ST. ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM

Affiliated to Mahatma Gandhi University, Kottayam

SYLLABUS FOR UNDERGRADUATE VOCATIONAL PROGRAMMES

FACULTY OF SCIENCE

EXPERT COMMITTEE FOR CORE INDUSTRIAL AND INFRASTRUCTURE SKILLS

B.VOC. (Honours) RENEWABLE ENERGY

SACA- B. VOC. (HONOURS)

(With effect from 2025 Admission)

Syllabus of B. Voc. (Honours) Renewable Energy

Prepared by the Board of Studies on 27th June 2025

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PREFACE

The University Grants Commission (UGC) has established guidelines in par with the rapidly changing demands of the 21st-century workforce that require higher education institutions to align academic programs with industry needs. In this context, the introduction of the **Four-Year Undergraduate Programme (FYUGP)** across universities from the 2024-2025 academic year presents a significant opportunity for integrating skill development into mainstream higher education. Institutions offering **Bachelor of Vocation (B.Voc.) degrees** must restructure their curriculum and credit structures to align with the multidisciplinary and flexible learning pathways emphasized in the FYUGP. This transition will allow B.Voc. Programs to remain relevant, industry-oriented, and seamlessly integrated into the broader academic framework.

To meet these objectives, the **vocational curriculum** needs to follow the FYUGP credit pattern while maintaining balanced integration of general education and skill education components. The skill components of the B.Voc. Programs will adhere to the **National Skills Qualification Framework (NSQF)** guidelines. These components will be aligned with proper **Qualification Packs (QPs)** and **National Occupation Standards (NOS)**, ensuring relevance and adherence to national standards. Certification will progress cumulatively from **NSQF Level 4.5** to **Level 6.0**, reflecting students' skill acquisition over the course of their studies. In the new Curriculum and Credit Framework for Undergraduate Programmes by UGC, undergraduate B.Voc (Honours) degrees can now be structured as either three-year or four-year programmes with multiple exit options. This framework aligns with the *National Credit Framework (NCrF)*, offering greater flexibility in academic progression and certification.

The certification levels are follows:

1st year – UG Certificate – 48 + an additional 4 credits [NHEQF Level – 4.5]

2nd year – UG Diploma – 96 + an additional 4 credits [NHEQF Level – 5.0]

3rd year B. Voc. Degree with minor –credits 140 up to 180 [NHEQF Level – 5.5]

4th year B. Voc. (Honours) Degree with minor –credits 180 up to 240 [NHEQF Level – 6.0]

4th year B. Voc. (Honours with research) Degree –credits 180 up to 240 [NHEQF Level – 6.0]

In the B. Voc. (Honours) Renewable Energy programme, Each academic year integrates both GEC and SDC to ensure a balanced learning experience. SDC accounts for a minimum of 60%and a maximum of 70% of the total credits, while GEC comprises the remaining portion. Students can earn **140 credits** over three years and graduate with a **B.Voc degree**. Alternatively, they can continue into a fourth year, completing an **apprenticeship, internship, or work-integrated honours programme**, earning an additional **40 credits**. This brings the total to **180 credits**, allowing them to exit with an **Honours degree**. B.Voc students must earn 54 credits from the General Education Components (GEC). GEC comprises two sub-components: (A) Foundation Components and (B) Minor Pathway Components. These components align with the FYUG program structure of respective universities.

B.Voc students are required to earn 36 credits from the General Foundation Courses of the FYUG degree program. These courses include Ability Enhancement Courses (AEC), Value-Added Courses (VAC), Skill Enhancement Courses, and Multidisciplinary Courses, aligning with the FYUGP framework. Students must complete three AECs (9 credits), with two mandatory English courses and one elective, which may be in English or another language. Skill Enhancement courses (SEC) are designed to include modules on Employability Skills, Soft Skills, and Life Skills, with specific modules to enhance employability.

GEC (AEC, MDC, VAC, SEC) - 3 credits x 12 courses= **36 credits**

Minor Courses: 6 courses= 24 Credits for **3-year B.Voc**

Minor Courses: 9 courses=36 Credits for credits for **4-year B.Voc**

SDC: 17 major courses + Project =68 + 4 Credits for **3-year B.Voc**

SDC: 17 major courses + Project =68 + 4 Credits + *28 credits (for honors in the 4th year)* or *20 credits(for honors with research in the 4th year) + 8 credits (from SDC online in the 4th year)* for **4-year B.Voc**

The B. Voc. (Honours) Renewable Energy programme is enriched with 2 week's OJT in the first 3 semesters, a summer internship at the end of the 4th semester and a project in the 6th semester. The reports of the same have to be submitted to the department soon after the training for the specific evaluation. The B. Voc. (Honours) Renewable Energy syllabus is upgraded with the recent changes and trends in the field of renewable energy. The curriculum enforces industry collaborations through OJTs, internships, projects and other training events.

In the present B. Voc. (Honours) Renewable Energy programme, an academic year contains 2 semesters (200 working days). One semester contains a minimum of 90 working days (18 weeks with 5 working days/week) including ESE & CCA. Students can opt for a change of major to their respective minor or MDC attended the first year. Total duration of the programme shall not exceed 7 years. MGU B.Voc academic committee, MGU B. Voc. Department committee, CSDCCP has to be properly constituted and maintained by the institution. The key aspects of the B. Voc. (Honours) programmes in Renewable Energy are different programme pathways with each year exit, signature courses, programme/course specific evaluation methods and outcome based approach.

Chairman

Board of Studies

THE ST.ALBERT'S COLLEGE (AUTONOMOUS) VOCATIONAL UNDERGRADUATE PROGRAMMES (HONOURS) REGULATIONS, 2025 SACA- B.VOC (HONOURS)

PREAMBLE

The University Grants Commission (UGC) has issued the Curriculum and Credit Framework for Vocational Undergraduate Programmes 2025 (CCFUP) which would provide a flexible choice-based credit system, multidisciplinary approach, multiple entry and exit options, and establish three Broad Pathways, (a) 3-year UG Degree, (b) 4-year UG Degree (Honours), and 4-year UG Degree (Honours with Research).

The Kerala Higher Education Reforms Commission has recommended a comprehensive reform in the Vocational undergraduate curriculum for the 2025-26 academic year, adopting 4-year Vocational undergraduate programmes to bring Kerala's Vocational undergraduate education at par with well acclaimed universities across the globe.

The Kerala State Curriculum Committee for Higher Education has been constituted and has proposed a model Kerala State Higher Education Curriculum Framework (KSHECF) for Vocational Undergraduate Education. Further, an Executive Committee and various sub committees were constituted for the implementation of the Regulations. Further, MGU has framed the Rules and Regulations based on this namely: THE MAHATMA GANDHI UNIVERSITY UNDERGRADUATE VOCATIONAL PROGRAMMES (HONOURS) REGULATIONS, 2025 {MGU-B.VOC (Honours)} under the New Curriculum and Credit Framework, 2025. Being an Autonomous College affiliated to MG University, St. Albert's College (Autonomous), Ernakulam is adopting all the major components of MGU B.VOC (HONOURS) 2025 in the title SACA-B.VOC (HONOURS) 2025 to our Vocational UG curriculum from the academic year (2025-26) onwards.

REGULATIONS

1. Short Title and Commencement

i) These Regulations will be called as 'THE ST.ALBERT'S COLLEGE (AUTONOMOUS) UNDERGRADUATE VOCATIONAL PROGRAMMES (HONOURS) REGULATIONS, 2025 {SACA-B.VOC. (HONOURS) 2025} under the New Curriculum and Credit Framework for B.Voc. Programmes by Kerala State Higher Education Council, 2025.

ii) These Regulations will come into effect from the academic year 2025-2026 and will have prospective effects.

2. Scope, Application

i) These Regulations shall apply to all Undergraduate Vocational Programmes under various faculties conducted by ST.ALBERT'S COLLEGE (AUTONOMOUS), ERNAKULAM and its affiliated institutions for the admissions commencing in the academic year 2025-2026.

ii) Every programme conducted under the SACA-B.Voc. (Honours) shall be monitored by SACA-B.Voc.(Honours) Academic Committee (Academic Council) comprising members nominated by the College Governing Body and by the University.

3. Definitions

i) FYUGP means Four Year UnderGraduate Programme.

ii) Academic Year: Two consecutive (one odd and one even) semester followed by a vacation in one academic year.

iii) Academic Coordinator/Nodal Officer: Academic Coordinator/Nodal Officer is a senior faculty/expert in the field nominated by the college council to coordinate the effective conduct of the SACA - B.Voc.(Honours) including Continuous Comprehensive Assessment (CCA) undertaken by various departments within the college. She/ he/ they shall be the convenor for the College level Academic Committee.

iv) Academic Week: A unit of five working days in which the distribution of work is organized, with five contact hours of one-hour duration on each day.

v) Academic Credit: A unit by which the course work is measured. It determines the number of hours of instructions required per week in a semester. It is defined both in terms of student efforts and teacher's efforts. A course which includes one hour of lecture or minimum 2 hours of lab work/ practical work/practicum/ hands-on skill training/field work per week is given one credit hour. Accordingly, one credit is equivalent to one hour of lecture or two hours of lab work /practical work/hands-on skill training/ field work/ practicum and learner engagement in terms of course related activities (such as seminars preparation, submitting assignments, group discussion, recognized club-related activities etc.) per week. Generally, a one credit course in a semester should be designed for 15 hours lectures or 30 hours of practical/ field work/ practicum/ hands-on skill training and 30 hours learner engagement. A two credit On the Job Training (OJT) in a semester should be designed for 5 hours per week. One credit of Apprenticeship/Research Internship is equivalent to 10 days.

vi) Academic Bank of Credits (ABC): An academic service mechanism as a digital/ virtual entity established and managed by Government of India to facilitate the learner to become its academic account holders and facilitating seamless learner mobility, between or within degree-granting Higher Education Institutions (HEIs) through a formal system of credit recognition, credit accumulation, credit transfers and credit redemption to promote distributed and flexible process of teaching and learning. This will facilitate the learner to choose their own learning path to attain a Degree/ Diploma/ Certificate, working on the principle of multiple entry and exit, keeping to the doctrine of anytime, anywhere, and any level of learning.

vii) Credit Accumulation: The facility created by ABC in the Academic Credit Bank Account (ABA) opened by the learner across the country in order to transfer and consolidate the credits earned by them by undergoing courses in any of the eligible HEIs.

viii) Credit Recognition: The credits earned through eligible/partnering HEIs and transferred directly to the ABC by the HEIs concerned.

ix) Credit Redemption: The process of commuting the accrued credits in the ABC of the learner for the purpose of fulfilling the credits requirements for the award of various degrees. Total credits necessary to fulfill the criteria to get a degree shall be debited and deleted from the account concerned upon collecting a degree by the learner.

x) Credit Transfer: The mechanism by which the eligible HEIs registered with ABC are able to receive or provide prescribed credits to individual's registered with ABA in adherence to the UGC credit norms for the course(s) registered by the learner in any HEIs within India.

xi) Credit Cap: Maximum number of credits that a student can take per semester, which is restricted to 30.

xii) Continuous Comprehensive Assessment (CCA): The mechanism of evaluating the learner by the course faculty at the institutional level.

xiii) End Semester Evaluation (ESE): The mechanism of evaluating the learner at the end of each semester.

xiv) Audit Course: A course that the learner can register without earning credits, and is not mandatory for completing the SACA -B.Voc.(Honours). The student has the option not to take part in the CCA and ESE of the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is eligible for a pass in that course, without any credit (zero-credit).

