ST. ALBERT'S COLLEGE (AUTONOMOUS),

ERNAKULAM

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

SYLLABUS FOR UNDERGRADUATE PROGRAMME

BACHELOR OF VOCATIONAL STUDIES IN RENEWABLE ENERGY

(WITH EFFECT FROM 2019 ADMISSION)

Syllabus of B.Voc. Renewable Energy

Proposed by the Board of Studies on 23rd February 2019

Dr. Nelson Rodrigues

Chairman, Board of Studies

Approved by the Academic Council on 28th February 2019

Dr. M.L. Joseph, Principal

Chairman, Academic Council.

Adopted by the Governing Council on 4th May 2019

Fr. Antony Arackal

Chairman, Governing Council

Board of Studies

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25	Sr. Lawrel Gregory	Associate Professor
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27	Sri. Justin Paiva	Associate Professor

28	Sri. Augustine Sumesh C J	Assistant Professor
29	Smt. Cicily Antony T	Assistant Professor
30	Smt. Greeshma S	Assistant Professor
31	Smt. Sanju Augustin	Assistant Professor
32	Smt. Nithya S Menon	Assistant Professor

Acknowledgement

The Board of Studies in Renewable Energy (Undergraduate – B. Voc.), St. Albert's College takes this opportunity to express our deep appreciation to all academicians who participated in the various meeting that were arranged during the year, held at St. Albert's College, Ernakulam. We express our sincere gratitude to Dr. Nelson Rodrigues, HoD, Asst. Professor, Department of Physics, St. Albert's College (Autonomous) Ernakulam for his guidance in the process of restructuring the undergraduate Zoology Programme. We also express our sincere gratitude to Dr. Nandakumar Kalarikkal, Hon. Director of International and Interuniversity Centre for Nanoscience & Nanotechnology, and Associate Professor, School of pure and Applied Physics Mahatma Gandhi University, Dr. Pramod Gopinath, Professor, International School of Photonics, CUSAT, Kalamassery, Dr. James Kurian, Professor, Department of Electronics, CUSAT, Kalamassery, for their guidance and contribution to the successful completion of the syllabus restructuring. Also, we extent our sincere thanks to all the other faculty members for their whole hearted co-operation and immense support at each level of its preparation. Above all we thankfully acknowledge Almighty God for strengthening us to accomplish this work.

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Preface

As envisaged in the recent regulations of Autonomous colleges in India by University Grants Commission, autonomous colleges enjoy the academic freedom to enrich the curriculum by incorporating recent trends and needs. Curriculum and syllabus of each academic program has to be revised periodically to impart major objectives like global competency, skill component, values and regional relevance. Academicians and scholars in the respective area of knowledge have to express a missionary zeal for this great purpose.

In 2016, when St. Albert's College was granted autonomy, we adopted the curriculum and syllabus followed by the Mahatma Gandhi University, Kottayam for the year 2016. In 2017, when the Mahatma Gandhi University made a comprehensive revision of their curriculum and syllabus, it was adopted by the college as it was a better curriculum that met the needs and current demands of the culture, the society, and the expectations of the population being served. However, the Syllabus revision committee of the department studied the present curriculum in detail and proposed some reasonable changes for further enrichment which may be implemented from 2019 admission onwards.

The present B.Voc. Degree Renewable Energy programme is a credit based semester system with 6 semesters. The cerification levels will lead to Diploma/Advanced Diploma/B. Voc. Degree and will be offered under the aegis of the University. The B.Voc. Programme shall include (a) General Courses (General Components) and (b) Core Courses (Skill Components). Credit Transfer and Accumulation system can be adopted in the programme. 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 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. Attempts were also made to integrate the essential components to generate interest for self-employment or start-ups among the pupils. All possible attempts have been made to update the syllabus by incorporating current and most recent developments in various branches of Renewable Energy.

Programme Outcomes

Critical Thinking: Take informed actions after identifying the assumptions that frame our thinking and actions, checking out the degree to which these assumptions are accurate and valid, and looking at our ideas and decisions (intellectual, organizational, and personal) from different perspectives.

Problem Solving: Solve problems from the Disciplines of concern using the Knowledge, skills and attitude acquired from humanities / science / mathematics / Social Sciences etc.

Individual and Team Work: An ability to work effectively as a member and leader in teams, preferably in a multi-disciplinary setting.

Environment and Sustainability: Understand the issues of environmental contexts and sustainable development.

Programme Specific Outcomes

- Understand and apply the principles of solid-state physics, thermodynamics, nanoscience and learn to execute the same in areas of science with the aid of mathematical and computational skills.
- Demonstrate competence in analysis, design, development and operation of energy systems: bio energy, heat energy, geothermal energy, wind power, ocean energy, chemical energy and photovoltaic systems.
- Attains individual and technical skills including leadership, project management and communication to work as a professional, or to pursue a career in research.
- To inculcate among the students systematic knowledge and skill about assessing the current energy scenarios and policies, energy efficiency, energy auditing, energy management and conservation techniques.

Regulations

1. TITLE

These regulations shall be called "ST. ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM - REGULATIONS FOR B. VOC. PROGRAMMES 2019".

2. SCOPE

This applies to all regular B. Voc. Programmes conducted by the College with effect from 2019 admissions. The medium of instruction is English except in the case of language courses other than English unless otherwise stated therein.

3. DEFINITIONS

'Academic Week' is a unit of five working days in which the distribution of work is organized from day one to day five, with five contact hours of one-hour duration on each day / is a unit of six working days in which the distribution of work is organized from day one to day five with 4 hours and day six with 5 contact hours of one-hour duration on each day as decided by the Governing body of the College.

3.1 NSQF means National Skills Qualifications Framework

3.2 'General components' means a course that provides a general awareness about the discipline.

3.3 'Skill components' means a course in the subject of specialization within a vocational degree programme.

3.4 'Course' means a portion of a subject to be taught and evaluated in a semester (similar to a paper under the annual scheme).

3.5 'OJT' means On-the-job training.

3.6 'HOT' means Hands-on training.

3.7 'Credit' is the numerical value assigned to a paper according to the relative importance of the syllabus of the programme.

3.8 'Department' means any teaching department in a college.

3.9 'Examination Coordinator' is a teacher nominated by a Department Council to coor-

dinate the continuous evaluation undertaken in that department.

3.10 'Department Council' means the body of all teachers of a department in a college.

3.11 'Class Tutor' means a teacher from the department nominated by the Department Council, who will advise the student on academic matters.

3.12 Grace Marks shall be awarded to candidates as per the Orders issued from the college from time to time at par with the affiliating University.

3.13 'Grade' means a letter symbol (A, B, C, etc.), which indicates the broad level of performance of a student in a Paper/Course/ Semester/Programme.

3.14 'Credit Point' (CP) is the numerical indicator of the percentage of marks awarded to a student in a course.

3.15 'Institutional Average (IA)' means average mark secured (Internal + external) for a course at the college level.

3.16 'Parent Department' means the department which offers the skill course/courses within an undergraduate programme.

3.17 'Programme' means a three-year programme of study and examinations spread over six semesters, the successful completion of which would lead to the award of a degree.

3.18 Semester' means a term consisting of 90 working days, inclusive of tutorials, examination days, and other academic activities within a period of five months.

3.19 'Vocational Course' (Skill Enhancement Course) means a course that enables the students to enhance their practical skills and ability to pursue a vocation in their subject of specialization.

3.20 Words and expressions used and not defined in this regulation shall have the same meaning assigned to them in the Acts and Regulations of UGC, Department of Higher Education, the affiliating University and regulations of the College.

4. ELIGIBILITY FOR ADMISSION AND RESERVATION OF SEATS

4.1 A pass in Plus Two or equivalent examination or an examination recognized as equivalent thereto by UGC and affiliating University unless for certain programmes

in which eligibility for admissions are approved by the Governing body and mentioned in the Prospectus.

4.2 Eligibility for admissions and reservation of seats for various Undergraduate Programmes shall be according to the rules framed by the Governing Body of the College in this regard, from time to time at par with the UGC norms and regulations of the Government of Kerala.

5. CURRICULUM

The curriculum in each of the years of the programme would be a suitable mix of general education and skill development components.

6. DURATION

6.1 The duration of the U.G. programme shall be 6 semesters.

6.2 There shall be two semesters in an academic year, the "ODD" semester commences in June, and on completion, the "EVEN" Semester commences.

6.3 There shall be a two month vacation during April/May.

6.4 The certification levels will lead to Diploma/ Advanced Diploma/B.Voc Degree and will be offered under the aegis of the College in association with the respective sector skill council of the programme in accordance with the NSQF as outlined in the Table given below.

Award	Duration
Diploma	2 Semesters
Advanced Diploma	4 Semesters
B.Voc. Degree	6 Semesters

7. ELIGIBILITY FOR HIGHER STUDIES

Those who pass B.Voc. Degree programmes are eligible for admission to higher studies.

8. CREDIT CALCULATION

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

One Credit would mean the equivalent of 15 periods of 60 minutes each, for theory, workshops/labs, and tutorials;

For internship/fieldwork/OJT/HOT, the credit weightage for equivalent hours shall be 50% of that for lectures/workshops.

9. REGISTRATION

The strength of students for each programme shall be as per the existing orders issued by the College following the UGC guidelines.

