMISTRY

Time: 3 hours Maximum: 80 marks

Part A

Answer **all** questions

Each question carries 1 mark

1. For exothermic reactions ΔH is ……..
2. Name the acid used in potentiometric titrartion of ferrous ion with potassium permanganate.
3. The value of standard reduction potential for the reaction $2H^+ + 2e \rightarrow H_2$ is ....
4. Entropy is a ……. Function
5. An open system is one which can exchange …… with its surroundings
6. Enthalpy H = E + ….
7. The titrant used in coulometric titration is ....
8. The unit for specific conductance is .....

(10×1=10)

Part B

Answer **any Six** questions

Each question carries 2 marks

9. Explain Ostwald's dilution law.
10. State and explain Third law of thermodynamics.
11. Define ionic strength.
12. Explain reversible and irreversible process.
13. Define and explain entropy of fusion.
14. Explain Faraday's law of electrolysis.
15. Distinguish between equivalent conductance and molar conductance
16. State and explain second law of thermodynamics.
17. Explain Nernst equation.
18. Define internal energy.

(8×2=16)

Part C

Answer **any Four** questions

Each question carries 4 marks

19. Write notes on amperometric titrations.
20. Define Gibbs free energy. Show that the decrease in free energy in a process is equal to the useful work done by the system.
21. Derive the equation for degree of hydrolysis for the hydrolysis of salt of strong acid with weak base, and weak acid with strong base
22. What is liquid junction potential? How can it be eliminated?
23. Write notes on the determination of transport number determination by Hittorf's method.
24. Distinguish between electrolytic cell and galvanic cell

(6×4=24)

Part D

Answer **any Two** questions

Each question carries 15 marks

25. Explain the theory of conductometric titration. Draw the titration curve for HCl vs NaOH, acetic acid vs NaOH, and oxalic acid vs NaOH.

26. (a) Explain the free energy criteria for (i) spontaneous reaction; (ii) equilibrium state; (iii) non-spontaneous process.

(b) In a certain process 700 joule of work is done on a system which gives off 250 joules of heat. Calculate the internal change in the process.

27. Explain Kohlrausch's law and its applications.

28. Write notes on different types of concentration cells. Give any one application.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

First Semester Degree Examination - , 2015

Complementary Course – RES-1T04 PHYSICS-I : UNITS & MEASUREMENTS, CIRCUIT THEORY AND ELECTRICAL FUNDAMENTALS

Time: 3 hours Maximum: 80 marks

Part A

Very Short Answer Questions-Answer **all** questions briefly

Each question carries 1 mark

1) What are the applications of Laser range finders?
2) Define one metre in terms of atomic standard.
3) What is meant by Echo sounding?
4) What is the SI unit of length? Define one standard unit of length in terms of the speed of light.
5) What are the different types of inductors?
6) Define capacitance.
7) State super position theorem.
8) What is meant by capacitive reactance.

(10×1=10)

Part B

Short answer questions**-** Answer **any Eight** questions

Each question carries 2 marks

9) Explain how Sonar works.
10) When measuring the thickness of a glass plate using screw gauge, we take a number of measurements instead of one. Why?
11) Give any four uses of Inclinometer
12) What do you mean by varying currents?
13) What is meant by time constant in an LR circuit?
14) What is Norton's theorem?
15) What is meant by Q-factor?
16) What is meant by rms value of ac?
17) Explain skin effect.
18) What is a constant voltage source?

(8×2=16)

Part C

Answer **any Six** questions

Each question carries 4 marks

19) How will you measure a small angle using a scale and telescope arrangement?
20) Derive the expression of current for series L-C-R circuit.
21) State and explain Thevenin's theorem.
22) If the resistance, inductance and capacitance of 200 ohm, 5 H and 40 microfarad, respectively are connected in series, find current and impedance.
23) Find the value of time constant in an LR circuit when the current rises to 63.2% of its steady value in one second.
24) Find the value of current through an inductance of 0.5H when an alternating e.m.f. of 220V at 50Hz is applied on it

(6×4=24)