xv) Courses: refer to the papers which are taught and evaluated within a programme, which include lectures, laboratory work, studio activity, field work, project work, vocational training, viva, seminars, term papers, presentations, assignments, self-study, group discussion, internship, etc., or a combination of some of these elements.

xvi) Choice Based Credit System (CBCS) means the system wherein students have the option to select courses from the prescribed list of courses.

xvii) College-level Academic Committee: Is a committee constituted for the SACA -B.Voc. (Honours) at the college level comprising the Principal as the Chairperson, the Academic Co- ordinator/ Nodal Officer as its convenor.

xviii) Course Faculty: A faculty member nominated by the Head of the Department shall be in charge of offering a particular course in a particular semester of SACA-B.Voc.(Honours).

xix) CSDCCP means Centre for Skill Development Courses and Career Planning (CSDCCP).

xx) Department means any teaching department in a college offering a course of study approved by the University as per the Statutes and the Act of the University and it includes a Department, Centre, or School of Teaching and Research conducted directly by the University.

xxi) Senior Faculty Advisor (SFA) is a faculty nominated by a Department Council to coordinate all the necessary work related to SACA-B.Voc.(Honours) undertaken in that department, including the continuous comprehensive assessment.

xxii) Department Council means the body of all teachers of a department in a college.

xxiii) Faculty Advisor (FA) means a teacher from the parent department nominated by the Department Council to advise students in academic matters.

xxiv) Graduate Attributes means the qualities and characteristics to be obtained by the graduates of a programme of study at the University or the Higher Education Institution, which include the learning outcomes related to the disciplinary areas in the chosen field of learning and generic learning outcomes. University will specify graduate attributes for its programmes.

xxv) Job Role: It refers to specific occupation or position within an industry, defined by a set of competencies, knowledge, and skills required to perform tasks effectively. Each job role is aligned with a particular NHEQF level.

xxvi) National Occupational Standards (NOS): National Occupational Standards (NOS) specify the standard of performance that a person must meet when performing a job along with the skills and knowledge required to satisfy a standard consistently. These standards can form the benchmarks for various education and training programs to match with the job requirements.

xxvii) NHEQF means National Higher Education Qualification Framework

xxviii) Programme means the entire duration of the educational process including the evaluation leading to the award of a degree.

xxix) Programme Pathway: Combination of courses that can be chosen by a student that give options to pursue interesting and unconventional combinations of courses drawn from different disciplinary areas, such as sciences, social sciences, humanities, and a wide range of vocational fields including information technology, tourism, logistics, agriculture, fashion technology etc. The pathways could be in terms of major- minor options with different complementary/ allied disciplines.

xxx) Qualification Pack (QP): A Qualification Pack (QP) is a set of NOS aligned to a job role. A QP is available for every job role in each industry sector.

xxxi) Regulatory Body: Regulatory Body means University Grants Commission (UGC), All India Council for Technical Education (AICTE), National Council for Teacher Education (NCTE), Medical Council of India (MCI), Pharmacy Council of India (PCI), Indian Council for Agricultural Research (ICAR), Bar Council of India, Council of Architecture, National Assessment and Accreditation Council (NAAC), National Board of Accreditation (NBA), National Council for Vocational Education and Training (NCVET), National Skill Development Corporation (NSDC) etc.

xxxii) Sector Skill Council (SSC): The NOSs and QPs for each job role corresponding to each level of the NSQF are being formulated by the respective Sector Skill Councils (SSCs) set up by NSDC with industry leadership.

xxxiii) Signature Courses: Signature courses are specialized courses classified under Skill Development Component Elective (SDCE) Courses, Skill Enhancement Courses (SEC) or Value Addition Courses (VAC) designed and offered by the regular/ ad hoc/ visiting/ emeritus/ adjunct faculty member of a particular college with the prior recommendation of the BoS and the approval of Academic Council of the University/ Institute.

xxxiv) Letter Grade or simply 'Grade' in a course is a letter symbol (O, A+, A, B+, B, C, P, F, and Ab). Grade shall mean the prescribed alphabetical grade awarded to a student based on their performance in various examinations. The Letter grade that corresponds to a range of CGPA.

xxxv) Grade Point: Each letter grade is assigned a 'Grade point' (G) which is an integer indicating the numerical equivalent of the broad level of performance of a student in each course. Grade Point means point given to a letter grade on a 10- point scale.

xxxvi) Semester Grade Point Average (SGPA) is the value obtained by dividing the sum of credit points obtained by a student in the various courses taken in a semester by the total number of credits in that semester. SGPA shall be rounded off to two decimal places. SGPA determines the overall performance of a student at the end of a semester.

xxxvii) Credit Point (P) of a course is the value obtained by multiplying the grade point (G) by the credit (C) of the course: P = G x C.

xi) Cumulative Grade Point Average (CGPA) is the value obtained by dividing the sum of credit points in all the semesters earned by the student for the entire programme by the total number of credits in the entire programme and shall be rounded off to two decimal places.

xii) Grade Card means the printed record of students' performance, awarded to them.

xiii) Words and expressions used and not defined in this regulation, but defined in the Mahatma Gandhi University Act and Statutes shall have the meaning assigned to them in the Act and Statutes.

4. Features and Objectives of SACA-B.Voc. (Honours) 2025

The features and objectives of the SACA-B.Voc.(Honours) shall be:

i) The features, meaning, and purpose of Four Year B.Voc. Honours Degree programmes shall be as stipulated by the UGC and as adapted by the Curriculum and Credit Framework for Bachelor of Vocation (B.Voc.) programmes proposed by Kerala State Higher Education Council.

ii) B.Voc. programme shall have five Broad Pathways, (a) 1-year UG Certificate, (b) 2-year UG Diploma (c) 3-year B.Voc. Degree and (d) 4-year B.Voc. Honours Degree (e) 4-year B.Voc. Honours with Research Degree.

iii) Students who choose to exit after 1 year shall be awarded UG Certificate -NHEQF Level 4.5 after the successful completion of the required minimum Courses with 48 credits and an additional 4-credits from Skill Enhancement Courses (SEC) in order to attain 60% of total credits in skill components.

iv) Students who choose to exit after 2 years shall be awarded UG Diploma-NHEQF Level 5.0 after the successful completion of the required minimum Courses with 96 credits and an additional 4-credits from Skill Enhancement Courses (SEC) in order to attain 60% of total credits in skill components.

v) Students who choose to exit after 3 years shall be awarded B.Voc. Degree with Minor- NHEQF Level 5.5 in their respective Discipline/Disciplines after the successful completion of the required minimum Courses with 140 credits.

vi) A 4-year B.Voc. (Honours) Degree - NHEQF Level 6.0 in the Discipline/Disciplines shall be awarded to those who complete a specific number of Courses with 180 credits. Students who have chosen the Honours programme shall do a one-year structured apprenticeship including 3 online courses from a minor discipline contributing 40 credits. Students who have chosen the Honours with Research programme shall do a one-year Research Internship including two courses from the Skill Development Components (SDC) and three courses from a minor discipline in online mode contributing 40 credits.

vii) The practice of lateral entry of students to various semesters exists. The students who exit with Certification and Diploma shall be eligible to re-enter the programme at the exit level to complete the programme or to complete the next level.

viii) Students who have chosen the Honours with research stream shall do their entire fourth year under the mentorship of a mentor.

ix) The mentor shall prescribe suitable advanced level/capstone level courses for a minimum of 8 credits to be taken along with the courses on research methodology, research ethics, and research topic-specific courses including online and blended modes.

x) Students who have opted for the Honours with Research should successfully complete an industry-linked research project under the guidance of the mentor and should submit a research report for evaluation from University/ College/ Recognized Research Institute. The research shall be in the Major/Allied discipline.

xi) The research outcomes of their project work may be published in peer-reviewed journals or presented at conferences or seminars or patented.

xii) The proposed B.Voc.(Honours) curriculum comprises Two Broad Parts: Part I) General Education Components (GEC) and Part II) Skill Development Components (SDC).

xiii) The General Education Component B.Voc.(Honours) shall consist of a set of General Foundation Courses and Minor Pathway Courses (MPC).

xiv) General Foundation Courses shall be grouped into 4 major baskets as Ability Enhancement Courses (AEC), Skill Enhancement Courses (SEC), Value Addition Courses (VAC), and Multi-Disciplinary Courses (MDC).

xv) Ability Enhancement Courses shall be designed specifically to achieve competency in English and other languages as per the student's choice with special emphasis on language and communication skills. Students must complete 3 AECs with two mandatory English Courses and one Elective, which may be in English or other language.

xvi) English or other language courses shall be designed to enable the students to acquire and demonstrate the core linguistic skills, including critical reading, academic and expository writing skills as well as the cultural and intellectual heritage of the language chosen.

xvii) Multi-Disciplinary Courses (MDC) shall be so designed as to enable the students to broaden their intellectual experience by understanding the conceptual foundations of Science, Social Sciences, Humanities, and Liberal Arts. Students shall not be permitted to take the MDC in all three semesters in the same discipline as studied under Part III during their Plus Two education, and MDC selection must also comply with the exclusion list published by the university. This shall be the sole condition for eligibility for MDC course selection. Third semester MDC can be Kerala Specific Content. Each BoS can prepare a basket of courses under MDC in first and second semesters.

xviii) Skill Enhancement Courses (SEC) shall be designed to include modules on Employability Skills, Soft Skills and Life Skills with specific modules to enhance employability. These modules are NHEQF- aligned and approved, offering certification options of 30, 60, 90, or 120 hours through professional skilling agencies. Among 9 credits, students are flexible to take 6 credits of SEC from Skill Development Courses.

xix) Value Addition Courses (VAC) are tailored to the students' skill domains, designed by the respective Boards of Studies (BoS) with CSDCCP's assistance and included in University VAC course baskets. Value Addition Courses (VAC) shall be so designed as to empower the students with personality development, perspective building, and self-awareness.

xx) Minor Pathway Courses (MPC) offer the flexibility to select subjects either related or unrelated to their vocational domain, promoting interdisciplinary learning and broadening academic horizons.

xxi) Skill Development Components (SDC) shall include any domain specific demand led skill training activity, enabling students to equip with practical skills leading to employment or improving employability or enabling them to acquire a duly assessed and certified skill in the chosen discipline. The skill development components shall be designed and delivered in line with National Occupational Standards (NOS) and Qualification Packs (QP), ensuring relevance to specific job roles and industries.

xxii) Students who complete a sufficient number of Courses in a discipline or an interdisciplinary area of study other than their chosen Major shall qualify for a Minor in that discipline or in a chosen interdisciplinary area of study.

xxiii) Major area of specialization shall be focused on Skill Development in the appropriate areas. By selecting a Major, the student shall be provided with an opportunity to pursue an in-depth study of a particular discipline.

xxiv) Each Board of Studies (BOS) shall identify specific Courses or baskets of Courses towards Minor Course credits. Students shall have the option to choose Courses from disciplinary/ interdisciplinary minors and skill-based courses related to a chosen programme.

xxv) Students shall be given options to choose courses from a basket of courses which the institution is offering. There shall be no rigidity of combination of subjects. Students enrolling in a particular vocational stream may be allowed to take a Multidisciplinary Course (MDC) from another vocational stream/SACA-B.Voc (Honours) in their first two semesters, alongside a minor subject as part of the General Education Component. Students can opt for a change of Major within the vocational stream at the end of the second semester to MDC courses they have studied. Alternatively, students also can opt for a change of Major to SACA-B.Voc (Honours) while retaining their vocational stream as minor.

xxvi) Students should opt for their 5th and 6th semester VAC and SEC from their SDC only.

xxvii) Course cum Credits Certificate: After the successful completion of a semester as proof for re-entry to another institution this certificate is essential. This will help the learner to preserve the credits in the Academic Bank of Credits.