10. SCHEME AND SYLLABUS

10.1 The U.G. programmes shall include (a) General components, (b) Skill components.

10.2 Credit Transfer and Accumulation system can be adopted in the programme with the concurrence of the Governing Body of the College. 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 College/University to continue their education in another College/University without break.

10.3 A separate minimum of 30% marks each for internal and external (for both theory and practical) and an aggregate minimum of 40% are required for a pass for a course. For the programmes with practical examinations, the practical examinations will be conducted every semester or at the end of even semesters as applicable.

10.4 For a pass in a programme, a separate minimum of Grade E is required for all the individual courses. If a candidate secures an 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. The candidate who secures E Grade and above will be eligible for higher studies.

11. PROGRAMME STRUCTURE

The B.Voc. programme shall include the following elements:

- General Education Components

- Skill Components
- Project
- Internships
- OJT
- Soft skills and Personality Development Programmes
- Industrial Visits
- HOT

	PARTICULARS	B.Voc Programmes
A	Programme Duration	6 Semesters
B	Total Credits required for successful completion of the Programme	180
C	Credits required from Skill Component	108
D	Credits required from General Component	72
G	Minimum attendance required	75%

12. COURSE STRUCTURE

NSQF Level	Credits		Normal Duration	Exit Points / Awards
	Skill Component	General Component		
Year 1	36	24	Two Semesters	Diploma
Year 2	36	24	Four Semesters	Advanced Diploma
Year 3	36	24	Six Semesters	B. Voc. Degree

As per the UGC guidelines, there are multiple exit points for a candidate admitted to this

course. If he/she is completing all six semesters successfully, he/she will get a B. Voc. Degree. If he/she is completing the first four semesters successfully, he/she will get an Advanced Diploma. If he/she is completing the first two semesters successfully, he/she will get a Diploma. A B.Voc. Degree holder is expected to acquire the skills needed for a Manager/Entrepreneur/skilled employee.

13. ATTENDANCE

The minimum number of hours of lectures, tutorials, seminars or practicals which a student shall be required to attend for eligibility to appear at the end semester examination shall not be less than 75% of the total number of lectures, tutorials, seminars, or practical sessions and shall have 75% separate attendance during their internship/OJT/HOT period also. Internships, HOT/OJT and soft skill and personality development programmes are part of the course and students must meet the attendance requirements for these activities to complete a semester.

14. EXAMINATION

The evaluation of each paper shall contain two parts:

Internal or In-Semester Assessment (ISA)

External or End-Semester Assessment (ESA)

The internal to external assessment ratio shall be 1:4.

Both internal and external marks are to be rounded to the next integer.

All papers (theory & practical), grades are given **on a 7-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

15. CREDIT POINT AND CREDIT POINT AVERAGE

The Credit Point (CP) of a paper is calculated using the formula:

CP = C × GP, where C is the Credit and GP is the Grade point.

Semester Credit Point Average (SCPA) of a Semester is calculated using the formula:

SCPA / CPA= TCP/TC, where TCP is the Total Credit Point of that semester.

Cumulative Credit Point Average (CCPA) is calculated using the formula:

CCPA = TCP/TC, where TCP is the Total Credit Point of that programme.

Credit Point Average (CPA) of different categories, of course, is calculated using the formula:

CPA = TCP/TC, where TCP is the Total Credit Point of a category of course.

TC is the total credit of that category of course.

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

CPA	Grade	
Above 9	A+	Outstanding
Above 8, but below or equal to 9	A	Excellent
Above 7, but below or equal to 8	B	Very Good
Above 6, but below or equal to 7	C	Good
Above 5, but below or equal to 6	D	Satisfactory
Above 4, but below or equal to 5	E	Adequate
4 or below	F	Failure

16. MARK DISTRIBUTION FOR EXTERNAL AND INTERNAL EVALUATIONS

The external theory examination of all semesters shall be conducted by the college at the end of each semester. Internal evaluation is to be done by continuous assessment. For all courses,

the total marks for external examination is 80 and the total marks for internal evaluation is 20.

For the courses having both theory and practical components, the external examination marks would include 60 for theory and 20 for practical. The internal evaluation would remain the same as above.

Mark distribution for external and internal assessments and the components for internal evaluation with their marks are shown below:

16.1 **For all theory courses**

Marks of external Examination : 80

Marks of internal evaluation : 20

Components of Internal Evaluation of theory	Marks
Attendance	5
Assignment/ Seminar	5
Test Paper 1	5
Test paper 2	5
Total	20

16.2 **For practical examinations,**

The total marks for external evaluation : 80

The total mark for internal evaluation : 20

Components for internal evaluation of Practical	Marks
Attendance	5
Internal Viva	5
Rough Record	5
Lab Performance	5
Total	20

*Marks awarded for Record should be related to the number of experiments recorded and duly

signed by the teacher concerned in charge.

All four components of internal assessments are mandatory unless for the courses otherwise mentioned in the BoS.

16.3 **For courses having both theory and practical components**

a) Marks of theory- external examination : 60

b) Marks of practical- external examination : 20

c) Marks of internal evaluation : 20

16.4 **For projects**

Marks of external evaluation : 80

Marks of internal evaluation : 20

Components of External Evaluation of Project	Marks
Dissertation (External)	50
Viva-Voce (External)	30
Total	80

*Marks for dissertation may include study tour report if proposed in the syllabus.

Components of internal Evaluation of Project	Marks
Guide visit/ review	5
Work done	5
Output	5
Report	5
Total	20

*All four components of internal assessments are mandatory unless for the courses otherwise mentioned in the BoS

16.5 **For Internships/HOT/OJT**

Components of Internal Evaluation- Internships/HOT/OJT

Components Internal evaluation- HOT/OJT	Marks
Attendance	5
Subject Knowledge/Viva	10
Report	5
Total	20

The marks for the OJT/HOT conducted in the odd semester shall be uploaded along with the Internship course of the consecutive even semester.

Components of External Evaluation- Internships

Components of External Evaluation of Project	Marks
Dissertation (External)	50
Viva-Voce (External)	30
Total	80

Attendance Evaluation for all papers

% 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)

17. ASSIGNMENTS

Assignments are to be done from Ist to VIth Semesters. At least two assignments should be done in each semester for all courses.

18. SEMINAR

A student shall present a seminar every semester for each course.

19. INTERNAL ASSESSMENT / TEST PAPERS

19.1 At least two internal test papers are 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 department for five years and shall be made available for verification by the College. The responsibility of evaluating the internal assessment is vested on the teacher(s), who teaches the course.

19.2 In case of any grievances regarding internal assessment, students can follow the procedures mentioned below under Grievance Redressal Mechanism - clause number 20 in regulation.

19.3 The CoE shall make arrangements for giving awareness of the internal evaluation components to students immediately after the commencement of the Ist semester.

19.4 The internal evaluation marks/grades in the prescribed format should reach the office of the Controller of Examinations, St. Albert's College before the commencement of study leave in each semester.

20. GRIEVANCE REDRESSAL MECHANISM WITH RESPECT TO INTERNAL EVALUATION

The internal assessment shall not be used as a tool for personal or other types of vengeance. A student has all rights to know how the teacher arrived at the marks. There is a provision for grievance redressal regarding internal evaluation which operates at four levels. Complaints regarding the internal evaluation shall be brought to the notice of the teacher concerned in the first instance. If the student is not satisfied with the decision of the teacher concerned, he/she may appeal to the Departmental Grievance Redressal Committee which shall have the Head of the department, the class Tutor, and the teacher against whom the complaint is made, as members. The student will also have the freedom to make further appeals to the College Level Grievance Redressal Committee which shall have the Principal, the COE, and the concerned Head of the department, as members. If the student is not satisfied, he may appeal to the Governing Body.

Level 1: Class level: The cell is chaired by the class tutor and the course teacher or a teacher nominated by the Head of the Department.

Level 2: Department level: The department cell chaired by the Head of the Department, Examination Coordinator and teacher-in-charge as members.

Level 3: College level: A committee with the Principal as Chairman, Examination Coordinator, HOD of concerned Department and a senior teacher nominated by the college council as members.

21. EXTERNAL EXAMINATION (END SEMESTER EXAMINATION)

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

b) 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 in a semester subject to a maximum of 2 times during the whole period of the programme may be granted by the college on valid grounds. This condonation shall not be counted for internal assessment. The 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, upon producing participation/attendance certificates, within one week, from competent authorities through the class tutor, HoD and Dean of Student Affairs and endorsed by the Principal. This is limited to a maximum of 10 days per semester and this benefit shall be considered for internal assessment also. Those students who are not eligible even with the condonation of shortage of attendance will not be readmitted.

c) There shall be special supplementary exams only for the fifth semester. For reappearance/ improvement for other semesters, the students can appear along with the next batch.

d) There shall be no provision for supplementary examination for the internal assessment.

e) A pass in the internal assessment is mandatory for registering for the End semester examination.

f) A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester provided he/she meet the academic re-

quirements.

g) All courses shall have a unique alphanumeric code.

22. PATTERN OF EVALUATION FOR EXTERNAL EXAMINATION – PRACTICAL / INTERNSHIP WITH PROJECT

The components of End Semester Examination of Practical/Internship with Project have to be set by the Chairman of the Boards of Studies concerned.