Part D

Long answer questions**-** Answer **any Two** questions

Each question carries 15 marks

25) Discuss the evolution of time measurement, from water clocks to atomic clocks.
26) Describe the measurement of high resistance by capacitor leakage method.
27) Give the circuit analysis of LCR series and parallel circuit. Obtain the condition of resonance in each case. Why a parallel LCR circuit is called a rejector circuit?
28) Explain the different types of Switches.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

First Semester Degree Examination - , 2015

Core Course – RES-1T05 RENEWABLE ENERGY-I : FUNDAMENTALS OF SUSTAINABLE ENERGY & DEVELOPMENT

Time: 3 hours Maximum: 80 marks

Part A

Very Short Answer Questions**-**Answer **all** questions briefly

Each question carries 1 mark

1) Write any four differences between renewable and non-renewable energy sources.
2) Define Solar Constant.
3) Distinguish between beam and diffuse radiation.
4) Define Air Mass ratio.
5) Give any two advantages and two disadvantages of wind energy.
6) What is photosynthesis?
7) What is biomass?
8) What is geothermal power?
9) What are the constituents of biogas?
10) What are spring tides and neap tides?

(10×1=10)

Part B

Short answer questions**-** Answer **any Eight** questions

Each question carries 2 marks

11) Explain the terms declination and solar altitude.
12) What is pyrheliometer? How does it differ from a pyranometer?
13) What are solar energy collectors?
14) State the various factors affecting the yield of biogas-plant.
15) What are the basic components of a wind energy conversion system?
16) What is biodiesel? How is it produced?
17) Explain thermosiphoning effect?
18) Give the basic structure of a collector pipe used in line focusing solar collectors.

19) Give the basic parameters of a solar cell.
20) Distinguish between active and passive solar space heating systems.
21) Classify the geothermal energy sources.
22) What are greenhouses? Mention the different types of greenhouses.

(8×2=16)

Part C

Answer **any Six** questions

Each question carries 4 marks

23) Explain the need for renewable energy sources.
24) Explain the following
    a. Liquid heating flat-plate collector
    b. Parabolic trough reflector
25) Write a note on the role of State and Central Government agencies in promoting renewable energy in India.
26) Explain
    a. Magneto Hydro Dynamic energy
    b. Hydrogen energy
27) Explain dry and wet process for biomass conversion.
28) Describe with a schematic diagram the principle of a solar still.
29) Describe natural-circulation and forced-circulation solar water heater.
30) Explain the various components of tidal power plants
31) What are the factors to be considered while selecting the site for a wind energy system?

(6×4=24)

Part D

Long answer questions**-** Answer **any Two** questions

Each question carries 15 marks

32) What is a solar thermal electric conversion system? Explain in detail a solar tower power plant.
33) What is photovoltaic effect? With the help of a schematic diagram, explain in detail a basic solar photovoltaic system.
34) Explain the techniques used for maintaining biogas production.
35) With a neat diagram, explain how wind energy can be converted into electrical energy.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

Second Semester Degree Examination - , 2015

Complementary Course – REG-2T06 ENGLISH-II

Time: 3 hours Maximum: 80 marks

Part A

*Answer **all** the following questions in a sentence or two*

Each carries 1 mark

1. Write a phrase used to close a conversation.
2. Best strategies that can be used to start a conversation with known/unknown individuals is _____
3. Write any two conversation openers?
4. What is a group discussion?
5. Write any problem solving skilss.
6. He loves listening to quality music/musics.
7. The armed force/forces can be seen on a move along the border.
8. Hearing is a/an _____ act.
9. The expression 'Best Wishes' is an example of _____close in email writing.
10. Content listening is also known as_____ listening.

(10×1=10)

Part B

*Answer any **eight** of the following questions in about 50 words*

Each carries 2 marks

11. Who is a poor listener?
12. What is hard listening?
13. What is the difference between Listening and Hearing?
14. What is Extensive reading?
15. What is over excitement?
16. What is case-based discussion?
17. What is small talk?