xxviii) The Advanced Level/ Capstone Level Courses shall be designed in such a manner as to enable students to demonstrate their cumulative knowledge in their main field of study, which shall include advanced thematic specialization or internships or community engagement or services, vocational or professional training, or other kinds of work experience.

xxix) Advanced/ Capstone level Major Specialization shall include Courses focused on a specific area of study attached to a specific Major, which could be an Elective Course. They shall include research methodology as well.

xxx) The student has the option to register for and attend a course without taking part in the CCA and ESE of that course. Such a course is called the Audit Course. If the student has 75% attendance in an Audit Course, he/she/they is eligible for a pass in that course, without any credit (zero-credit). The Audit Course will be recorded in the final grade card of the student.

xxxi) All students shall undergo Summer Internship or Apprenticeship in a Firm, Industry or Organization; or Training in labs with faculty and researchers or other Higher Education Institutions (HEIs) or Research Institutions. University will publish a separate guideline for Internship Programmes.

xxxii) Students will be provided the opportunities for internships with local industries, business organizations, agriculture, health and allied sectors, Local Government institutions (such as panchayats, municipalities), State Planning Board, State Councils/ Boards, Research Institutions, Research Labs, Library, elected representatives to the parliament/ state assembly/ panchayath, media organizations, artists, crafts persons etc. These opportunities will enable the students to actively engage with the practical aspects of their learning and to improve their employability.

xxxiii) The University will provide opportunities for field-based learning/minor projects enabling them to understand the different socio-economic and development-related issues in rural and urban settings. The University will provide the students with opportunities for Community engagement and services, exposing them to socio- economic issues to facilitate theoretical learning in real-life contexts.

xxxiv) Additional Credits will be awarded for those who actively participating in Social Activities, which may include participation in National Service Scheme (NSS), Sports and Games, Arts, participation in University/ college union related activities (for respective elected/ nominated members), National Cadet Corps (NCC), adult education/ literacy initiatives, mentoring school students, and engaging in similar social service organizations that deemed appropriate to the University.

xxxv) Grace marks shall be awarded to a student for meritorious achievements in co curricular activities (in Sports/ Arts/ NSS/ NCC etc.). Such a benefit is applicable in the same academic year spreading over two semesters, in which the said meritorious achievements are earned. The Academic Council will decide from time to time the eligibility and other rules of awarding the grace marks.

xxxvi) Options will be made available for students to earn credit by completing quality-assured remote learning modes, including Online programmes offered on the Study Webs of Active-Learning for Young Aspiring Minds (SWAYAM) or other Online Educational Platforms approved by the competent body/university from time to time.

xxxvii) Students shall be entitled to gain credits from courses offered by other recognized institutions directly as well as through distance learning.

xxxviii) For the effective operation of the four year vocational programmes, a system of flexible academic transaction timings shall be implemented for the students and teachers.

5. Eligibility for Admission and Reservation of Seats

i) The eligibility for admissions and reservation of seats for various SACA-B.Voc.(Honours) Degree Programmes shall be in accordance with the norms/rules made by the Government/University from time to time.

ii) No student shall be eligible for admission to SACA-B.Voc. (Honours) Degree Programmes in any of the disciplines unless he/she/they has successfully completed the examination conducted by a Board/University at the +2 level of schooling or its equivalent.

iii) Students shall be admitted and enrolled in the respective programmes solely based on the availability of the academic and physical facilities within the institution. The College shall provide all students with a brochure detailing the Courses offered by the various departments under the various programmes and the number of seats sanctioned by the University for each Programme.

iv) During the time of admission each student may be provided with a unique higher education student ID which may be linked with the Aadhar number of the student so that this ID can be transferred if required to other higher education institutions as well.

v) The students at the end of second semester may be permitted to change their major programme of study to any course/ institution/ university across the state. Based on the availability of seats and other facilities, the students may be permitted to opt any discipline which he/she/they had studied during the first two semesters as Minor Pathway Courses (MPC) /Multidisciplinary Courses (MDC). If ranking is required it will be in the order of the highest-grade points secured in the discipline to which the switching of Major is sought.

vi) Students shall be allowed to change their major programmes, if required, to a maximum of 10% of the sanctioned strength of that particular programme depending upon the academic and infrastructural facilities available in the Institution.

vii) Depending upon the availability of academic and infrastructural facilities, the Institution may also admit a certain number of students who are registered for particular programmes in each semester by transfer method, if required, from other Institutions subject to conditions as may be issued by the University.

viii) Students who exit with Certificate or Diploma shall be eligible to reenter the programme at the exit level to complete the programme or to complete the next level.

ix) A student who has already successfully completed a First-Degree Programme and is desirous of and academically capable of pursuing another First-Degree Programme may also be admitted with the prior approval of the University as per the conditions regarding programme requirements specified by the University.

x) A Student can also be admitted for an additional major/ second major/ additional minor and on completion of the required credits he/she/they can be awarded a second major/ additional major/ minor. He/she/they may be exempted from minor pathways and general foundation course requirements.

xi) The HEIs can also enroll students in certain courses as per their choice depending upon the availability of infrastructure and other academic facilities from other recognized HEIs who are already registered for a particular programmes there either through regular/online/distance mode irrespective of the nature of programme (Govt/ Aided/ Self-finance/ Autonomous). On successful completion of the course the credits may be transferred through the Academic Bank of Credit or it may be communicated to the University against the unique higher education ID provided by the University at the time of admission.

6. Academic Monitoring and Student Support

The academic monitoring and student support shall be in the following manner, namely

i) College should appoint a Senior Faculty member/expert in the field as Academic Co-ordinator/ Nodal officer for the smooth conduct of SACA-B.Voc.(Honours).

ii) Advisory System: There shall be one Senior Faculty Advisor (SFA) for each departmentand one Faculty Advisor (FA) for 20 to 30 students of the class to provide advice in all relevant matters. The Head of the Department, in consultation with the SFA, shall assign FA for each student.

iii) The documents regarding all academic activities of students in a class shall be kept under the custody of the FA/ SFA.

iv) All requests/ applications from a student or parent to higher offices are to be forwarded/ recommended by FA/ SFA.

v) Students shall first approach their FA/ SFA for all kinds of advice, clarifications, and permissions on academic matters.

vi) It is the official responsibility of the institution to provide the required guidance, clarifications, and advice to the students and parents strictly based on the prevailing academic regulations.

vii) The SFA shall arrange separate or combined meetings with FA, faculty members, parents, and students as and when required and discuss the academic progress of students.

viii) The FA/ SFA shall also offer guidance and help to solve the issues on academic and non-academic matters, including personal issues of the students.

ix) Regular advisory meetings shall be convened immediately after the commencement of the semester and immediately after announcing the marks of the Continuous Comprehensive Assessment (CCA).

x) The CCA related results shall be uploaded on the University portal only after displaying the same on the department notice board/ other official digital platforms of the college at least for two working days.

a) Any concern raised by the students regarding CCA shall be looked into in the combined meetings of advisors, HoD, course faculty, and the students concerned.

b) If the concerns are not resolved at the advisor's level, the same can be referred to the properly constituted college-level grievance redressal committees as per the existing UGC/ University/ Government norms.

c) The Principal/ HOD shall ensure the proper redressal of the concerns raised by the students regarding CCA.

d) If the students raise further concerns about the issue, the principal shall refer the issue to the University-level grievance committee with proper documents and minutes of all the committees.

xi) The FA/ SFA shall be the custodian of the minutes and action taken reports of the advisory meetings. The SFA shall get the minutes and action taken reports of advisory meetings approved by the Head of Department and the Principal. It shall be the duty of the HoD and the Principal to produce them before the University as and when required.

xii) The Principal shall inform/forward all regulations, guidelines, communications, announcements, etc. issued by the University regarding student academic and other matters to the HODs/ SFA for information and timely action.

xiii) It shall be the official responsibility of the Principal to extend the required administrative and financial support to the HODs, SFAs and FAs to arrange necessary orientation programmes for students regarding student counselling, the prevailing University norms, regulations, guidelines and procedures on all academic and other University related matters.

xiv) An integrated educational planning and administration software will be made available by the college to manage the academic information of all students, which include student admissions and registration, managing student personal and academic information, course registrations, attendance management, all process related to assessments including regular & online examinations, grading, publishing of results, supplementary examinations, LMS, stakeholder's feedback, etc.

xv) Faculty, staff, students, and parents shall be allowed to access this software system over a highly secure authenticated mechanism from within the campus and outside the campus.

7. Course Registration

i) Each department shall publish well in advance the relevant details of courses offered, such as the name, academic level, expected outcomes, time slot, and course faculty members.

ii) Students shall be allowed to visit and interact with respective faculty members during the first week of each semester, to gather more information about the courses and the availability of seats.

iii) Based on consultations and advice from the faculty advisor, each student shall complete course registration within one week from the commencement of each semester.

iv) The number of credits that a student can take in a semester is governed by the provisions in these Regulations, subject to a minimum of 16 and a maximum of 30 Credits.

v) A student can opt out of a Course or Courses registered, subject to the minimum Credit/ Course requirement, if he/she/they feels that he/she/they has registered for more Courses than he/she/they can handle, within 30 days from the commencement of the semester.

vi) The college shall publish a list of the students registered for each course including audit course, if any, along with the chosen Programmes, repeat/ reappearance courses, if any, and shall forward the same to the university.

vii) The higher education institutions shall admit candidates not only for programmes, but also for courses.

8. Re-admission and Scheme Migration

i) Students who opt out shall be provided with a 'Course cum Credits Certificate' after the successful completion of a semester as proof for re-entry to another institution.

ii) Students who exit with Certificate or Diploma shall be eligible to reenter the programme at the exit level to complete the programme or to complete the next level.

iii) Students who have successfully completed a particular programme pathway may be permitted to take an additional minor or second major.

iv) Those students who are opting for a second major are eligible for getting certain credit transfer/ credit exemption from their previous minor programs of study, subject to the prior recommendation of the BoS that those credits are relevant for the present major programme of study.

9. Duration of Programme, Credits Requirements and Options

1. Students will be offered the opportunity to take breaks during the programme and resume after the break, but the total duration for completing the SACA -B.Voc.(Honours) programme shall not exceed 7 years.

2. Students will get a NHEQF Level 4.5 Undergraduate Certificate after completing first two semesters with a credit of 48 (28 credits from SDC and 20 credits from GEC) and an additional 4-credits from Skill Enhancement Courses (SEC) in order to attain 60% of total credits in skill components.

3. Students will get a NHEQF Level 5.0 Undergraduate Diploma after completing first four semesters with a credit of 96 (56 credits from SDC and 40 credits from GEC) and an additional 4-credits from Skill Enhancement Courses (SEC) in order to attain 60% of total credits in skill components.

4. Students will get a NHEQF Level 5.5 B.Voc. degree after completing six semesters with a credit of 140 (86 credits from SDC and 54 credits from GEC).

5. Students will get a NHEQF Level 6.0 Honours degree after completing eight semesters with a credit of 180 (110 credits from SDC and 70 credits from GEC).

6. Students who wish to complete the undergraduate programmes faster may do so by completing different courses equivalent to the required number of credits and fulfilling all other requirements in N-1 semesters, where N is the number of semesters in the SACA -B.Voc.(Honours).

7. Provided further that the students may complete the undergraduate programme at a slower pace, they may pursue the three years or six semester programme in 4 to 5 years (8 to 10 semesters), and four years, or eight semester programme in 5 to 6 years (10 to 12 semesters) without obtaining readmission.

8. For students who crossed 6 semesters at a slower pace, the requirement of 16 credits per semester from the institutions where they enrolled may be relaxed.