All students are required to complete Hands-on training (HOT)/ On-job training (OJT), Internship and a project, as directed in the respective syllabus. The project can be done individually or as a group, as decided by the Department. The HOT and OJT has to be done during the period as prescribed in the particular semester of the programme. The project, if it is a requisite of the syllabi, has to be done in the final year of the programme. The reports of HOT and OJT (in duplicate) have to be submitted to the department during the particular semester prescribed in the programme and the report of the project (in duplicate) is to be submitted to the department in the sixth semester. The project report should be produced before the examiners appointed by the College.

For reappearance/ improvement, the students can appear along with the next batch. A student who registers his/her name for the external exam for a semester will be eligible for promotion to the next semester.

23. PATTERN OF QUESTIONS

Questions shall be set to assess knowledge acquired, standard and application of knowledge, application of knowledge in new situations, critical evaluation of knowledge, and the ability to synthesize knowledge. The question setter shall ensure that questions covering all skills are set. She/he shall also upload a detailed scheme of answer type, short essay type/problem-solving type, and long essay type questions to be generated from the question bank. A question paper shall be a judicious mix of short answer type, short essay type /problem-solving type, and long essay type questions and to be generated from the question bank.

a) Pattern of questions for external examination for theory paper without practical.

Pattern	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Short Answer/ Problem type	10	10	1	10
Short Answer	12	8	2	16
Short essay/problem	9	6	4	24
Essay/problem	4	2	15	30
		Total		80

b) Pattern of questions for external examination for courses having both theory and practical components.

Pattern	Total no. of questions	Number of questions to be answered	Marks of each question	Total marks
Short Answer/ Problem type	8	8	1	8
Short Answer	10	6	2	12
Short essay/problem	6	4	4	16
Essay/problem	4	2	12	24
		Total		60

24. MARK CUM GRADE CARD

The College under its seal shall issue to the students a MARK CUM GRADE CARD on completion of each programme, which shall contain the following information:

a) Name of the College

b) Title & Model of the B.Voc. Programme

c) Name of the Semester

d) Name and Register Number of the student

e) Date of publication of result

f) Code, Title, Credits, and Maximum Marks (Internal, External & Total) of each course opted in the semester.

g) Internal, External and Total Marks awarded, Grade, Grade point, and Credit point in each course opted in the semester.

h) The total credits and total credit points in the semester.

i) Semester Credit Point Average (SCPA) and corresponding Grade.

j) Cumulative Credit Point Average (CCPA), CPA corresponding to General and skill Courses.

k) The final Mark cum Grade Card issued at the end of the final semester shall contain the details of all courses taken during the final semester examination and shall include the final Grade (SCPA) scored by the candidate from 1st to 5th semesters, and the overall Grade for the total programme.

25. RANK/POSITION CERTIFICATE

The college publishes a position list of the top 5 candidates for each programme after the publication of 6th-semester results. Position certificate shall be issued to candidates who secure positions from 1st to 3rd in the rank list. Candidates shall be ranked in the order of merit based on the CCPA scored by them. Grace marks awarded to the students should not be counted in fixing the rank/position. Rank certificate and position certificate shall be signed by the Controller of Examinations.

26. There shall be 3 level monitoring committees for the successful conduct of the programme. They are -

26.1 Department Level Monitoring Committee (DLMC), comprising the HOD and two senior-most teachers as members.

26.2 College Level Monitoring Committee (CLMC), comprising the Principal, Controller of Examinations, and A.O/Superintendent as members.

26.3 Governing body.

27 TRANSITORY PROVISION

Not with standing anything contained in these regulations, the Governing body shall, for one year from the date of coming into force of these regulations, have the power to provide by an order that these regulations shall be applied to any programme with such modifications as may be necessary.

27.1 The Governing body is authorized to make necessary criteria for eligibility for higher education in the grading scheme, if necessary. The Governing body is also authorized to issue orders for the perfect realization of the Regulations.

Annexure I: Model Mark Cum Grade Card

St. Albert's College (Autonomous)

Ernakulam-682 018, Kerala, India.

Accredited by National Assessment and Accreditation Council (NAAC)

at A Grade ISO 9001: 2015 Certified

Affiliated to Mahatma Gandhi University, Kottayam, Kerala

GRADE CARD

NAME OF THE CANDIDATE		**Student Photo**
PERMANENT REGISTER NUMBER (PRN):		
DEGREE		
PROGRAMME		
STREAM		
NAME OF THE EXAMINATION		
DATE OF ISSUE		

COURSE CODE	COURSE TITLE	MARKS							GP	GRADE	CGP	RESULT
			INTERNAL		EXTERNAL		TOTAL					
		CREDITS	AWARDED	MAXIMUM	AWARDED	MAXIMUM	AWARDED	MAXIMUM				
General Component												
Skill Component												
	TOTAL											
	SEMESTER RESULT	SCPA:							SG:			

Controller of Examinations Principal

Annexure II: Consolidated Model Mark cum Grade Card

St. Albert's College (Autonomous)

Ernakulam-682 018, Kerala, India.

Accredited by National Assessment and Accreditation Council
(NAAC) at A Grade ISO 9001: 2015 Certified

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CONSOLIDATED MARK CUM GRADE CARD

NAME OF THE CANDIDATE	
PERMANENT REGISTER NUMBER (PRN)	
DEGREE	
PROGRAMME	
STREAM	
DATE OF BIRTH	
DATE OF ELIGIBILITY	

Student Photo

		SEMESTER RESULTS					
SEMESTER	MARKS AWARDED	MAXIMUM MARKS	CREDITS	SCPA	GRADE	MONTH AND YEAR OF PASSING	RESULT
SEMESTER 1							
SEMESTER 2							
SEMESTER 3							
SEMESTER 4							
SEMESTER 5							
SEMESTER 6							
TOTAL							

	PROGRAMME PART RESULTS					
PROGRAMME PART	MARKS AWARDED	MAXIMUM MARKS	CREDIT POINTS	CREDITS	CCPA	GRADE
GENERAL COMPONENTS						
SKILL COMPONENTS						
TOTAL						

FINAL RESULT			
CREDITS	CCPA	GRADE	RESULT

COURSE CODE	COURSE TITLE	MARKS									RESULT
		CREDITS	AWARDED	INTERNAL MAXIMUM	AWARDED	EXTERNAL MAXIMUM	AWARDED	TOTAL MAXIMUM			
SEMESTER 1											
General Components											
Skill Components											
SEMESTER RESULT			SCPA:							SG:	
SEMESTER 2											
General Components											
Skill Components											
SEMESTER RESULT			SCPA:							SG:	
SEMESTER 3											
General Components											
Skill Components											
SEMESTER RESULT			SCPA:							SG:	
SEMESTER 4											
General Components											
Skill Components											
SEMESTER RESULT			SCPA:							SG:	
SEMESTER 5											
General Components											

Skill Components											
SEMESTER RESULT	SCPA:								SG:		
SEMESTER 6											
General Components											
Skill Components											
SEMESTER RESULT	SCPA:								SG:		

Controller of Examination Principal

Annexure III: Reverse side of the mark cum Grade Card (Common to all Semesters)

DESCRIPTION OF EVALUATION PROCESS

Grade and Grade Point

The evaluation of each course comprises Internal and External components with the ratio 1:4 for all courses. Grade and grade points are given on a 7-point scale based on the percentage of marks (internal + external) as given in table I. Decimals are corrected to next higher whole number.

Table I

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

Credit Point and Credit Point Average

Credit point (CP) of a course is calculated using the formula CP = C x GP Where C = Credit, GP = Grade Point

Credit Point average of a semester (SCPA) or Cumulative Credit Point Average (CCPA) for a programme is calculated using Total Credit point, TC = Total Credit

CCPA	Grade
Above 9	A + - Outstanding
Above 8 but «= 9	A – Excellent

Above 7 but <= 8	B - Very Good
Above 6 but <= 7	C – Good
Above 5 but <= 6	D – Satisfactory
Above 4 but <= 5	E – Adequate
<=4	F – Failure

Note: A separate minimum of 30 % marks each for internal and external (for both Theory and practical) and an aggregate minimum of 40 % is required for a pass in a course. To pass in a programme, a separate minimum of Grade E for all the individual courses and an overall grade E or above is mandatory. If a candidate secures Grade F for any of the courses offered in a semester or a programme only grade F will be awarded to that semester/Programme until the candidate improves this to Grade E or above within the permitted period.