18. List four conversation openers?

19. Email writing

20. Write any strategies for making your speech interesting.

21. What is introductory speech?

22. What are the advantages of speaking by looking at the manuscript?

(8×2=16)

Part C

*Answer any **six** of the following questions in about 100 words*

Each carries 4 marks

23. Difference between Extensive listening and Intensive listening?

24. Prepare a short formal welcome speech. Invent details.

25. Guiding principle for email composition

26. Prepare a conversation between a shop keeper and a customer.

27. Poor listening vs. Effective listening.

28. Barriers to effective listening.

29. Prepare an email for placing an order of a product.

30. Group discussion.

31. Different levels of perception.

(6×4=24)

Part D

*Answer any **two** of the following questions in about 300 words*

Each carries 15 marks

32. Discuss listening skill, its types and important facts.

33. Imagine that as the Media Relation officer of Mega Product Pvt. Ltd, Delhi, you are required to deliver a speech on the role of Media in Corporate Sector. Write the full text of your speech. Invent the necessary details.

34. Email writings – Reason for popularity, guiding principles for composition and Common pitfalls.

35. Group Discussion- Skills required for effective participation in group discussion, two types of Group Discussion.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

Second Semester Degree Examination - , 2015

Complementary Course – REG-2T07 MATHEMATICS-II

Time: 3 hours Maximum: 80 marks

Section – A

*Answer **all** questions from 1 to 10. Each question carries **1 mark**.*

1. State Mean Value Theorem for definite integrals.
2. What is the area under the curve y = f(x) over [a, b]?
3. State fundamental theorem of calculus?
4. What is the volume of a solid of cross sectional area A(x) from x = a to x = b?
5. State Fubini's Theorem.
6. State mean value theorem.
7. State first derivative theorem for local extreme values.
8. State true or false: Functions with zero derivatives are constant.
9. Define points of inflection.
10. State Taylor's theorem.

(10×1=10)

Section – B

*Answer **any eight** questions from 11 to 22. Each question carries **2 marks**.*

11. Compute $\int_0^b x dx$.
12. Find the average value of f(x) = $x^2 - 1$ on [0, $\sqrt{3}$].
13. Find area under the curve y = $x^2 - 4$ over the interval [–2, 2].
14. Evaluate $\int_{\pi/4}^{\pi/2} cot\theta \; cosec^2\,\theta \; d\theta$.
15. Find the volume of the solid generated by revolvinig the region between Y-axis and the curve x = 2/y, 1 ≤ y ≤ 4 about Y-axis.
16. Evaluate $\int_1^2 \int_0^4 2xy \; dy \; dx$.
17. Find $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ where f(x, y) = x^2 – xy + y^2.
18. Find $\frac{\partial f}{\partial x}$ and $\frac{\partial f}{\partial y}$ where f(x, y) = x^2y + cosy + y sinx.
19. Verify that $\frac{\partial^2 f}{\partial x \partial y} = \frac{\partial^2 f}{\partial y \partial x}$ where f(x, y) = x^y.
20. Find absolute extrema values of $g(t) = 8t - t^4$ on [-2,1].
21. Find Maclaurin's series expansion of log(1+x).
22. Find critical points of the function $g(x) = -x^3 + 12x + 5, -3 \leq x \leq 3$

(8×2=16)

Section – C

*Answer **any six** questions from 23 to 31. Each question carries 4 **marks**.*

23. Show that if f is continuous on [a, b] and if $\int_a^b f(x)dx = 0$ then f(x) = 0 atleast once in [a,b] .
24. Evaluate $\int \frac{2z\,dz}{\sqrt[3]{z^2+1}}$.
25. Find the area of the region enclosed by the parabola $y = 2 - x^2$ and the line $y = -x$.
26. Find the length of the curve $y = (x/2)^{2/3}$ from x = 0 to x = 2.
27. The line segment $x = 1 - y$, $0 \le y \le 1$ is revolved about Y-axis to generate a cone. Find its surface area.
28. Find the points of inflection of the curve $f(x) = x^3 - 9x^2 + 5x$.
29. Verify mean value theorem for the function $f(x) = e^x$ on [0,1].
30. Find $\frac{\partial w}{\partial r}$ and $\frac{\partial w}{\partial s}$ in terms of r and s if $w = x + 2y + z^2$, $x = \frac{r}{s}$, $y = r^2 + \log(s)$, $z = 2r$.
31. Find the intervals on which $g(x) = -x^3 + 12x + 5, -3 \le x \le 3$ is increasing and decreasing.