9. Credit Structure and Levels of Awards

NHEQF Level	**Skill Development Component Credits**	**General Education Component Credit**	**Total Credits for Award**	**Normal Duration**	**Exit Point**
4.5	28	20	48	Two semester	UG Certificate (48 credits)+SEC (4 credits)

5.0	56	40	96	Four semester	UG Diploma (96 credits)+SEC (4 credits)
5.5	86	54	140	Six semester	B. Voc. Degree with minor
6.0	114	66	180	Eight semester	B. Voc. Honours/ Honours with Research

10. Credit Structure

The proposed number of credits per course and the credit distribution of them for the SACA - B.Voc. (Honours) Programmes are given below-

A. An academic year shall consist of 200 working days; one semester consists of 90 working days; and an academic year consists of two semesters.

B. Ten working days in a semester shall be used for extracurricular activities. One semester consists of 18 weeks with 5 working days per week. In each semester, 15 days (3 weeks) should be kept aside for End Semester Evaluation (ESE) and CCA.

C. The maximum number of available weeks for curriculum transactions should be fixed at 15 in each semester. A minimum of 5 teaching hours could be made available for a day in a 5-day week.

D. A course that includes one hour of lecture or two hours of lab work/ practical work/ field work/ practicum/hands-on skill training per week is given one credit hour.

E. One credit in a semester should be designed for 15 hours of lectures or 30 hours of lab work/ practical work/ field work/ practicum and 30 hours of learner engagement in terms of course-related activities such as seminar preparation, submitting assignments, etc.

F. A one-credit seminar or internship or studio activities or field work/ projects or community engagement and service will have two-hour engagements per week (30 hours of engagement per semester).

G. A course can have a combination of lecture credits, practical credits, hands-on skill training credits, OJT credits and practicum credits.

H. Minimum credit for one Course should be 2 (Two), and the maximum credit should be 4 (Four).

I. All Skill Development Components/ Minor Pathway Courses shall be of 4 (Four) credits. A 4-credit course can include five modules, out of which one will be Teacher Specific content.

J. Each semester requires a minimum of 18 skill credits (including theory, practicals and on the job-training) over six semesters.

K. For all Skill Development Components/ Minor Pathway Courses, there may be practical/ practicum of two or four hours per week.

L. All Courses under the Multi-Disciplinary, Ability Enhancement, Value Addition and Skill Enhancement categories are of 3 credits. A 3-credit course can include four modules, out of which one will be Teacher Specific content.

M. 20% syllabus of each course will be prepared by the teacher as 'Teacher Specific Content' and will be evaluated under CCA.

N. A two credit OJT in a semester should be designed for 5 hours per week.

O. One credit of Apprenticeship/Research Internship is equivalent to 10 days.

P. Summer Internship, Apprenticeship, Community outreach activities, etc. may require sixty hours (or as appropriate) of engagement for acquiring one credit.

Q. A student shall be able to opt for a certain number of extra credits over and above the requirements for the award of a degree.

R. Maximum number of credits that a student can earn per semester shall be restricted to 30. Hence, a student shall have the option of acquiring credits to a maximum of 180 credits for 6-semester UG programmes and 240 credits for 4-year (8-semester) programmes.

S. Each faculty member shall offer a maximum of 16 credits per semester. However those who are offering both practical and theory courses shall offer a maximum of 12-16 credits per semester.

T. For a four-credit theory course, 60 hours of lecture class shall be assured as a mandatory requirement for the completion of that course.

11. Course Structure of the SACA-B.Voc.(Honours) Programmes

The SACA -B.Voc.(Honours) consists of the following categories of courses and the minimum credit requirements for pathway option-one shall be as follows;

Sl. No.	Categorization of Courses for all Programmes	Minimum Number of Credits Required	
		3-year B.Voc.	4-year B.Voc.
1	Skill Development Components (SDC)	72	72
2	Minor Pathway Courses (MPC)	24	36
3	Multi-Disciplinary Courses (MDC)	9	9
4	Skill Enhancement Courses (SEC)	9	9
5	Ability Enhancement Courses (AEC)	9	9
6	Value Addition Courses (VAC)	9	9
7	Summer Internship	2	2
8	On the Job Training (OJT)	6	6
9	Apprenticeship/ Research Internship		28
	Total Credits	**140**	**180**

1. 6 out of 9 credits of the SEC are part of the SDC.

2. The Summer Internship/OJT must be undertaken in an area aligned with the SDC. The credits earned through this activity shall contribute to the SDC.

3. Students enrolled in the Honours degree programme must earn a minimum of 12 credits from MPC at level 300 or above.

4. Students pursuing the Honours with Research degree must complete an industry- linked research project of 20 credits and earn the remaining 8 credits of the SDC through research-oriented courses.

12. Academic Levels of Pathway Courses

Semester	Difficulty level	Nature of Course
1 & 2	100-199	Foundation level or introductory courses
3 & 4	200-299	Intermediate level courses
5 & 6	300-399	Higher level courses
7 & 8	400-499	Advanced/Capstone level courses

13. Signature Courses

1. With a prior recommendation of BoS and the approval of academic council, each faculty member can design and offer at least one signature course per semester, which may be offered as SDCE /SEC/ VAC.

2. Each institution may publish a list of their signature courses in SDCE/ SEC/ VAC offered by their faculty members with a prior recommendation of BoS and the approval of the academic council.

5. An institution may empanel distinguished individuals who have excelled in their field of specialization like science and technology, industry, commerce, social research, media, literature, fine arts, civil services etc. as adjunct faculty as per the UGC guidelines with the approval of the University. With a prior recommendation of BOS and the approval of the academic council, the adjunct faculty can offer SEC/VAC as a signature course.

6. Adhoc/ Guest faculty/ Visiting faculty/ Visiting Scholars can also offer SDCE/ SEC/ VAC as signature courses with a prior recommendation of BOS and the approval of academic council.

7. The faculty concerned may design the particular course and it should be forwarded to the University BOS after the approval of department and college level academic committees formed as part of this regulations.

8. The examinations and evaluation of the signature courses designed by the faculty shall be conducted by the faculty themselves and an external expert faculty chosen by the college from a panel of experts submitted by the faculty and recommended by the BOS concerned.

14. Programme Pathways and Curriculum Structure

Students who have joined for any programme under these regulations shall have the option to choose the following pathways for their B.Voc. Degree and Honours programme.

- **Degree with single Major**: A student pursuing the B.Voc. programme in a specific discipline shall be awarded a Major degree if he/she/they secures at least 60% of the total credits in the specific discipline required for the award of the Degree in that Discipline.

  Example: Logistics Management Major/ Information Technology Major/ Fashion Technology Major/ Renewable Energy Management Major etc.

- **Degree Major with Minor**: If a student pursuing the B.Voc. Programme is awarded a Major Degree in a particular discipline, he/she/they is eligible to be awarded a Minor in another discipline of his/her/their choice, if he/she/they earns a minimum of 24 credits from 6 pathway courses in that discipline.

  Example: Travel and Tourism Major with Information Technology Minor/ Fashion Technology Major with Commerce Minor/ Finance and Taxation Major with Retail Management Minor/ Animation and Graphic Design Major with Literature Minor/

Agriculture Technology Major with Culinary Arts and Hospitality Management Minor etc.

- **Major with Multiple Disciplines of Study**: This pathway is recommended for students who wish to develop core competencies in multiple disciplines of study. In this case, the credits for the minor pathway shall be distributed among the constituent disciplines/ subjects. If a student pursuing B.Voc. Degree Programme is awarded a major Degree in a particular discipline, he/she/they is eligible to get mentioned his/her/their core competencies in other disciplines of his/her/their choice if he/she/they has earned 18 credits from the pathway courses of that discipline.
  Example: Information Technology Major with Minors in Travel and Tourism and History, Agro Food Processing Major with Minors in Banking and Financial Services and Biotechnology, Data Analytics and Machine Learning Major with Minors in Logistics Management and Commerce etc.
- **Interdisciplinary Major**: For these programme pathways, the credits for the major and minor pathways shall be distributed among the constituent disciplines/subjects to attain core competence in the interdisciplinary programme.
  Example: Fashion Innovation and Retail Management Major, Agri-Business and Food Technology Major, Financial Technology and Banking Analytics Major, Econometrics Major, Global Studies Major, Biostatistics Major etc.
- **Multi-Disciplinary Major**: For multidisciplinary major pathways, the credits for the major and minor pathways will be distributed among the broad disciplines such as Management Studies, Design and Creative Arts, Communication and Media Studies, Environmental and Sustainability Studies, Applied Technologies, Life Sciences, Physical Sciences, Mathematical and Computer Sciences, Data Analysis, Social Sciences, Humanities, etc.
  Example: Biomedical Informatics, Computational Social Science, Life Science, Data Science, Nano Science etc.
- **Degree with Double Major**: A student who secures a minimum of 50% credits from the first major will be awarded a second major in another discipline if he/she/they could secure 40% of credits from that discipline for the 3-year/ 4-year UG degree to be awarded a double major degree.

- Example: Information Technology and Logistics Management Major, Fashion Technology and Travel and Tourism Major, Renewable Energy and History Major, Finance and Taxation and Journalism and Mass Communication Major etc.

Pathway Option - Major with Minor

Course and Components	Semester 1	Semester 2	Semester 3	Semester 4		Semester 5	Semester 6	Total	Semester 7&8	Total
SDC (4 Credit /Course)	3 (2P)	3 (2P)	3 (2P)	3 (2P)		3* (2P)	2* (2P)	17	2** (2 online)	17/19**
MPC (4 Credit /Course)	1 (P)	1	1 (P)	1 (P)		1	1	6	3 (3 online)	9
(MDC) (3 Credit /Course)	1	1 (P)	1#					3		3
(AEC) (3 Credit /Course)	1(English)	1(English/ OL)	1(English)					3		3
(SEC) (3 Credit /Course)				1		1## (P)	1##	3		3

(VAC) (3 Credit /Course)				1		1##	1##	3		3
Total Courses	**6**	**6**	**6**	**6**		**6**	**5**	**35**		**38/40**
OJT (2 Credits)	1	1	1					3		3
Project (4 Credits)							1	1		1
Apprenticeship (28 credits)/ **Research Internship** (20 credits)									1	1
Total Credits	**24**	**24**	**24**	**22**	**2**	**22**	**22**	**140**	**40**	**180**
Total Hours per week	**30**	**30**	**30**	**25**		**25**	**28**			

*One of the courses in 5th and 6th semesters will be Skill Development Component Elective (SDCE)

** Honours with Research

The MDC offered in the third semester shall focus on Kerala-based content.

The SECs and VACs offered in 5th and 6th semester shall be chosen from domains that align with the SDC.

15. Guidelines for Acquiring Credit from Other Institutions/Online/Distance Mode

- A student shall register to a minimum of 16 credits per semester from the college/ department where he/she/they officially admitted for a particular programme. However, students enrolled for a particular programme in one institution can simultaneously enroll for additional credits from other HEIs within the University or outside University subject to a maximum of 30 credits per semester including the 16 institutional credits.
- Each institution shall publish a list of courses that are open for admission for students from other institutions well in advance before the commencement of each semester.
- Each BOS shall prepare and publish a list of online courses at different levels before the commencement of each semester offered in various online educational platforms recognized by the academic council of the college, which can be opted by the students for acquiring additional credits.
- BOS shall prepare and publish a list of allied/ relevant pathway courses before the commencement of each semester offered by other Board of Studies that can be considered as pathway courses for major/ minor for their disciplines at different levels.
- At the end of each semester college will include the credit acquired by the student through online courses in their semester grade card subject to a maximum of 30 credits.