Read By	
Verified By	

QR Code

Programme Design

SEMESTER 1

No.	Course code	Course Title	Course Category	Hours Per Week	Credits
1	ENG1CMT0119	English-I Fine Tune Your English	General Component	3	4
2	RMA1CMT0119	Mathematics-I	General Component	3	4
3	REG1CMT0119	Fundamentals of computer	General Component	3	4
4	RPH1CRT0119	Physics-I: Units and measurements, circuit theory and electrical fundamentals	Skill Component	4	5
5	REG1CRT0119	Renewable Energy-I : Fundamentals of sustainable energy & development	Skill Component	4	5
6	REG1CRP0119	General Physics Lab	Skill Component	4	4
7	REG1CRP0219	Computer Application Lab- MATLAB	Skill Component	4	4

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

SEMESTER 2

No.	Course Code	Course Title	Course Category	Hours/ Week	Credits
1	ENG2CMT0119	English-II: Issues That Matter	General Component	3	4
2	RMA2CMT0119	Mathematics-II	General Component	3	4
3	RPH2CMT0119	Physics-II : Basic electronics	General Component	3	4
4	REG2CRT0119	Renewable Energy-II : Physico-chemical processes for water and wastewater treatment	Skill Component	4	5
5	REG2CRT0219	Renewable Energy-III : Photovoltaic module installation	Skill Component	4	5
6	REG2CRP0119	Practical- Electronics & Photovoltaic module installation	Skill Component	4	4
7	REG2HOT0119	HOT	Skill Component	4	4

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

SEMESTER 3

No	Course Code	Course Title	Course Category	Hours per week	Credits
1	RCH3CMT0119	Chemistry-II: Physical Chemistry	General Component	4	60
2	RPH3CMT0119	Physics-III : Thermodynamics and Fluid Mechanics	General Component	4	60
3	REG3CMT0119	Renewable Energy-IV : Novel Energy Resources	General Component	4	60
4	REG3CRT0119	Renewable Energy-V : Solar Thermal Technology-I	Skill Component	5	75
5	REG3CRT0219	Renewable Energy-VI : Wind Energy	Skill Component	5	75
6	REG3CRP0119	Practical- Thermodynamics & Solar Thermal	Skill Component	4	60
7	REG3CRP0219	Practical- Fluid dynamics & Wind Energy	Skill Component	4	60

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

SEMESTER 4

No.	Course Code	Course Title	Course Category	Hours/Week	Credits
1	REG4CMT0119	Renewable Energy-VII : Solar Thermal Technology-II	General Component	3	4
2	REG4CMT0219	Material Science	General Component	3	4
3	REG4CMT0319	Environmental Education	General Component	3	4
4	REG4CRT0119	Renewable Energy-VIII : Solar Photovoltaic Energy Conversion-I	Skill Component	4	5
5	REG4CRT0219	Renewable Energy-IX : Energy Storage Systems	Skill Component	4	5
6	REG4CRP0119	Practical- Solar Photovoltaics & Energy Storage Systems	Skill Component	4	4
7	REG4OJT0119	OJT	Skill Component	4	4

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

SEMESTER 5

No.	Course Code	Course Title	Course Category	Hours/ Week	Credits
1	RPH5CMT0119	Physics-IV : Laser and optical Instrumentation	General Component	3	4
2	REG5CMT0119	Renewable Energy-X : Environment, Health and Safety in Industries	General Component	3	4
3	REG5CMT0219	Renewable Energy-XI: Project Management	General Component	3	4
4	REG5CRT0119	Renewable Energy-XII : Energy Conservation Techniques	Skill Component	4	5
5	REG5CRT0219	Renewable Energy-XIII : Solar Photovoltaic Energy Conversion-II or Solar Thermal Technology-III	Skill Component	4	5
6	REG5CRP0119	Practical-Advanced Solar Photovoltaic Lab	Skill Component	4	4
7	REG5CRP0219	Practical-Advanced Solar Thermal Lab-I	Skill Component	4	4

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

SEMESTER 6

No.	Course Code	Course Title	Course Category	Hours per Week	Credits
1	RPH6CMT0119	Physics-V : Spectroscopy and experimental techniques	General Component	3	4
2	RPH6CMT0219	Physics-VI : Power Electronics	General Component	3	4
3	REG6CMT0119	Renewable Energy-XIV: Fuel cell systems and hydrogen	General Component	3	4
4	REG6CRT0119	Renewable Energy-XV: Energy Management and Auditing	Skill Component	4	5
5	REG6CRP0119	Practical-Advanced Solar Thermal Lab-II	Skill Component	4	5
6	REG6CRP0219	Practical-Experimental Techniques & Power electronics	Skill Component	4	4
7	REG6CPR0119	Final Project Report and Viva	Skill Component	4	4

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

Detailed Syllabus: Semester I

General Component: Mathematics-I (RMA1CMT0119)

60 Hours **4 credits**

Course Outcomes

- Review different types and properties of sets, relations and functions
- Examine complex numbers, its operations and different forms.
- Correlate limits, continuity and differentiability of functions
- Representing statistical data diagrammatically and graphically
- Analyze statistical data using measures of central tendency

Module I: Sets and Functions **(15 Hours)**

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

Module II: Complex Numbers **(5Hours)**

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.

Module III: Limit, Continuity and Differentiability **(10 Hours)**

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.

Module IV: Statistical Methods of Analysis **(20 Hours)**

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.

References

- Set Theory and Related Topics, Lipchitz, Schaum Outline Series, 2009, 2nd Edition, Tata McGraw Hill Publishing Company, New Delhi
- Discrete Mathematics and its Applications, K. H. Rosen, 6th Edition, Tata Mc Graw Hill Publishing Company, New Delhi.
- Fundamentals of Complex Analysis, E. B. Staff and A. D. Snider, 2009, 3rd Edition, Pearson Education.
- Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 2.1 to 2.6 and 3.1 to 3.2)

General Component: Fundamentals of Computers (REG1CMT0119)

60 Hours **4 credits**

Course Outcomes

- Explain the basics of computer hardware and software
- Recalling the fundamental concepts of computers
- Illustrate and describe the basic tasks or operations in MS Word
- Illustrate and describe basic tasks or operations in MS Excel
- Illustrate and describe the basic tasks in MS PowerPoint

Module I: Exploring the Computer **(15 Hours)**

Computer –definition - Computer users - Computer for individual users - Computer for organizations - Computer in society –Components of Computer - input unit - output unit - storage unit CPU- ALU - control unit - registers - computer hardware –System software - Application software- Computer systems - Types of Computer systems- Micro, Mini, Mainframe and Super Computers - Analog, Digital and Hybrid Computers - Business andScientific Computer systems

Module II: Data Processing and Peripheral Devices **(15 Hours)**

Computer data - Information –Data Processing - Data Storage and Data retrieval capabilities – storage devices - primary memory - RAM, ROM, PROM, EPROM, cache memory - secondary memory - magnetic tape, hard disk, Compact disks - Importance of computers in business - Computer applications in various areas of business- Computer related jobs in business. Peripheral devices Input devices –keyboard, mouse, scanner - output devices –monitor - VDU, LCD, CRT - printers - Commonly used printers, High-quality printers, Thermal-wax printers, Dye sublimation printers, Plotters.

Module III: Understanding MS Office **(15 Hours)**

Word Processing Basics –Opening and closing Documents – Text Creation and manipulation - Formatting the Text - Table Manipulation- Using spread sheet – Elements of Spread Sheet - Manipulation of Cells - Formulas and Function

Module IV: Making Small Presentations **(15 Hours)**

Using PowerPoint - Creation of Presentation - Preparation of Slides - Inserting Word Table or An Excel Worksheet - Adding Clip Art Pictures - Presentation of Slides – Slide Show.

References

- Computer and Common Sense-Roger Hunt and John Shelley
- Using Micro Computers- Bright man and Dims dale
- Introduction to Computers-Alexis Leon and Mathews Leon
- Michael Miller, Absolute Beginner's guide to computer Basics, Fourth Edition, Pearson Education (2007)
- Peter Norton, Introduction to computers, Sixth Edition Tata McGraw Hill (2007)
- Manuals for MS DOS, MS Office, MS Windows, UNIX.
- Office 2000/2003 Complete, BPB Publication.
- Internet basic reference A to Z, by Falk B., BPB, Delhi
- Operating Systems by Stallings, PHI.

Skill Component: PHYSICS-I: Units and Measurements, Circuit Theory and Electrical Fundamentals (RPH1CRT0119)

75 hours **5 credits**

Course Outcomes

- Define the measurement system and demonstrate the ability to convert measurements
- Associate the concept of semiconductors with real world applications
- Analyze the working of basic electronic circuits and devices
- Apply semiconductor principles in optoelectronic devices
- Analyze the properties of various components of electric circuit

Module I **(25 Hours)**

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

Module II: Varying Currents **(15 Hours)**

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)

Module III: Alternating Currents & Circuit Theory **(20 Hours)**

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

Module IV **(15 Hours)**

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.

References

- Fundamentals of Physics; David Halliday& Robert Resnick; 2010; John Wiley & Sons
- Basic Electronics- Solid state; BL Thereja; 2005; S. Chand & Co.
- Instrumentation devices and systems, C. S Rangan, G. R. Sharma, V. S. V. Mani, Tata McGraw–Hill

Skill Component: Renewable Energy Fundamentals of Sustainable Energy & Development (REG1CRT0119)

75 hours **5 Credits**

Course Outcomes

- Summarize about the need of different renewable energy resources and to relate about the historical and latest developments.
- Analyze about the potential of solar energy and to discuss about the harvesting of solar energy
- Illustrate the various applications of solar energy
- Illustrate about the usable forms of biomass, biomass conversion technologies and biogas plants
- Associate about basic principles of wind energy conversion and various forms of sustainable energy resources.

Module I: Introduction to Energy Sources **(5 Hours)**

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

Module II: Solar Energy **(25 Hours)**

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.

Module III: Biomass and Biogas Energy **(25 Hours)**

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

Module IV: Wind Energy **(20 Hours)**

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

- Non-conventional energy sources; G.D. Rai; 2011; Fifth Edition, Khanna Publishers
- Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers
- Non-conventional energy sources; G.D.Rai; 2011; Fifth Edition, KhannaPublishers
- Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd
- Non-conventional energy sources; G.D. Rai; 2011; Fifth Edition, Khanna Publishers
- Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.
- Solar Thermal and Biomass Energy; G. Lorenzini, C. Biserni& G. Flacco; 2010; First Edition; WIT Press,UK.