(6×4=16)

Section – D

*Answer **any two** questions from 32 to 35. Each question carries 1**5 marks**.*

32. (i) Find the area enclosed by the lemniscates $r^2 = 4\cos 2\theta$.
    (ii) Using polar integration find the area of the region R in the XY- plane enclosed by the circle $x^2 + y^2 = 4$ above the line y = 1 and below the line $y = \sqrt{3}\,x$.
33. (i) Find the length of the curve $y = \frac{x^3}{12} + \frac{1}{x}$, $1 \le x \le 4$.
    (ii) The region bounded by the curve $y = \sqrt{x}$, the x-axis and the line x = 4 is revolved about X-axis to generate a solid. Find the volume of the solid by shell method.
34. Find the absolute maximum and minimum values of $f(x, y) = 2x^2 - 4x + y^2 - 4y + 1$ on the closed triangular plate in the first quadrant bounded by the lines $x = 0, y = 2, y = 2x$.
35. Use the method of Lagrange multipliers to find the maximum and minimum values of $f(x, y, z) = x - 2y + 5z$ on the sphere $x^2 + y^2 + z^2 = 30$.

(2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

Second Semester Degree Examination - , 2015

Complementary Course – REG-2T08 PHYSICS-II : BASIC ELECTRONICS

Time: 3 hours Maximum : 80 marks

Part A

Very Short Answer Questions**-**Answer **all** questions briefly

Each question carries 1 mark

1) What are the two types of charge carriers in a semiconductor?
2) What is the range of Band gap for semiconductors
3) Which is the most popular transistor configuration used in amplifiers?
4) What are diodes?
5) LASER stands for ……..
6) What are the various types of filter circuits
7) What is a transistor
8) Give two advantages of Bridge rectifiers over the other types of rectifiers

(10 ×1=10)

Part B

Short answer questions**-** Answer **any 8** questions

Each question carries 2 marks

9) Distinguish between a photodiode and solar cell
10) What is meant by ripple factor? Give the ripple factor of a half wave rectifier
11) What are zener diodes? Give its application
12) What are Energy bands?
13) Draw the symbols for NPN and PNP transistors
14) Draw the IV characteristics of a pn junction diode
15) What do you meant by Fill factor of a solar cell
16) What is LED ? briefly explain its working
17) Explain the function of various regions of a transistor
18) How to realize a constant Voltage source

(8×2=16)

Part C

Answer **any Six** questions

Each question carries 4 marks

19) Explain the transistor action
20) Explain biasing of a PN junction?
21) Write a note on
    a) PIN Photodiode
    b) Opto-isolators
22) What do you meant by Voltage stabilization? Explain a circuit for realizing the same
23) Distinguish between intrinsic and extrinsic semiconductors
24) What are the various parameters of a Solar cell? Draw its IV characteristics

(6×4=24)

Part D

Long answer questions**-** Answer **any Two** questions

Each question carries 15 marks

25) Explain the various configurations in which a bi polar junction transistor can be used in a circuit
26) Explain how materials can be classified based on the relative values of their Energy band gap. Enlist the properties of a semiconductor with proper justification
27) What do you meant by a rectifier? Explain with the help of a neat circuit diagram the working of a centre- tap full wave rectifier and a haf wave rectifier
28) What do you meant by doping? Give its significance. Explain in detail the doping process in semiconductors.

(2×15=30)

MODEL QUESTION PAPER

B.Voc. IN RENEWABLE ENERGY

Second Semester Degree Examination, ….. 2015.

Core Course-RES-2T09 RENEWABLE ENERGY-II: Physico Chemical Processes for Water and Wastewater Treatment

Time: 3 hours Maximum Marks:80

Part A

Answer all questions. Each carries 1 mark.