16. Attendance

(a) A student shall be permitted to register for the end-semester evaluation of a specific course to acquire the credits only if he has completed 75% of the prescribed classroom activities in physical, online, or blended modes, including any makeup activities as specified by the course faculty of that particular course.

(b) A student is eligible for attendance as per the existing university and government orders which includes participation in a meeting, or events organized by the college or the university, a regularly scheduled curricular or extracurricular activity prescribed by the college or the university. Due to unavoidable or other legitimate circumstances such as illness, injury, family emergency, care-related responsibilities, bad or severe weather conditions, academic or career-related interviews students are eligible for authorized absence. Apart from this, all other eligible leaves such as maternity leave, and menstrual leave shall also be treated as authorized absences.

(c) The condonation facility can be availed as per the university norms.

17. Workload

1. The workload of a faculty who offers only lecture courses during an academic year shall be 32 credits.
2. The workload of a faculty offering both practical courses and theory courses may be between 24-32 credits per academic year.
3. An academic year shall consist of two semesters.
4. Programme wise workload calculation will be as per the FYUGP workload ordinance.
5. The teachers given the administrative responsibilities in the department and college level may give a relaxation in their work load as specified in the UGC regulations 2018.

18. Credit Transfer and Credit Accumulation

- University will establish a digital storage (DIGILOCKER) of academic credits for the credit accumulation and transfer in line with ABC.
- The validity of credits earned shall be for a maximum period of seven (7) years or as specified in the university/ UGC regulations.
- The students shall be required to earn at least 50% of the credits from the university.
- Students shall be required to earn the required number of credits as per any of the pathway structure specified in this regulation for the award of the degree.

19. Outcome Based Approach

(a) The curriculum will be designed based on Outcome Based Education (OBE) practices. The Graduate Attributes (GA) and Programme Outcomes (PO) are provided as Appendix-1. The OBE based syllabus template is provided as Appendix-2.

(b) The Institution will establish an appropriate Board of Studies (BoS) to approve the curriculum and course content developed by the institution in consultation with the CSDCCP and industry partners.

(c) The CSDCCP will support the institution in developing a regionally relevant skill curriculum based on appropriate Qualification Packs (QPs) and National Occupational Standards (NOSs).

20. Assessment and Evaluation

1. The assessment for SACA B.Voc. (Honours) programmes include evaluations of both the General Education Components and the Skill Development Components.
2. The College will conduct examinations for the General Education components and Skill Components of the B.Voc. programme in accordance with the existing norms of the University.
3. The assessment shall be a combination of Continuous Comprehensive Assessment (CCA) and an End Semester Evaluation (ESE).
4. 30% weightage shall be given for CCA. The remaining 70% weight shall be for the ESE.
5. Teacher Specific Content will be evaluated under CCA.
6. CCA will have two sub-components- Formative Assessment (FA) and Summative Assessment (SA). Each of these components will have equal weightage and to be conducted by the course faculty/ course coordinator offering the course.
7. FA refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, module or course. FA is to encourage students to build on their strengths rather than fixate or dwell on their deficits. FA can help to clarify and calibrate learning expectations for both students. FA will help students become more aware of their learning needs, strengths, and interests so they can take greater responsibility over their

own educational growth. FA will be the prerogative of the course faculty/ course coordinator based on specific requirements of the student.

8. Suggestive methods of FA are as follows: (anyone or in combinations as decided by the course faculty/ course coordinator)
    - Practical assignment
    - Observation of practical skills
    - Viva voce
    - Quiz
    - Interview
    - Oral presentations
    - Computerized adaptive testing
    - In-class discussions
    - Group tutorial work
    - Reflection writing assignments
    - Home assignments
    - Self and peer Assessments
    - Any other method may be required for a specific course/ student by the course faculty/ course coordinator.

9. Summative Assessments (SA) are used to evaluate student learning, skill acquisition, and academic achievement at the conclusion of a defined instructional period- typically at the end of a project, unit, module, course or semester. SA may be a class test, assignment, or project, used to determine whether students have learned what they were expected to learn. It will be based on evidence, collected using single or multiple ways of assessment. The systematically collected evidence should be kept in record by course faculty/ course coordinator and the marks should be displayed on the college notice board/ other official digital platforms of the college before the end semester examinations.

10. The method of SA will be as follows: (any one as decided by the course faculty/ course coordinator)

- Written test

- Open book test
- Laboratory report
- Problem based assignments
- Individual project report
- Case study report
- Team project report
- Literature survey
- Standardized test
- Any other pedagogic approach specifically designed for a particular course by the course faculty/ course coordinator.

11. A student may repeat SA only if for any compulsive reason due to which the student could not attend the assessment.
12. The prerogative of arranging a CCA lies with the course faculty/ course coordinator with the approval of SACA -B.Voc. Academic Committee based on justified reasons.
13. The course faculty/ course coordinator shall be responsible for evaluating all the components of CCA. However, the college may involve any other person (External or Internal) for evaluation of any or all the components as decided by the Chairman/ Principal from time to time in case any grievances are raised.
14. Written tests shall be precisely designed using a variety of tools and processes (e.g., constructed responses, open-ended items, multiple-choice), and the students should be informed about the evaluation modalities before the commencement of the course.
15. The course faculty may provide options for students to improve their performance through continuous assessment mechanisms.
16. There shall be theory and practical examinations at the end of each semester.
17. Regarding evaluation, one credit may be evaluated for 25 marks in a semester; thus, a 4-credit course will be evaluated for 100 marks; 2-credit courses for 50 marks.

18. Odd semester examinations will be conducted by the university and will be evaluated at the institution level. However, even semester examinations will be conducted and evaluated by the university itself.
19. Individual Learning Plans (ILPs) and/ or specific assessment arrangements may be put in place for differently abled students. Suitable evaluation strategies including technology assisted examinations/ alternate examination strategies will be designed and implemented for differently abled students.
20. Students possessing a valid examination hall ticket may enter the examination hall up to 15 minutes after the scheduled start of the examination, with the permission of the Principal or the Chief Superintendent of Examinations.
21. Duration of Examination

Questions shall be set as per the defined Outcome. The question setter shall ensure that there will be Time and Mode (T & M) flexibility for all End Semester Examinations. The BoS may recommend T & M from the following list, considering a half-hour evaluation for the 1-credit course, except when the evaluation mode consists entirely of multiple-choice questions.

Mode	**Time (in Hours)**	
	Minimum	**Maximum**
Written Examination	1	2
Multiple Choice	0.75	1.5
Open Book	1	2
Any Other Mode	1	2

21.Practical Examination

(a) The end semester practical examination will be conducted and evaluated by the institution.
(b) There shall be a CCA of practical courses conducted by the course faculty/ course coordinator.
(c) The scheme of evaluation of practical courses will be as given below:

Components for the Evaluation of Practical Courses	Weightage
CCA of practical/practicum.	30%
ESE conducted under the supervision of internal examiner	70%

(d) Those who have completed the CCA alone will be permitted to appear for the ESE.

(e) For grievance redressal purposes, the college shall have the right to call for all the records of CCA.

(f) The BOS can suggest appropriate Time and Mode (T & M) for practical examinations.

22. Evaluation of Project/ Dissertation

The evaluation of project work shall be CCA with 30% and ESE 70%. The scheme of evaluation of the Project is given below:

Project type	Maximum Marks	CCA	ESE
Industry-Linked Research project of Honours with Research (20 credits)	200	60	140
Apprenticeship of Honours (28 credits)	300	90	210
Project (4 credits)	100	30	70

23. Evaluation of Internship/OJT

The evaluation of internship/OJT shall be done by a committee constituted by the Department Council. The scheme of CCA and ESE is given below:

Components of Evaluation of Internship/ OJT	Weightage	Marks for Internship/ OJT 2 Credits/ 50 Marks
CCA	30%	15
ESE	70%	35

The department council may decide any mode for the completion of the Internship/OJT. If evaluation is not specified in any of the selected internship programmes/OJT, institutions can adopt a proper evaluation method as per the weightage specified in the table above.

24. Letter Grades and Grade Points

Mark system is followed for evaluating each question. For each course in the semester, letter grade and grade point are introduced in 10-point indirect grading system as per guidelines given below,

1. The Semester Grade Point Average (SGPA) is computed from the grades as a measure of the student's performance in a given semester. The SGPA is based on the grades of the current term, while the Cumulative Grade Point Average (CGPA) is based on the grades in all courses taken after joining the programme of study.
2. Based on the SGPA/ CGPA obtained, the grade point will be mentioned in the student's grade cards

Letter Grade	SGPA/ CGPA range (x)	Class
O (Outstanding)	$9.5 \leq x$	First Class with Distinction
A+ (Excellent)	$8.5 \leq x < 9.5$	
A (Very good)	$7.5 \leq x < 8.5$	
B+ (Good)	$6.5 \leq x < 7.5$	First Class
B (Above average)	$5.5 \leq x < 6.5$	
C (Average)	$4.5 \leq x < 5.5$	Second Class

P (Pass)	$3.5 \leq x < 4.5$	Third Class
F (Fail)	$x < 3.5$	Fail
Ab (Absent)		Fail

3. **Conversion of CGPA to percentage**

Equivalent Percentage = $\frac{CGPA\ obtained}{Maximum\ CGPA\ (=10)} X100$

4. Based on the marks obtained, the grade point will be mentioned in the student's grade cards.

Letter Grade	Grade Point	Percentage of Marks (Both CCA & ESE Marks put together) (y)	Class
O (Outstanding)	10	$95\% \leq y$	First Class with Distinction
A+ (Excellent)	9	$85\% \leq y < 95\%$	
A (Very good)	8	$75\% \leq y < 85\%$	
B+ (Good)	7	$65\% \leq y < 75\%$	First Class
B (Above average)	6	$55\% \leq y < 65\%$	
C (Average)	5	$45\% \leq y < 55\%$	Second Class
P (Pass)	4	$35\% \leq y < 45\%$ Along with a minimum of 30% in ESE	Third Class
F (Fail)	0	y s< 35% Below an aggregate (CCA and ESE put together) of 35% or below 30% in ESE	Fail

Ab (Absent)	0		Fail

5. When students take audit courses, they may be given pass (P) or fail (F) grade without any credits.
6. If a course evaluation consists of both theory and practical components, the minimum passing criteria for each component must be met separately

7. The marks for CCA components and ESE shall be rounded to two decimal places.

8. The aggregate marks for CCA and ESE should be rounded up to the next highest integer.

25. Computation of SGPA and CGPA

The following method is recommended to compute the Semester Grade Point Average (SGPA) and Cumulative Grade Point Average (CGPA):

- The SGPA is the ratio of the sum of the product of the number of credits with the grade points scored by a student in all the courses taken by a student and the sum of the number of credits of all the courses undergone by a student in the semester, i.e.

  SGPA (Si) = Σ(Ci x Gi) / ΣCi

Where Si is the SGPA in the i^{th} semester, Ci is the number of credits of the i^{th} course and Gi is the grade point scored by the student in the i^{th} course.

$$\text{SGPA}=\frac{\textit{Sum of the credit points of all the courses in a semesters}}{\textit{Total Credits in that semester}}$$

Illustration – Computation of SGPA

Semester	**Course**	**Credit**	**Letter Grade**	**Grade point**	**Credit Point** (Credit x Grade)
I	SDC 1	4	A	8	4 x 8 = 32

I	SDC 2	4	B+	7	4 x 7 = 28
I	SDC 3	4	B	6	4 x 6 = 24
I	MPC	4	B	6	4 x 6 = 24
I	AEC	3	O	10	3 x 10 = 30
I	MDC	3	C	5	3 x 5 = 15
I	OJT	2	A	8	2 x 8 = 16
	Total	24			169
	SGPA				169/24 = 7.04

- The CGPA is also calculated in the same manner considering all the courses undergone by a student over all the semesters of a programme, i.e.