Skill Component: **Practical: General Physics Lab (REG1CRP0119)**

60 hours **4 credits**

Course Outcomes

- Develop practical knowledge by applying the experimental methods to associate with the Physics theory.
- Analyze the role of direct observation in physics and also the coherence between theory and practical experiments
- Understand advanced measurement technology, usage of new instruments.
- Analyse the basic circuit diagrams and construct the electric circuit for taking measurements
- Develop scientific measurement skill and analysis and verification of observational data

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

Skill Component: **Practical: Computer Applications Lab - MATLAB (REG1CRP0219)**

60 hours **4 credits**

Course Outcomes

- Understand the main features of MATLAB program and enable to use in higher learning
- Interpret and visualize simple mathematical functions and operations there on graphing them using plots/display.
- Apply a variety of common numeric techniques to solve and visualize engineering-related computational problems.
- Analyze the program for correctness and determine/estimate/predict the output and verify it under simulation environment using MATLAB tools.
- Demonstrate the application of loop control statements in MATLAB program

  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.

1. 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.)
2. Plot a 2-D graph with axes , x= cos θ , y = sin θ ,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.
3. 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 $= \omega T$

1. Write a program to plot a bar graph to show the comparison of average temperature in cities: - Ernakulam, Palakkad, Kollam, for months from October to May.
2. 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,

c) using 'pie ' function.

1. Write a program to

a) Draw the stairs to plot, to show the function y= x^3, where -3 ≤ x≤3.

b) Draw the stem plot for the following data:

X= [0 1 2 3 4 56 7] Y = [3 -9 8 -7 5 3 13]

1. Plot a graph by dividing the figure window into four sub- windows and plot the followingfunctions:

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) Fort=0:π/60:5π ,plot cos(t) *v/s*t.

2. Write a program to find the largest of given 'n' numbers using for loop and if structure.

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

3. 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.

4. Write a program using while loop to reverse the digits of a number.

5. Write a program to add two given row vectors, with the following data:

[4 5 8] and [3456].

Detailed Syllabus: Semester II

General Component: Mathematics-II (RMA2CMT0119)

60 hours **4 credits**

Course Outcomes

- Determine the extreme values of functions using derivative tests
- Define functions having more than one variable.
- Determine partial derivatives of functions of several variable
- Determine rank and inverse of a matrix using elementary row transformations
- Apply different numerical methods to obtain approximate solutions to mathematical problems

Module I: Applications of Derivatives **(15 Hours)**

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

Module II: Partial Derivatives **(15 Hours)**

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

Module III: Theory of Matrices **(15 Hours)**

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

Module IV: Numerical Analysis **(15 Hours)**

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

References

- Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 4.1 to 4.3)
- Thomas' Calculus, George B. Thomas Jr., 2008, 11th Edition, Pearson. (Sections 14.3 to 14.4)
- Matrices: Schaum's Outline Series, Frank Ayres Jr., TMHEdition.
- A Text Book of Matrices, Shanthi Narayanan and P. K. Mittal, S. Chand Publications.

- Matrix Theory, David W. Lewis, Allied Publications.
- Introductory Methods of Numerical Analysis, S. S. Sastry, 4th Edition, PHI (Sections 2.2 to 2.5)

General Component: Physics-II: Basic Electronics (RPH2CMT0119)

60 Hours **4 Credits**

Course outcomes

- Recall the basics of electronics
- Discuss the fundamentals of semiconductors
- Illustrate the basics of semiconductor diode and transistors
- Discuss the fundamentals of Opto-electronic devices
- Understand the ways of classification of photodetectors and its efficiency parameters

Module I **(10 Hours)**

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 II **(15 Hours)**

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- p n junction – current flow in forward biased pn junction– VI characteristics of p n 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 III **(20 Hours)**

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 voltagestabilizer.

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 IV **(15 Hours)**

Opto-electronic devices

Radiation Sources- LED - Principle - characteristics (V-I and light-current) applications, advantages Photo-detectors: Introduction – classification of detectors – qualitative idea of each type – Photo-diode, phototransistor, PIN photodiode- opto-isolators, APD

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

Reference

- Optoelectronic Engineering, S.N. Biswass, Dhanpat Rai Publications
- Photonics Elements and Devices, V. V. Rampal , Wheeler Publishing Co
- Semiconductor optoelectronic devices – PallabBhattacharya

Additional Reading

1. Basic Electronics-B.L.Theraja: S.ChandCo.
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 Opto electronis, 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

Skill Component: Renewable Energy-II: Physico-Chemical Processes For Water and Wastewater Treatment (REG2CRT0119)

75 Hours **5 Credits**

Course Outcomes

- Explain how and why the physical, chemical and biological parameters of water vary
- Organize the types of sedimentation and disinfection
- Classify the filtration techniques
- Design various methods for water treatment process
- Significance of wastewater treatment and filtration methods

Module I **(22 Hours)**

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 II **(23 Hours)**

Sedimentation and Disinfection

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

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

Reference

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

Module III **(18 Hours)**

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

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

Module IV **(12 Hours)**

Miscellaneous Methods

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

Reference

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

Skill Component: Renewable Energy-III: Photovoltaic Module Installation (REG2CRT0219)

75 Hours **5 Credits**

Course outcomes

- To identify various types of solar cells and PV modules and also the various parameters relating to it.
- To analyse and compare about different types of inverters and to examine various connection systems.
- To estimate the need for site surveys and to focus on the effect of shading analysis on PV modules.
- Illustrate the concepts of planning and sizing of grid connected photovoltaic systems.
- Familiarize the sizing and selection of cables, PV modules, AC/DC switches etc.

Module I **(15 Hours)**

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 II **(20 Hours)**

Inverters & Cables: PV array combiner/junction boxes, string diodes and fuses - Inverter single phase and three phase-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, MPPT, 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 III **(20 Hours)**

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 IV **(20 Hours)**

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, earthen/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.

Skill Component: Practical Electronics and Photovoltaic Module Installation (REG2CRP0119)

60 Hours **4 Credits**

Course outcomes

- Perform experiments to plot the V-I characteristics of electronic components
- Apply the electronic principles to calculate the efficiency and regulation of rectifiers.
- Familiarize with appropriate access equipment and basic roofing techniques for PV module installation
- Carry out measurement within PV modules and array
- Fault diagnosis on modules array

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 equipment 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

Detailed Syllabus: Semester III

General Component: Chemistry-II: Physical Chemistry (RCH3CMT0119)

60 Hours **4 Credits**

Course outcomes

- Interpret the chemical reaction rates
- Explain crystal systems, bonding in crystals and magnetic properties of solids
- Develop theoretical basis for photochemistry to handle photochemical instrumentations
- Discuss the basics of nuclear chemistry applications: nuclear power and carbon dating.
- Discuss the working of nuclear reactor and disposal of nuclear waste

Module I **(15 Hours)**

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

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

Module II **(18 Hours)**

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, Bravais 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

- Principles of Physical Chemistry, B. R. Puri, L. R. Sharma, M.S. Pathania, 2013, 46thedn. Chapter 31, Vishal Pub.Co.
- Introduction to Solids, L.V. Azaroff, 1984, McGrawHill,.

Module III **(12 Hours)**

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. Jablonski 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 chemiluminescence. Photosynthesis, photosystem– 1 and 2. Chemistry of Ru(bpy)2 complexes in charge transfer reactions.

Reference

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

Module IV **(15 Hours)**

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

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

General Component: Physics-III: Thermodynamics and Fluid mechanics (RPH3CMT0119)

60 Hours **4 Credits**

Course outcomes

- Interpret the laws of thermodynamics
- Apply the fundamentals of the three heat transfer modes in hands on experiments
- Identify the properties of fluids and fundamentals of fluid mechanics
- Evaluate the performance characteristic of fluid flow through pipes and orifice
- Understand Bernoulli's equation and its application

Module I **(10 Hours)**

Laws of thermodynamics: - First law of thermodynamics- second law of thermodynamics-Clausius and kelvin statement-thermodynamic processes-reversible and irreversible- Isothermal and adiabatic changes-Work done during adiabatic and isothermal expansion-Heat engine and efficiency-Carnot's cycle- efficiency- Difference between heat pump and refrigerator.

Reference

- Thermodynamics- Zeman sky and Ditt mann (Tata McGraw-Hill)
- Heat and Thermodynamics- Brijlal and Subrahmanyam (S. Chand&Co)

Module II **(15 Hours)**

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

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

Module III **(15 Hours)**

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 Poiseuille's method-determination of viscosity by Stokes method-Surface tension-Definitions, units and dimensions

Reference

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

Module IV **(20 Hours)**

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

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

General Component: Renewable Energy-IV: Novel Renewable Energy Sources (REG3CMT0119)

60 Hours **4 Credits**

Course outcomes

- Explain the field applications of hydrogen energy
- Identify the need of energy conversion and the various methods of energy storage
- Explain Geothermal & Ocean energy, its mechanism of production and its applications
- Illustrate the concepts of Direct Energy Conversion systems & their applications
- Understand magnetic and electric storage system

Module I **(15 Hours)**

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

Reference

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

Module II **(15 Hours)**

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

Reference

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

Module III **(15 Hours)**

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

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

Module IV **(15 Hours)**

Magneto hydrodynamic (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

Reference

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

Skill Component: Renewable Energy-V: Solar Thermal Technology-I (REG3CRT0119)

75 Hours **5 Credits**

Course Outcome

- Explain the principles that underlie the ability of various natural phenomena to deliver solar energy.
- Evaluate and analyze the performance of solar collectors.
- Analyze the working of various solar concentrators.
- Discuss the potential applications of solar thermal energy.
- Understand solar cooling of building and solar thermal energy

Module I **(15 Hours)**

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 II **(20 Hours)**

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 III **(20 Hours)**

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 IV **(20 Hours)**

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.