1. The estimation of hardness of water by EDTA method involves a ..... titration.
2. Sterilization of water can be done by .....
3. Colloids can be precipitated by .....
4. Name some impurities present in water.
5. Which of the following methods is not used for disinfection of water?
   a . Chlorination
   b. Ozonisation
   c. Electro dialysis
   d. UV treatment
6. The exhausted zeolite can be regenerated by ..... solution.
7. The permissible limit of pH in drinking water is .....
8. One method of removing hardness of water is ..... (10× 1 = 10)

Part B

Answer any Eight questions. Each carries 2 marks

9. What are the different impurities present in water?
10. Write a note on sedimentation.
11. Explain filters.
12. What is brackish water?
13. What is the main advantage of reverse osmosis over ion exchange?
14. Define alkalinity of water.
15. What is break point chlorination?
16. State the significance of COD.
17. What are the steps involved in primary treatment of sewage?
18. Explain why hard water does not produce lather with soap. (8 ×2=16)

Part C

Answer any Six questions. Each carries 4 marks

19. Discuss demineralization process in detail.
20. Describe the sand filter used for purification of municipal water.

21. How many grams of $FeSO_4$ dissolved per litre of water give 210.5 ppm of hardness?
22. Explain stability of colloids.
23. List out the factors affecting disinfection of water.
24. Describe the argentometric method of estimation of chloride content of water sample.

(6×4=24)

Part D

Answer any Two questions. Each carries 15 marks

25. With a neat diagram, explain the ion exchange process for purification of water. Discuss its merits and demerits.
26. Briefly describe the principle and method of determination of
    a) fluoride by SPADNS method
    b) sulphate by gravimetric method.
27. Explain the Principe of working and design of pressure filters
28. Write notes on
    i) mechanism of filtration
    ii) chloramines for disinfection.
    iii) electro dialysis
    iv) clariflocculation. (2×15=30)

MODEL QUESTION PAPER

B.VOC. IN RENEWABLE ENERGY

Second Semester Degree Examination - , 2015

Core Course – RES-2T10 RENEWABLE ENERGY-III : PHOTOVOLTAIC MODULE INSTALLATION

Time: 3 hours Maximum: 80 marks

Part A

Very Short Answer Questions**-**Answer **all** questions briefly

Each question carries 1 mark

1) What is a solar cell?
2) What do you mean by a photovoltaic module?
3) What is the function of a bypass diode?
4) Mention the different types of shading
5) What is the function of grid connected inverters
6) What is the first step in checking the system after completing the module installation?
7) What should be checked first before applying power from a photovoltaic module either to an inverter, a charge controller, batteries or a load?
8) Why site survey is needed before installing a PV module?
9) Mention any one way of finding the shadow outline of the area where the module is to be installed.
10) Mention any one type of encapsulation used in embedding the solar cells

(10×1=10)

Part B

Short answer questions**-** Answer **any Eight** questions

Each question carries 2 marks

11) What are the types of PV modules?
12) What are hot spots?
13) What do you mean by inverter sizing?
14) What do you mean by the current rating of a cable?
15) Mention the procedures for minimizing the cable losses and voltage drops.
16) How can we protect a PV module from lightning?
17) What is shading analysis?

18) Give the wiring symbols.
19) What are junction boxes?
20) What is a string diode?
21) What are the factors to be considered while installing an inverter?
22) Draw the equivalent circuit diagram of a solar cell

(8×2=16)

Part C

Answer **any Six** questions

Each question carries 4 marks

23) Explain the irradiance dependence of PV module.
24) Describe the properties of grid connected inverters.
25) Explain different PV array configurations.
26) Write down a sample checklist for the survey of building before installing a PV module.
27) Explain how to reduce the mutual shading losses of rack-mounted PV modules.
28) What is meant by 'sizing the module and string cabling'? Explain.
29) Explain briefly the concept of central inverter.
30) Write notes on
    (i) DC main cable
    (ii) DC main switch
31) Explain
    (i) Stand-alone system
    (ii) Grid-connected system

(6×4=24)

Part D

Long answer questions**-** Answer **any Two** questions

Each question carries 15 marks

32) Write an essay on planning and sizing of grid connected PV systems.
33) Elaborate on the process of site survey and shading analysis for installing PV systems.
34) Explain the method of operation of inverter.
35) Write notes on
    (i) Cabling
    (ii) Connection systems

(2×15=30)