  CGPA = Σ(Ci x Si) / ΣCi

  Where Si is the SGPA in the i^{th} semester, Ci is the total number of credits in the i^{th} semester.

  $$\text{CGPA} = \frac{Sum\ of\ the\ credit\ points\ of\ all\ the\ courses\ in\ six/\ eight\ semesters}{Total\ Credits\ in\ Six\ (140)/\ Eight\ (180)\ semesters}$$

- The SGPA and CGPA shall be rounded off to 2 decimal points and reported in the transcripts.

26. Skill Assessment and Certification

(a) Awarding Bodies

NCVET recognised Awarding Bodies who are entitled to award NCVET certificate to trainees/ learners after successful completion of training and assessment of NHEQF aligned and approved qualifications which are either developed or adopted by the Awarding Body. The college level Center for Skill Development Courses and Career

Planning may try to get status of deemed Awarding Bodies of NCVET and can issue a dual certification for their skill courses.

(b) Assessment Agencies (AA):

An NCVET recognized Assessment Agency is authorized to assess trainees after completion of the trainees' training under an NSQC aligned and approved qualification. The recognized Assessment Agency is eligible to carry out assessments for NSQF aligned and approved qualifications in the sector allocated to the AA for which adequate capacity (Question Banks, SMEs, Industry connects, Governance processes etc.) Current there are around 56 approved AAs by NCVET. The list of the all the NCVET recognised Assessment Agencies can be accessed https://ncvet.gov.in/assessment- agencies/ The universities or the CSDCCP centers may get the assistance of these Assessment agencies for doing an effective assessment of the Skill Domains of the learner.

(c) Training Provider (TP)/ Training Centre (TC):

A TP/TC means a person or an organization, which is affiliated by an awarding body or an Higher Education Institution recognized by the NCVET/ Higher Education Council for providing Vocational Education, Training & Skilling and related activities with respect to a qualification/ course. The CSDCCP centers may be recognised as authorized training centers / training providers for the NHEQF aligned Skill Development courses/qualification.

(d) The Skill component of the course can be assessed and certified by the respective Sector Skill Councils.

(e) In case, there is no Sector Skill Council for a specific trade, the assessment may be done by an allied Sector Council or the Industry partner.

(f) CSDCCP/Training Provider/Industry shall do the assessment for skill competency through certified skill assessors.

(g) Wherever the university/college may deem fit, it may issue a joint certificate for the courses with the respective Sector Skill Councils.

(h) The credits regarding skill components will be awarded in terms of NHEQF level certification which will have a minimum of 60% weightage of total credits of the course.

27. Committees to be constituted for the Implementation and Monitoring of SACA-B.Voc.(Honours)

1. There shall be an SACA-B.Voc.(Honours) implementation cum monitoring committee at the College level under the chairmanship of the Principal to ensure the smooth implementation of the SACA-B.Voc.(Honours)
2. Apart from this, there shall be a college level SACA-B.Voc.(Honours) Academic Co-ordinator/ Nodal Officer, academic committee and an SACA-B.Voc. (Honours) department committee in each department of the affiliating colleges.
3. The affiliating colleges should provide an undertaking regarding the constitution of these two committees within one month from the date of effect of this regulation.
4. The tenure of the college level committees will be 4 years.

i. SACA-B.Voc. (Honours) Academic Committee

i. The Principal (Chairman)

ii. Academic Co-ordinator/ Nodal Officer (Convenor)

iii. CSDCCP Co-ordinator

iv. Academic Co-ordinator/ Nodal Officer of SACA- B.Voc (Honours).

v. All the Heads of Departments associated with B.Voc programmes

vi. Four teachers of the college representing different discipline nominated by the college council by rotation

vii. Not less than two experts/ academicians from outside the college representing areas such as Industry, Management, Commerce, Technology, Sciences etc., to be nominated by the college council preferably from the alumni of the college

viii. One nominee of the affiliating University (not less than the designation of associate professor in a college/ university department)

ii. Functions of SACA-B.Voc. (Honours)Academic Committee

i. Scrutinize, approve, recommend to the University all the proposals submitted by the department committee with regard to the SACA-B.Voc. (Honours) such as, academic pathway, allowed syllabi enrichment/ updation, details of elective courses, Online courses, blended teaching, courses offering to the students of other HEIs, panel of examiners, summative and formative evaluation tools proposed by the course faculty concerned, new courses and syllabus proposed by the faculty members as signature courses etc. The Academic Committee can differ on any proposal and it shall have the right to return the matter for reconsideration to the Department committee concerned or reject it, after giving sufficient reasons to do so.

ii. Scrutiny of all documents related to Teacher Specific Content.

iii. Recommend to the college governing council for starting innovative programmes using the flexibility and holistic nature of the SACA-B.Voc. (Honours) curriculum framework.

iii. SACA-B.Voc. Department Committee

i. Head of the Department concerned (Chairman)

ii. The entire faculty of the Department

iii. Two subject experts from outside the college to be nominated by the SACA - B.Voc. (Honours) Academic Committee

iv. One representative from industry/ corporate sector/ allied area relating to placement

v. One meritorious alumnus of the department to be nominated by the department council

vi. The department council of the SACA-B.Voc.(Honours), may with the approval of the principal of the college, co-opt:

- Experts from outside the college whenever special courses of studies are to be formulated.
- Other faculty members of the same Faculty within the college

iv. Functions of SACA-B.Voc. (Honours) Department Committee

i. Prepare teacher specific content of syllabi for various courses keeping in view the objectives of the SACA-B.Voc.(Honours) and submit the same for the approval of the academic committee.

ii. Scrutinize the signature course content and its evaluation techniques.

iii. Suggest methodologies for innovative teaching and evaluation techniques.

iv. Suggest panel of examiners to the academic committee.

v. Coordinate research, teaching, extension and other academic activities in the department/ college.

v. CSDCCP

Constitution of CSDCCP: CSDCCP Advisory Body consists of seven members

i. Head of the institution: Chairperson

ii. Director/Co- ordinator of CSDCCP (One senior faculty nominated by the Head of the institution): Convenor

iii. Academic Co- ordinator /Nodal Officer- SACA-B.Voc.(Honours)

iv. Four members : Internal and External Experts

vi. Functions of CSDCCP

i. Propose skill components for SACA B.Voc. (Honours) courses, ensuring they meet the standards of the National Skills Qualification Framework (NSQF).

ii. Propose sector-specific skill curricula in line with National Occupational Standards (NOS) and Qualification Packs (QPs), ensuring relevance to specific job roles and industries.

iii. Conduct competency-based assessments in collaboration with Sector Skill Councils (SSCs) and provide certifications at appropriate NHEQF levels to enhance employability.

28. Proposed Options for Higher Studies for the Students of SACA-B.Voc.(Honours)

The following higher education and research opportunities at the postgraduate level:

a) **Postgraduate Diploma:**

After completing the 3-year B.Voc. programme, students may opt for a 1-year Postgraduate Diploma in industry-linked, work-integrated, or apprenticeship-embedded programmes.

b) **Honours Degree:**

Students may pursue a 1-year structured apprenticeship or work-integrated programme in collaboration with relevant industries, leading to an Honours Degree in their skill domain and enhancing their professional credentials.

c) **Honours with Research:**

For research-oriented students, an Honours with Research option may be offered through a work-integrated programme involving industry-linked research projects in their skill domain, preparing them for research careers.

d) **Lateral Entry to M.Voc.:**

Students who complete a Postgraduate Diploma are eligible for lateral entry into M.Voc. programme, allowing for advanced specialization in their skill areas.

e) PG or Research Programs:

Students with Honours or Honours with Research degrees are eligible to pursue 1-year PG or research programme, in accordance with UGC norms. Students with a standard B.Voc. Degrees are eligible for 2-year M.Voc. programme or other regular PG programme, subject to the eligibility conditions prescribed by the relevant regulatory bodies.

29. Power to Remove Difficulties

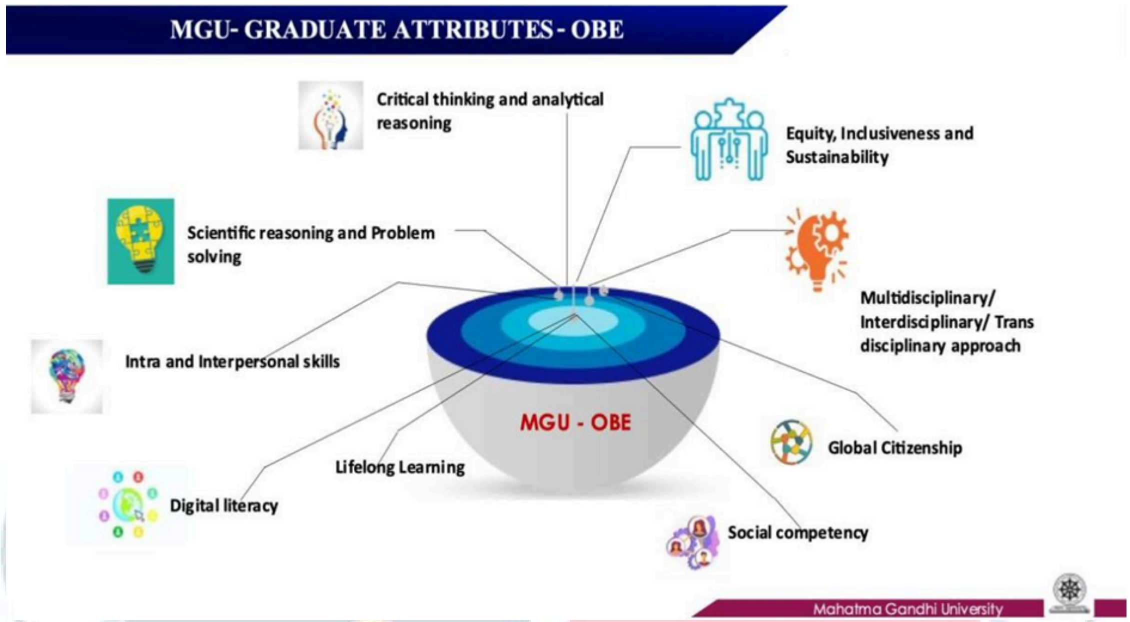
If any difficulty arises in giving effect to the provisions of these Regulations, the Principal may by order make such provisions not inconsistent with the Act, Statutes, Ordinances or other Regulations, which appears to him to be necessary or expedient for removing the difficulty. Every order made under this rule shall be subject to ratification by the appropriate university authorities.

30. Modifications to the Regulations

Notwithstanding anything contained in these Regulations, any amendments or modifications issued or notified by the University Grants Commission or the State Government, from time to time, shall be deemed to have been incorporated into these Regulations and shall constitute an integral part thereof.

Graduate Attributes (GA) of St. Albert's College Autonomous

The fundamental premise underlying the learning outcomes-based approach to curriculum planning and development is that higher education qualifications are awarded on the basis of demonstrated achievement of outcomes (expressed in terms of knowledge, understanding, skills, attitudes and values) and academic standards expected. The expected learning outcomes are used as reference points that would help formulate graduate attributes, qualification descriptors, programme outcomes and course outcomes which in turn will help in curriculum planning and development, and in the design, delivery and review of academic programmes. The graduate attributes of St. Albert's College Autonomous are



GA 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

GA 2: Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

GA 3: Multidisciplinary/interdisciplinary/transdisciplinary Approach

Acquire interdisciplinary /multidisciplinary/transdisciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/transdisciplinary- approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

GA 4: Intra and Interpersonal skills

Ability to work effectively and respectfully with diverse teams; facilitate cooperative or coordinated effort on the part of a group, and act together as a group or a team in the interests of a common cause and work efficiently as a member of a team; lead the team to guide people to the right destination, in a smooth and efficient way.