Skill Component: Renewable Energy-VI: Wind energy (REG3CRT0219)

75 Hours **5 Credits**

Course outcomes

- Evaluate different wind energy policy environments and analyze and critique the relative merits of alternative policy scenarios
- Analyze key wind farm planning studies and explain the implications of the studies for wind farm development
- Understand the wind energy systems and design tradeoffs for the large components
- Identify problems and potential solutions associated with integrating high wind penetrations into the electric grid
- Understand the factors influencing wind energy economics and site specific parameters

Module I **(30 Hours)**

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 Satyajit; 2006; Springer

Module II **(15 Hours)**

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 III **(20 Hours)**

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 IV **(10 Hours)**

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-Hill2011

Skill Component: Practical-Thermodynamics and Solar Thermal (REG3CRP0119)

60 Hours **4 Credits**

Course outcomes

- Experimental investigations of solar thermal systems and understand the implications of the results.
- Estimate the system efficiency and heat loss of a flat plate collector.
- To study the effect of change in parameters such as wind speed, irradiation and ambient temperature
- To understand and compare the pressure in various tubes with design values
- Understand the behaviour of flat plate collector with variation in radiation level and water temperature

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 thermo symphonic mode of flow with fixed input parameters
11. Evaluation of different parameters of Flat-Plate Collector in thermo symphonic mode of flow with different radiation level
12. Evaluation of different parameters of Flat-Plate Collector in thermo symphonic mode of flow with different inlet water temperature.

Skill Component: Practical: Fluid Dynamics and Wind Energy (REG3CRP0219)

60 Hours **4 Credits**

Course outcomes

- Develop practical knowledge by applying the experimental methods to associate with fluid dynamics and wind energy.
- Evaluate the role of direct observation in wind turbines and also the comparison between theory and practical experiments.
- Analyze the advanced measurement of wind energy with the aid of new instruments.
- Analyze the power output and its quality of wind energy systems
- Analyze the effect of load on power output and its quality

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

Detailed Syllabus: Semester IV

General Component: Renewable Energy-VII: Solar Thermal Technology-II (REG4CMT0119)

60 Hours **4 Credits**

Course outcomes

- Apply principles of heat and mass transfer to predict transfer coefficients.
- Analyzing and testing various flat plate collectors
- Evaluating the performance of evacuated tubular collectors
- Thermal analysis of solar systems
- Analyzing the economic aspects of solar system

Module I **(10 Hours)**

Heat Transfer: Concepts and Definitions

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

Reference

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

Module II **(20 Hours)**

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 III **(15 Hours)**

Evacuated solar collector

Introduction-Evacuated-TubeCover 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 IV **(15 Hours)**

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.

General Component: Material Science (REG4CMT0219)

60 Hours **4 Credits**

Course outcomes

- Describe the fundamentals of nanoscience and discuss the various properties and synthesis of nanoparticles.
- Describe the synthesis of nanoparticles and characterization methods
- Explain the actual working areas and applications of nanotechnology
- Discuss on the various classification of polymers.

Describe thin film technology and differentiate physical and chemical methods of thin film fabrication.

Module I **(18 Hours)**

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

- Nano: The Essentials, T. Pradeep, 2007, McGraw Hill Publishing Company, NewDelhi.
- Nanosciece and nanotechnology, V. S. Muraleedharan and A. Subramania, 2009, Ane Books Pvt. Ltd. NewDelhi.
- Nanotubes and Nanowires, C. N. R. Rao and A.Govindraj, 2005, Royal Society ofChemistry.
- Nanotechnology, R. Booker and , E. Boysen, 2008, Wiley India PvtLtd
- Nanoscale materials in chemistry, K. J. Klabunde, 2004, John Wiley andSons.

Module II **(15 Hours)**

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

- Nano: The Essentials, T. Pradeep, 2007, McGraw Hill Publishing Company, NewDelhi.
- Nanosciece and nanotechnology, V. S. Muraleedharan and A. Subramania, 2009, Ane Books Pvt. Ltd. NewDelhi.
- Nanotubes and Nanowires, C. N. R. Rao and A.Govindraj, 2005, Royal Society ofChemistry.
- Nanotechnology, R. Booker and , E. Boysen, 2008, Wiley India PvtLtd
- Nanoscale materials in chemistry, K. J. Klabunde, 2004, John Wiley andSons.
- Introduction to nanotechnology, C. P. Poole Jr and F J Owens, 2009, Wiley IndiaPvtLtd.
- Nanotechnology: Science, Innovation and Opportunity, L. E. Foster, 2008, PearsonEducation

Module III **(15 Hours)**

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

- Polymer Science, V. R. Gowariker, 2010, NewAgeInternational
- Text book of polymer science, Billmeyer F.W., 1994, Jr.John Wiley and Sons

Module IV **(12 Hours)**

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

- Thin film Phenomena; K L Chopra; 1969; McGrawHill.
- Handbook of Thin film technology; L. I. Meissel& R. Glang; 1970; McGrawHill.

General Component: Environmental Education (REG4CMT0319)

60 Hours **4 Credits**

Course outcomes

- To assess necessary scientific concepts while encountering environmental problems
- To prepare for employment and graduate studies in the analysis and mitigation of environmental problems
- Analyse the national and international level environment protection measures and environment management
- To appreciate the ethical, cross cultural and historical context of environmental issue and the links between human and natural systems
- To understand the environmental problems and ways to minimize them

Module I **(15 Hours)**

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

- Sharma, R. A. (2008). Environmental Education. Meerut: R.LallBooksDepot.
- Sharma, B. L., &Maheswari, B. K. (2008). Education for Environmental and Human value. Meerut: R.LallBooksDepot.
- Singh,Y. K. (2009). Teaching of environmental science. New Delhi: APH PublishingCorporation.
- Sharma, V. S. (2005). Environmental education. New Delhi: Anmolpublication.

- Reddy, P. K.,& Reddy, N. D. (2001). Environmental Education. Hyerabad: Neelkamalpublications.
- Kelu,P.(2000).Environmentaleducation:Aconceptualanalysis.Calicut:CalicutUniversity.
- Joy, P., & Neal, P. (1994). The handbook of environmental education: London, New FetterLane
- Sharma, R. G. (1986). Environmental Education. New Delhi : Metropolitan Book Co., Pvt.Ltd.

Module II **(15 Hours)**

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

- Harrison R.M. 1993. Pollution: Causes, Effects and Control. Royal Society ofChemistry.
- Marquata K. Hill. 1997. Understanding Environmental pollution. Cambridge UniversityPress.

Module III **(15 Hours)**

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

- Kumar, A. (2009). A text book of environmental science. New Delhi: APH PublishingCorporation.
- Singh,Y. K. (2009). Teaching of environmental science. New Delhi: APH

PublishingCorporation.

- Sharma, V. S. (2005). Environmental education. New Delhi: Anmol publication.
- Reddy, P. K.,& Reddy, N. D. (2001). Environmental Education. Hyderabad: Neelkamalpublications

Module IV **(15 Hours)**

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 Warming1997.

References

- Ian Paulford., Hugh Flowers., 2006. Environmental Chemistry at a Glance.Blackwell.
- Marquata K. Hill. 1997. Understanding Environmental pollution. Cambridge UniversityPress.
- Harrison R.M. 1993. Pollution: Causes, Effects and Control. Royal Society ofChemistry.
- Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management. Himalaya PublishingHouse

General Component: Renewable Energy-VIII: Solar Photovoltaic Energy Conversion-I (REG4CRT0119)

75 Hours **5 Credits**

Course outcomes

- Cite about the working of solar cell,various parameters and methods to maximise its performance.
- Analyse about different solar PV modules, its design and different type of connections.
- Analyse the quality of a solar module and identification of optimum location for installation
- Identification and the use of tools and equipment for solar PV installation
- Review the overall system inspection

Module I **(15 Hours)**

Solar Cell Fundamentals

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

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

Module II **(20 Hours)**

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

- Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall ofIndia.
- Solar Energy: Fundamentals and Applications; H. P. Garg& J. Prakash; 2000; TataMcGraw-Hill.
- Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley andSons.

Module III **(20 Hours)**

Identification and uses of tools and equipment used for solar PV installation- Assessment of quality of solar module- identify key technical parameter of solar module- identification of optimum location of installation- importance of accurate load and site assessment- design of standalone system- KSEB rules and regulations

Reference

- Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall ofIndia.
- Solar Energy: Fundamentals and Applications; H. P. Garg& J. Prakash; 2000; TataMcGraw-Hill.
- Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley andSons.

Module IV **(20 Hours)**

Overall system inspection-Testing of array-Wire and earthing continuity tests-Testing of charge controller-Testing of batteries- Battery capacity test- Battery fault detection – specific gravity observation - Start up the PVsystem-Unintentional Islanding - functionality tests

Reference

- Solar Photovoltaics: Fundamental, Technologies and Applications; C.S. Solanki; 2011; Prentice Hall ofIndia.
- Solar Energy: Fundamentals and Applications; H. P. Garg& J. Prakash; 2000; TataMcGraw-Hill.
- Handbook of Photovoltaic Science and Engineering; Antonio Luque, Steven Hegedus; 2003; John Wiley andSons.

Skill Component: Renewable Energy-IX: Energy Storage Systems (REG4CRT0219)

75 Hours **5 Credits**

Course outcomes

- Apply engineering fundamentals to design and implement electrical energy storage technologies such as hydrogen based systems and batteries to support sustainable energy solutions
- Evaluate electrical energy storage systems when used in conjunction with sustainable energy solutions
- Discuss the scientific principles underpinning the operations of energy storage systems
- Develop problem solving skills in energy storage engineering as a means of resolving intermittency of renewable energy sources such as solar and wind
- Analyse latent heat and thermal energy storage systems

Module I **(15 Hours)**

Energy Storage

Need of energy storage- Different modes of Energy Storage- Mechanical Energy Storage- Electrical Storage: Nickel Cadmium battery, Lead-acid battery- Chemical Storage- Electromagnetic energy storage- Thermal Energy Storage

Reference

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

Module II **(25 Hours)**

Electrochemical, electrical and magnetic energy storage systems

Primary & Secondary Batteries- Solid-State and Molten Solvent Batteries- Advanced Batteries- Types of batteries-C24 battery- Battery lifetime- selection of right battery for an application- Determination ofbattery size-instruments used for battery maintenance 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 III **(15 Hours)**

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 IV **(20 Hours)**

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; Springe

Skill Component: Practical- Solar Photovoltaic & Energy Storage Systems (REG4CRP0119)

60 Hours **4 Credits**

Course outcomes

- Practice PV systems electrical and mechanical design/integration and examine the system performance.
- Analyze the operation of relevant energy storage systems and usage of tools in the system evaluation.
- Understand advanced measurement technology, usage of new instruments
- Analysis of the working of PV system under various physical conditions
- Develop the skills for experimental design, analysis and numerical calculations of PV system

Temperature dependent conductivity of semiconductor

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

Detailed Syllabus: Semester V

General Component: Physics-IV: Lasers and Optical Instrumentation (RPH5CMT0119)

60 Hours **4 Credits**

Course outcomes

- Describe the requirements for a system to act as a laser
- Relate the structure and properties of lasers to this performance and intended applications
- Assess which laser would best meet the need for a particular industrial/ research task
- Develop an awareness of the safety responsibilities involved in working with lasers
- Analyse various fabrication techniques of optical glasses

Module I **(15 Hours)**

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-conductorlaser.

Reference

An introduction to lasers theory and applications; M N Avadhanulu; 2012; S.Chand&Co

Introduction to lasers and Applications; D.C. O'shea and W. R. Callen; 1978; AddisionWesley.

Module II **(15 Hours)**

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

An introduction to lasers theory and applications; M N Avadhanulu; 2012; S.Chand&Co

Introduction to lasers and Applications; D.C. O'shea and W. R. Callen; 1978; AddisionWesley.

Module III **(15 Hours)**

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 IV **(15 Hours)**

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, crystallinematerials.

Reference

Optics and optical instruments, Johnson, Dover.

General Component: Renewable Energy-X: Environment, Health and Safety in Industries (REG5CMT0119)

60 Hours **4 Credits**

Course outcomes

- To study and implement practical aspects of environmental protection and safety at work
- To make sure that their activities do not cause any harm to anyone
- To understand the different types of safety problems and their sustainable solutions
- Illustrate the health & safety concepts and objectives for the H&S work and how to behave safely during field work
- To understand the principles and methods of effective Training programmes

Module I **(17 Hours)**

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

Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management; Himalaya Publishing House.

Effective Environmental, Health, and Safety Management Using the Team Approach by Bill Taylor, Culinary and Hospitality Industry Publications Services2005

Kumar R. (Editor).,1997. Environmental pollution and health hazards in India. Ashish Publication.

Ghosh G.K., 1987. Environmental pollution: a scientific dimension. Ashish Publication.

Module II **(17 Hours)**

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

Jogdand S.N., 1995. Environmental biotechnology and industrial pollution management. Himalaya PublishingHouse.

Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY, 1995

Ian Paulford., Hugh Flowers., 2006. Environmental Chemistry at a Glance.Blackwell.

The Facility Manager's Guide to Environmental Health and Safety by BrianGallant

Module III **(16 Hours)**

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

Environmental and Health and Safety Management by Nicholas P. Cheremisinoff and Madelyn L. Graffia, William Andrew Inc. NY,1995

The Facility Manager's Guide to Environmental Health and Safety by Brian Gallant, Government Inst Publ.,2007.

Khitoliya R.K., 2004, Environmental pollution management and control for sustainable development. S. Chand publication.

Bhattiya S.C., 2003. Managing industrial pollution. McMillanIndiaLtd.

Trivedi R.K. (Editor). Pollution and Bio monitoring of Indian Rivers. ABDpublication.

Module IV **(10 Hours)**

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

Reddy, P. K.,& Reddy, N. D. (2001). Environmental Education. Hyerabad: Neelkamal publications.

Kelu, P. (2000). Environmental education: A conceptual analysis. Calicut: CalicutUniversity.

Agarwal, S.P. and Aggarwal, J.C. (1996) Environmental Protection, Education and Development. New Delhi: NewConcepts

General Component: Renewable Energy-XI: Project Management (REG5CMT0219)

60 Hours **4 Credits**

Course outcomes

- Explain the basics of project Management and its scope
- Describe and develop skills about project implementation and monitoring
- Describe about project team management, rules and organizations
- Discuss the termination of and inventory management of project
- Explaining Practical and Legal aspects of Project Team Management

Module I **(15 Hours)**

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

Project Management – for 21st Century-Bennet P Lientz, Kathryn Rea- Academic Press,1995

The Essentials of Project Management-Dennis Lock-Gower Publishing Ltd.,2014

Project management - David I Cleland - Mcgraw Hill International Edition,1999

Project Management-Harvey-Maylor-Pearson Publication,2009

Module II **(15 Hours)**

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

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

Module III **(15 Hours)**

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

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

Module IV **(15 Hours)**

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

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

Skill Component: Renewable Energy-XII: Energy Conservation Techniques (REG5CRT0119)

75 Hours **5 Credits**

Course outcomes

- List several ways to conserve energy
- Explain that energy in its various form that affect everyday objects and involved in everyday events
- Describe remedies/potential solutions to the supply environmental issues associated with fossil fuels and other energy resources
- Examine strategic and policy recommendations on energy conservation and energy auditing
- Familiarize Energy Efficient Building Techniques

Module I **(20 Hours)**

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

Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, NewDelhi

Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress

Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M.Dekker

Module II **(20 Hours)**

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 - HVACsystems

References

Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, NewDelhi

Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress

Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M.Dekker

Module III **(20 Hours)**

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

Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, NewDelhi

Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress

Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M.Dekker

Module IV **(15 Hours)**

Energy Conservation in Housing & Commercial Building

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

References

Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, NewDelhi

Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress

Industrial Energy Conservation; Melvin H. Chiogioji; 1979; M.Dekker

Additional Reading

www.bee-india.com

Energy Efficiency in Thermal Utilities, 2010, BEE guidebook

Energy Efficiency in Electrical Utilities, 2010, BEE guidebook

Skill Component: Renewable Energy-XIII Option-A: Solar Photovoltaic Energy Conversion-II (REG5CRT0219)

75 Hours **5 Credits**

Course outcomes

- Identify various parameters and design of solar cells
- Analyse different types of solar cells based on the method of fabrication
- Discuss about various processes in the purification of silicon
- Differentiate between types of Solar PV systems and calculation of Life cycle costing of a PV system
- Discuss the positive and negative aspects of solar energy in relation to natural and human aspects

Module I **(15 Hours)**

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

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

Module II **(20 Hours)**

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

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

Module III **(20 Hours)**

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

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

Option-B: Solar Thermal Technology-III

60 Hours **5 Credits**

Course outcomes

- Analyse the working of the solar thermal systems.
- Describe the economic concepts of solar thermal systems.
- Describe the process of solar system cooling process and design.
- Describe the concept of solar air systems and its components.
- Programming simulations of solar thermal systems.

Module I **(20 Hours)**

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 Yield 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

Reference

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

Module II **(20 Hours)**

Large-scale 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

Reference

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

Module III **(20 Hours)**

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

Reference

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

Module IV **(15 Hours)**

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

Reference

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

Skill Component: Practical - Advanced Solar Photovoltaic Lab (REG5CRP0119)

60 Hours **4 Credits**

Course outcomes

- Collect basic knowledge in solar photo voltaic system operations
- Analyze photovoltaic system performance and design.
- Understand advanced measurement technology, usage of new instruments.
- Analyze the relationship between current and voltage at various cell characteristics
- Understand the relationship between current and voltage for various module combination

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.