GA 5: Digital literacy

Capability to use ICT in a variety of learning situations, demonstrate ability to access, evaluate, and use a variety of relevant information sources; and use appropriate software for analysis of data.

GA 6: Global citizenship

Possess knowledge of the values and beliefs of multiple cultures and a global perspective; and capability to effectively engage in a multicultural society and interact respectfully with diverse groups.

GA 7: Social Competency

Ability to contemplate the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

GA 8: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

GA 9: Lifelong Learning

Ability to acquire knowledge and skills, including “learning how to learn”, that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/reskilling.

Programme Outcomes (PO)

PO 1: Critical thinking and Analytical reasoning

Capability to analyse and evaluate evidence, arguments, claims, beliefs on the basis of empirical evidence; identify relevant assumptions or implications; formulate coherent arguments; critically evaluate practices, policies and theories to develop knowledge and understanding; critical sensibility to lived experiences, with self awareness and reflexivity of both self and society.

PO 2: Scientific reasoning and Problem solving

Ability to analyse, interpret and draw conclusions from quantitative/qualitative data; and critically evaluate ideas, evidence and experiences from an open-minded and reasoned perspective; capacity to extrapolate from what one has learned and apply their competencies to solve different kinds of non-familiar problems, rather than replicate curriculum content knowledge; and apply one's learning to real life situations.

PO 3: Multidisciplinary/interdisciplinary/trans-disciplinary Approach

Acquire interdisciplinary /multidisciplinary/trans-disciplinary knowledge base as a consequence of the learning they engage with their programme of study; develop a collaborative-multidisciplinary/interdisciplinary/trans-disciplinary approach for formulate constructive arguments and rational analysis for achieving common goals and objectives.

PO 4: Communication Skills

Ability to express thoughts and ideas effectively in writing and orally; Communicate with others using appropriate media; confidently share one's views and express herself/himself; demonstrate the ability to listen carefully, read and write analytically, and present complex information in a clear and concise manner to different groups.

PO 5: Leadership Skills

Ability to work effectively and lead respectfully with diverse teams; setting direction, formulating an inspiring vision, building a team who can help achieve the vision, motivating and inspiring team members to engage with that vision, and using management skills to guide people to the right destination, in a smooth and efficient way.

PO 6: Social Consciousness and Responsibility

Ability to contemplate the impact of research findings on conventional practices, and a clear understanding of responsibility towards societal needs and reaching the targets for attaining inclusive and sustainable development.

PO 7: Equity, Inclusiveness and Sustainability

Appreciate equity, inclusiveness and sustainability and diversity; acquire ethical and moral reasoning and values of unity, secularism and national integration to enable to act as dignified citizens; able to understand and appreciate diversity (caste, ethnicity, gender and marginalization), managing diversity and use of an inclusive approach to the extent possible.

PO 8: Moral and Ethical Reasoning

Ability to embrace moral/ethical values in conducting one's life, formulate a position/argument about an ethical issue from multiple perspectives, and use ethical practices in all work. Capable of demonstrating the ability to identify ethical issues related to one's work, avoid unethical behavior.

PO 9: Networking and Collaboration

Acquire skills to be able to collaborate and network with educational institutions, research organizations and industrial units in India and abroad.

PO 10: Lifelong Learning

Ability to acquire knowledge and skills, including "learning how to learn", that are necessary for participating in learning activities throughout life, through self-paced and self-directed learning aimed at personal development, meeting economic, social and cultural objectives, and adapting to changing trades and demands of work place through knowledge/skill development/re-skilling.

Syllabus Index

Name of the Major: Renewable Energy

Semester: 1

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	P	O
25SACVRE1SP101	Fundamentals of renewable energy technology	SDC A2	4	5	3	2	0
25SACVRE1SP102	Mathematics for renewable energy- 1	SDC A3	4	5	3	2	0
25SACVRE1ST101	Electrical fundamentals and electronics	SDC A1	4	4	4	0	0
25SACVRE1MD101	Renewable energy in daily life	MDC 1	3	3	3	0	0
25SACVRE1OJ101	OJT	OJT1	2	5 (Saturdays)	0	0	5
25SACVRE1MP101	Fundamentals of renewable energy technology	MPC B1	4	5	3	2	0

Semester: 2

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	P	O
25SACVRE2ST101	Energy and power fundamentals	SDC A4	4	4	4	0	0

25SACVRE2SP101	Solar photovoltaic systems	SDC A5	4	5	3	2	0
25SACVRE2SP102	Mathematics for Renewable Energy- 2	SDC A6	4	5	3	2	0
25SACVRE2MD101	Energy efficient buildings	MDC 1	3	4	2	2	0
25SACVRE2OJ101	OJT	OJT2	2	5 (Saturdays)	0	0	5
25SACVRE2MT101	Energy and power fundamentals	MPC B2	4	4	4	0	0

Semester: 3

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	**P**	**O**
25SACVRE3ST201	Material science for renewable energy technology	SDC A7	4	4	4	0	0
25SACVRE3SP201	Solar thermal technology	SDC A8	4	5	3	2	0
25SACVRE3SP202	Aerodynamics for wind turbine generators	SDC A9	4	5	3	2	0
25SACVRE3MD201	IKS for renewable energy transformation in Kerala	MDC 3	3	3	3	0	0
25SACVRE3AE201	English	AEC E2	3	3	3	0	0
25SACVRE3OJ201	OJT	OJT3	2	5 (Saturdays)	0	0	5
25SACVRE3MP201	Introduction to solar cell and applications	MPC B3	4	5	3	2	0

Semester: 4

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	P	O
25SACVRE4ST201	Sustainable development and climate changes	SDC A10	4	4	4	0	0
25SACVRE4SP201	Hydro power system	SDC A11	4	5	3	2	0
25SACVRE4SP202	Biomass conversion system	SDC A12	4	5	3	2	0
25SACVRE4SE201	Data analytic and computational techniques	SEC 1	3	3	3	0	0
25SACVRE4VA201	Environmental education	VAC 1	3	3	3	0	0
25SACVRE4IN201	Internship	INTERNSHIP	2	-	-	-	-
25SACVRE4MP201	Solar heating and cooling techniques	MPC B4	4	5	3	2	0

Semester: 5

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	P	O
25SACVRE5ST301	Tidal, nuclear and geothermal energy systems	SDC A13	4	4	4	0	0
25SACVRE5EP301	Energy storage systems	SDC A14 (Any one)	4	5	3	2	0

25SACVRE5EP302	Green Hydrogen Manufacturing and Applications						
25SACVRE5SP301	Grid integration and smart grid technologies	SDC A15	4	5	3	2	0
25SACVRE5SE301	Softwares for renewable energy system design	SEC 2	3	4	2	2	0
25SACVRE5VA301	Industrial Health and Safety	VAC 2	3	3	3	0	0
25SACVRE5MT301	Novel renewable energy sources	MPC B5	4	4	4	0	0

Semester: 6

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	Hours /week	Hour distribution/ week		
					L	P	O
25SACVRE6EP301	Power electronics	SDC A16 (Any one)	4	5	3	2	0
25SACVRE6EP302	Photovoltaic module installation						
25SACVRE6SP301	Wind power technology	SDC A17	4	5	3	2	0
25SACVRE6SE301	Renewable energy policies and business models	SEC 3	3	3	3	0	0
25SACVRE6VA301	Energy conservation techniques	VAC 3	3	3	3	0	0
25SACVRE6PR301	Project	PROJECT	4	8	0	8	0
25SACVRE6MT301	Energy Management & Auditing	MPC B6	4	4	4	0	0

B.Voc Honours with Minor

Semester: 7 & 8

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	No. of days	Credit distribution		
					L	P	O
25SACVRE7SN401	APPRENTICESHIP	SDC	28	280	0	28	0
*************	----------------	MPC B7	4	NA	4	0	0
************	----------------	MPC B8	4	NA	4	0	0
************	----------------	MPC B9	4	NA	4	0	0

B.Voc Honours with Research with Minor

Semester: 7 & 8

L- Lecture, P- Practical/Practicum, O- On the Job Training

Course Code	Title of the course	Type of the course	Credit	No. of days	Credit distribution		
					L	P	O
25SACVRE7SR401	RESEARCH INTERNSHIP	SDC	20	200	0	20	0
**************	*Online	SDC A18					
*************	*Online	SDC A19					
*************	----------------	MPC B7	4	NA	4	0	0
************	----------------	MPC B8	4	NA	4	0	0
************	----------------	MPC B9	4	NA	4	0	0

Job Roles and Qualification packs for certificate, Diploma, Bachelor's and Honours Degrees.

Job Roles	NHEQF Level	QPs Aligned	Sector Skill
Solar PV Installer	4.5	SGJ/Q0101	Renewable Energy / Environmental Science
Solar PV Module Manufacturing Technician	5	SGJ/Q0119	Renewable Energy / Environmental Science
Solar Enterprise Assistant Manager	5.5	SGJ/Q2601	Renewable Energy / Environmental Science
Rooftop Solar Grid Junior Engineer	6	SGJ/Q0106	Renewable Energy / Environmental Science

Semester 1

Course Code	Title of the course
25SACVRE1SP101	Fundamentals of renewable energy technology
25SACVRE1SP102	Mathematics for renewable energy- 1
25SACVRE1ST101	Electrical fundamentals and electronics
25SACVRE1MD101	Renewable energy in daily life
25SACVRE1AE101	English
25SACVRE1OJ101	OJT
25SACVRE1MP101	Fundamentals of renewable energy technology

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Fundamentals of renewable energy technology</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1SP101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive introduction to the principles and applications of renewable energy systems. It covers the fundamental scientific and engineering concepts behind various renewable energy sources, including solar, wind and biomass energy. The course emphasizes the need for sustainable energy development, energy conversion processes, and the environmental implications of renewable energy utilization. Students will gain foundational knowledge of energy resource assessment, system components, efficiency analysis, and practical implementation of renewable technologies.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practical/ Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the classifications and characteristics of various energy sources.	K	PO1, PO4
2	Explain the fundamental principles and working mechanism of various renewable energy sources.	U	PO1, PO2
3	Apply the fundamental principles of energy conversion	A	PO1, PO2
4	Analyze the performance of various solar collectors, wind system and biomass conversion systems	An	PO2, PO7
5	To get expertise in using various components and instruments	A	PO1, PO2 PO10
6	Analyze the performance of various biogas plants	An	PO2, PO4, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	1	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	0	3	0	0	0	0	1	0	0	0
CO 5	2	3	0	0	0	0	0	0	0	1
CO 6	0	3	0	2	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to energy sources**		**15**	
	1.1	Classification of energy sources	1	1
	1.2	Energy sources and their availability	1	1
	1.3	Conventional energy sources	2	1
	1.4	Non-conventional energy sources	2	1
	1.5	Advantages of renewable energy sources	1	1
	1.6	Practical- Familiarization and operational experience of solar energy measurement instruments	8	5
2	**Solar energy**		**20**	
	2.1	Radiation	1	2
	2.2	Solar constant	2	2
	2.3	Principle of conversion of solar radiation into heat	2	3
	2.4	Solar collectors	3	4
	2.5	Solar photovoltaic system	1	4
	2.6	Greenhouse effect	1	1
	2.7	Practical- Familiarization of solar collectors	10	5