Skill Component: Practical-Advanced Solar Thermal Lab-I (REG5CRP0219)

60 Hours **4 Credits**

Course outcomes

- Experimental investigations of solar thermal systems and understand the implications of the results.
- Estimate the system efficiency and heat loss of a parabolic trough solar concentrator.
- To study the effect of change in parameters such as wind speed, irradiation and ambient temperature
- To understand and compare the pressure in various tubes with design values
- To determine performance of collector with various parameters

1. Evaluation of different parameters of Flat-Plate Collector in thermos phonic 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.

Detailed Syllabus: Semester VI

General Component: Physics-V: Spectroscopy and Experimental Techniques (RPH6CMT0119)

60 Hours **4 Credits**

Course outcomes

- Discuss the basic elements of spectroscopy
- Identify various spectroscopic techniques
- Discover the recent advances in vacuum science and applications
- Organize the knowledge towards recent advances in spectroscopy
- Apply the spectroscopic techniques in renewable energy production area

Module I **(15 Hours)**

Spectroscopy, Basic elements of practical spectroscopy- Regions of spectrum- 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 II **(15 Hours)**

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-Inter science

Module III **(15 Hours)**

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 IV (15 Hours)

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-Inter science

General Component: Physics-VI: Power Electronics (RPH6CMT0219)

60 Hours **4 Credits**

Course outcomes

- Recall types of FET, its use and applications
- Analyze the construction and operation of Thyristors, SCR, DIAC, TRIAC
- Describe the purpose and operation of UJT and SCS
- Discuss the operation and characteristics of controlled rectifiers
- Apply the theory and operating principles in conversion and control of electric power from renewable energy sources

Module I **(15 Hours)**

Field-Effect Transistors (FET)-Types of FET -MOSFETs- Types-Depletion type-Enhancement type-IGBT-Power quality- Filter- PWM-Dead Band-Drive microcontroller

Reference

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

Module II **(15 Hours)**

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 III **(15 Hours)**

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 IV **(15 Hours)**

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.

General Component: Renewable Energy-XIV: Fuel Cell Systems and Hydrogen (REG6CMT0119)

60 Hours **4 Credits**

Course outcomes

- Explain the basics of fuel cells
- Discuss the various types of fuel cells
- Illustrate the properties of hydrogen and its production
- Describe the storage and various application of hydrogen
- Apply the different hydrogen production and storage techniques from renewable energy sources while reducing operating and capital costs.

Module I **(10 Hours)**

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

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

Module II **(15 Hours)**

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

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

Module III (15 Hours)

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 ofwater.

References

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

Module IV (10 Hours)

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

References

- Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press,UK.
- Hydrogen Energy: Challenges and Prospects; David Anthony James Rand and Ronald Dell;2008;

Skill Component: Renewable Energy-XV: Energy Management and Auditing (REG6CRT0119)

75 Hours **5 Credits**

Course outcomes

- Understand the Indian energy scenario, energy policies, pricing and reforms
- Understand the importance of implementing energy audits as part of energy efficiency and conservation exercise
- Develop a platform for the implementation of energy saving measures based on the energy audit report outcome
- Analyze the quality of measuring instruments
- Explain the implementation of energy saving measures based on the energy audit report outcome

Module I **(15 Hours)**

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

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

Module II **(20 Hours)**

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 to requirement Maximizing System - Fuel & energy Substitution.

Reference

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

Module III **(20 Hours)**

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

- Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress
- General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

Module IV **(20 Hours)**

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

- Energy Management Handbook; Wayne C. Turner; 2001; FairmontPress
- General Aspects of Energy Management & Energy Audit, Bureau of Energy Efficiency

Skill Component: Practical-Advanced Solar thermal Lab-II (REG6CRP0119)

60 Hours **4 Credits**

Course outcomes

- Experimental investigations of solar thermal systems and understand the implications of the results.
- Estimate the charging period and discharging period of heat transfer fluid.
- To study the performance analysis of paraffin wax based latent heat thermal energy storage systems with different heat exchangers
- To do the performance analysis of a Fatty acid based thermal energy storage system with different insulating materials: an experimental study
- To collaborate with industry and research field

List of Experiments

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

General Component: Practical – Experimental Techniques and Power Electronics

(REG6CRP0219)

60 Hours **4 Credits**

Course outcomes

- Develop power semiconductor circuits to electrical power system.
- Examine firing circuit for Thyristors.
- Develop power semiconductor circuits to electrical power system.
- Analyze the operation of converters.
- Describe the control in grid connected renewable energy systems

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.

Gist of Changes

Gist of Changes proposed in the syllabus of B.Voc. RENEWABLE ENERGY from 2019 admission onwards-

SEMESTER	CHANGES	
I	Thermodynamics and Electrochemistry (THEORY) Module I – Thermodynamics Module II - Electrochemistry Module III–Electromotive Force Module IV – Electro analytical methods	FUNDAMENTALS OF COMPUTER (THEORY) **Module I**: Exploring the computer Computer –definition - Computer users - Computer for individual users - Computer for organizations - Computer in society – Components of Computer - input unit - output unit - storage unit CPU- ALU - control unit - registers - computer hardware –System software - Application software- Computer systems - Types of Computer systems- Micro, Mini, Mainframe and Super Computers - Analog, Digital and Hybrid Computers - Business and Scientific Computer systems **Module II** : Data processing and peripheral devices Computer data - Information –Data Processing - Data Storage and Data retrieval capabilities –storage devices - primary memory - RAM, ROM, PROM, EPROM, cache memory - secondary memory - magnetic tape, hard disk, Compact disks - Importance of computers in business - Computer applications in various areas of business- Computer related jobs in business. Module IV

		Peripheral devices (10 Hrs) Input devices – keyboard, mouse, scanner - output devices – monitor - VDU, LCD, CRT - printers - Commonly used printers, High-quality printers, Thermal-wax printers, Dye sublimation printers, Plotters. **Module III:** Understanding MS office Word Processing Basics –Opening and closing Documents – Text Creation and manipulation - Formatting the Text - Table Manipulation- Using spread sheet – Elements of Spread Sheet - Manipulation of Cells - Formulas and Function Module IV: Making small presentations Using PowerPoint - Creation of Presentation - Preparation of Slides - Inserting Word Table or An Excel Worksheet - Adding Clip Art Pictures - Presentation of Slides – Slide Show References 1. Computer and Common Sense-Roger Hunt and John Shelley 2. Using Micro Computers- Bright man and Dims dale 3. Introduction to Computers-Alexis Leon and

		Mathews Leon 4. Michael Miller, Absolute Beginner's guide to computer Basics, Fourth Edition, Pearson Education (2007) 5. Peter Norton, Introduction to computers, Sixth Edition Tata McGraw Hill (2007) 6. Manuals for MS DOS, MS Office, MS Windows, UNIX. 7. Office 2000/2003 Complete, BPB Publication. 8. Internet basic reference A to Z, by Falk B., BPB, Delhi 9. Operating Systems by Stallings, PHI.

II	RENEWABLE ENERGY- III : Photovoltaic Module Installation (THEORY) Module I Solar Cells and PV modules Module II: Inverters and Cables Module III: Site Surveys and Shading Analyses Module IV: Planning and Sizing Grid-Connected Photovoltaic Systems	RENEWABLE ENERGY- III : Photovoltaic Module Installation (THEORY) **Module II** - Inverter single phase and three phase, MPPT (ADDITIONS)
IV	RENEWABLE ENERGY-VIII : Solar Photovoltaic Energy Conversion (THEORY) Module I- Solar Cell Fundamentals Module II - Solar Cell characteristics Module III - Classification of Solar Cells Module IV – Solar photovoltaic (PV) module, panel and array construction	RENEWABLE ENERGY-VIII : Solar Photovoltaic Energy Conversion (THEORY) Module II - Solar photovoltaic (PV) module, panel and array construction **Module III** - Identification and uses of tools and equipment used for solar PV installation **Module IV** – Overall system

		inspection
IV	RENEWABLE ENERGY-IX : Energy Storage Systems (THEORY) Module I- Energy Storage Module II - Electrochemical, electrical and magnetic energy storage systems Module III - Sensible heat storage (SHS) Module IV - Latent Heat Thermal Energy Storage (LHTES)	RENEWABLE ENERGY-IX : Energy Storage Systems (THEORY) Module I - Nickel Cadmium battery, Lead-acid battery (ADDITIONS)_ Module II - Types of batteries-C_{24} battery- Battery lifetime- selection of right battery for an application- Determination of battery size- testing of batteries- battery capacity test- battery fault detection-instruments used for battery maintenance (ADDITIONS)
VI	PHYSICS-V : Spectroscopy and Experimental Techniques Module I- Spectroscopy Module II - Spectroscopic techniques Module III - Vacuum Techniques	PHYSICS-V : Spectroscopy and Experimental Techniques Module I - Basic elements of practical spectroscopy- Regions of spectrum (ADDITIONS)

	Module IV – Qualitative ideas of spectroscopy	
	PHYSICS-VI: Power Electronics Module I - Field-Effect Transistors (FET) Module II - Thyristors, SCR, DIAC, TRIAC Module III - UJT and SCS Module IV - Controlled Rectifiers	PHYSICS-VI: Power Electronics Module I - IGBT-Power quality-Filter-PWM-DeadBand-Drive microcontroller (ADDITIONS)