3	**Wind energy**		**20**	
	3.1	Nature of the wind	2	2
	3.2	Wind energy conversion	3	3
	3.3	Site selection considerations	2	4
	3.4	Components of wind energy conversion system	2	4
	3.5	Applications of wind energy	3	4
	3.6	Interconnected systems	2	4
	3.7	Practical- Measurement of wind speed	6	5
4	**Biomass**		**20**	
	4.1	Categories of biomass resources	2	4
	4.2	Biomass conversion technologies	3	4
	4.3	Biogas generation	4	4
	4.4	Community biogas plants	3	4
	4.5	Materials used for biogas generation	2	4
	4.6	Practical- Analysis of performance of a biogas plant	6	6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17

Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Non-conventional energy sources- G D Rai, Khanna publishers, chapters 1, 2, 3, 4, 6, 7

SUGGESTED READINGS

1. Non conventional energy sources and utilization (Energy engineering), R K Rajput, 2012, first edition, S. Chand & company ltd.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT'S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Mathematics for Renewable Energy I</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1SP102</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a foundational understanding of essential mathematical concepts and their application using computational tools, particularly MATLAB. It is designed to strengthen the learner's analytical and problem-solving skills across a range of mathematical domains such as Number Systems,Basic Computational Techniques , Solving Equations,Matrix Operations and Applications,Trigonometric Functions and Set operations.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td>Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td></td><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recalling the basics of number systems,basic computational techniques and solving of equations	K	PO1, PO2, PO10
2	Understanding the basics of MATLAB	U , A	PO1, PO3
3	Analysing the different matrix operations and its applications	A , An	PO1, PO2
4	Understanding and analysing the different trigonometric functions	An	PO1, PO2
5	Understanding the different set operations	U	PO1, PO2

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	2
CO 2	2	2	2	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	2	2	0	0	0	0	0	0	0	0
CO 5	2	2	0	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Computational Mathematics**		**15**	
	1.1	Types of numbers, HCF & LCM,	2	1
	1.2	Fractions,simplifications, squares and square roots	2	1
	1.3	Quadratic equations and linear equations	3	1
	1.4	Practical: Performing different arithmetic and algebraic operations	8	1,2
2	**Introduction to Matrices**		**20**	
	2.1	Basic Matrix Operations: Addition, subtraction, and scalar multiplication	4	3
	2.2	Transpose of a matrix - Matrix multiplication - Special Matrices and Functions: Identity matrix - Zeros and ones matrix - Diagonal matrix	4	3
	2.3	Matrix Algebra Applications: Determinant - Inverse of a matrix - Rank of a matrix - Trace of a matrix.	4	3

	2.4	Practical : Constructing a matrix, performance of arithmetic operations and finding its inverse.	8	2 , 3

3	**Introduction to Trigonometric Functions**		**20**	
	3.1	Overview of sine and cosine functions	3	4
	3.2	Definitions and properties (periodicity, amplitude, frequency, phase shift)	3	4
	3.3	Relationship between sine and cosine	3	4
	3.4	Basics of circle geometry and parametric equations of a circle	3	4
	3.5	Practical: Plot different trigonometric functions	8	2, 4

4	**Basics of Set Theory**		**20**	
	4.1	Definition of sets and elements, Set notation and roster/tabular form	2	5
	4.2	Types of sets: finite, infinite, empty (null) set, singleton	3	5
	4.3	Subsets, proper subsets, power sets	3	5
	4.4	Set Operations: Union, intersection, difference, complement	3	5

	4.5	Properties of set operations and Cartesian product of sets	3	5
	4.6	Practical: Analysing the different set operations	6	2, 5
5		**Teacher Specific Content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)

Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Program/ Demonstration	10
Skill and Performance	10
Output	10
Viva	5

References

1. Steven J. Leon, “Discrete Mathematics Using MATLAB”
2. R.D. Sharma, “Algebra, Calculus, Trigonometry, Coordinate Geometry, etc.”

SUGGESTED READINGS

1. Rosen,Kenneth H. “Discrete Mathematics and its Applications”.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Electrical fundamentals and electronics</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1ST101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the foundational principles of electrical and electronics. It begins with basic electrical concepts and extends to the analysis of DC and AC circuits using fundamental laws and theorems. The course also explores essential electronic components along with their applications in rectification and amplification.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall basic electrical laws, circuit components, and electronic device symbols.	K	PO1
2	Understand the basic concepts and laws of electric circuits.	U	PO1, PO2
3	Apply fundamental laws and theorems to calculate electrical parameters in simple circuits.	A	PO2, PO10
4	Identify and explain the characteristics and working principles of basic electronic devices	U, A	PO1, PO2
5	Design simple rectifier and amplifier circuits using semiconductor devices.	A	PO1, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	0	2	0	0	0	0	0	0	0	1
CO 4	2	2	0	0	0	0	0	0	0	0
CO 5	2	0	0	0	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Electrical measurements and controls**		**15**	
	1.1	Voltage sources-constant voltage source- constant current sources	3	1
	1.2	Ohm's law- resistors- fixed and variable- colour code- capacitors- inductors	3	1
	1.3	Types of cables- hook-up, coaxial- multicore power and control cable	3	1
	1.4	Switches- slide- toggle- push to on and push to off	3	1
	1.5	Applications of rocker- construction and working of relay	3	1

2	**Varying and alternating current**		**15**	
	2.1	Growth and decay of current through inductor, charging and discharging of capacitor	5	2
	2.2	Alternating current- peak and rms value	4	2
	2.3	LCR circuit- series and parallel- practical applications- Q-factor- power factor	6	2

3	**Network theorems**		**10**	
	3.1	Distribution of three phase current- star connection- delta connection	3	3

	3.2	Thevenin’s theorem	2	3
	3.3	Norton's theorem	2	3
	3.4	Maximum power transfer theorem, superposition theorem	3	3

4	**Electronics**		**20**	
	4.1	Atomic structure- electrons- valence electrons- conduction electrons- Classification of materials- metals- insulators- semiconductors	5	4
	4.2	Doping- pn junction- biasing	3	4
	4.3	Diodes, applications, rectifiers, filter circuits	3	5
	4.4	Zener diode voltage regulation	2	5
	4.5	Transistors, amplifiers, transistor as a switch	4	5
	4.6	LED, phototransistor	3	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Principles of electronics- V K Mehta and Rohith Megta, S. Chand and Company ltd. Chapters 1, 8, 9, 10, 11.
2. A textbook of applied electronics- R S Sedha, S. Chand and Company ltd. Chapter 33

SUGGESTED READINGS

1. Electricity and magnetism- K K Tewari, S Chand & company Ltd.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Renewable Energy in Daily Life</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1MD101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course will introduce different types of renewable energy resources like solar, wind, biomass, geothermal and nuclear and discusses solar , wind and biomass in detail.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>3</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the classification of energy sources	K, U	PO1, PO3
2	Integrating renewable energy in daily life	A	PO1, PO6, PO8
3	Understanding the principles of energy economics and energy conservation	U	PO1, PO3
4	Executing an environmentally sustainable attitude	A	PO7, PO8, PO10
5	Estimating the challenges in the renewable energy sector	U, An	PO1, PO5
6	Extending the knowledge to the society	U, A	PO4, PO5, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	1	0	0	0	0	0	0	0
CO 2	2	0	0	0	0	2	0	1	0	0
CO 3	2	0	2	0	0	0	0	0	0	0
CO 4	0	0	0	0	0	0	2	2	1	0
CO 5	1	0	0	0	2	0	0	0	0	0
CO 6	0	0	0	2	2	1	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to energy sources**		**15**	
	1.1	Classification of energy sources- primary, secondary and supplementary	2	1
	1.2	Energy sources and their availability	2	1
	1.3	The energy crisis and climate change	2	1, 2
	1.4	Importance of renewable energy in reducing carbon footprint	2	4
	1.5	Qualitative ideas of solar energy	1	1
	1.6	Wind energy, biomass	2	1
	1.7	Tidal energy and geothermal energy	1	1
	1.8	Renewable energy resources- advantages and obstacles	1	1
	1.9	Earlier applications of renewable energy	1	2
	1.10	Growth & development of renewable energy-	1	1

2	**Applications in daily life**		**15**	
	2.1	Categories of solar energy applications	1	2

	2.2	solar water heating	1	2
	2.3	space heating- passive heating-direct gain	2	2, 3
	2.4	thermal storage wall- attached sunspace	1	3
	2.5	roof storage- solar distillation	2	2
	2.6	qualitative ideas of solar pumping, solar furnace	1	2, 4
	2.7	solar cooking, solar thermal electric conversion and solar electric power generation	2	2
	2.8	Solar street lighting and home lighting systems	1	2, 4
	2.9	Biogas for cooking in rural areas	1	2, 6
	2.10	Wind-powered water pumps	1	2
	2.11	Hybrid energy systems for homes and small communities.	2	2

3	**Energy conservation**		**15**	
	3.1	Economic concept of energy	3	3
	3.2	Principles of energy conservation	3	3
	3.3	Energy conservation approaches	3	3, 6
	3.4	Cogeneration- types- waste heat utilization	3	3

	3.5	Heat exchanger- uses- classification.	3	3, 5
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Leverage a blended learning approach with a mix of lectures, interactive discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 30 out of 32
Part B	5 mark	Answer any 4 out of 6

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Non-conventional energy sources- G D Rai, Khanna publishers

SUGGESTED READINGS

1. Solar energy- fundamentals and applications- H P Garg and J Prakash.
2. Non conventional energy sources and utilization (Energy engineering), R K Rajput, 2012, first edition, S. Chand & company ltd.

<table>
<tr><td colspan="6">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">On- Job Training</td></tr>
<tr><td>Type of Course*</td><td colspan="5">OJT</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1OJ101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is designed to bridge the gap between academic learning and industry requirements. It provides students with practical exposure and hands-on experience in real-world renewable energy projects and workplaces. Through this learning experience, students apply theoretical knowledge, develop technical and soft skills, understand work ethics, and gain familiarity with industrial practices and safety protocols.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>2</td><td rowspan="2">Hours/ week*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	PO1, PO2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	PO8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	PO2, PO7, PO10
4	Communicate effectively and collaborate with professionals and team members.	A, An	PO4, PO9
5	Prepare technical reports and presentations on work experiences and learnings.	C	PO4

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	2	0	0
CO 3	0	2	0	0	0	0	2	0	0	2
CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	2	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT
	A. Continuous Comprehensive Assessment (CCA)

Total mark: 15	
Type of assessment	
Feedback from the hosting organization	5
Internal supervisor feedback	10

B. End Semester Evaluation (ESE)

Total mark: 35	
Type of assessment	
Presentation	10
Report	10
Viva	15

<table>
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<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Fundamentals of renewable energy technology</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MPC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE1MP101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive introduction to the principles and applications of renewable energy systems. It covers the fundamental scientific and engineering concepts behind various renewable energy sources, including solar, wind and biomass energy. The course emphasizes the need for sustainable energy development, energy conversion processes, and the environmental implications of renewable energy utilization. Students will gain foundational knowledge of energy resource assessment, system components, efficiency analysis, and practical implementation of renewable technologies.</td></tr>
<tr><td>Semester*</td><td>1</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the classifications and characteristics of various energy sources.	K	PO1, PO4
2	Explain the fundamental principles and working mechanism of various renewable energy sources.	U	PO1, PO2
3	Apply the fundamental principles of energy conversion	A	PO1, PO2
4	Analyze the performance of various solar collectors, wind system and biomass conversion systems	An	PO2, PO7
5	To get expertise in using various components and instruments	A	PO1, PO2 PO10
6	Analyze the performance of various biogas plants	An	PO2, PO4, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	1	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	0	1	0	0	0
CO 5	2	2	0	0	0	0	0	0	0	1
CO 6	0	2	0	2	0	2	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to energy sources**		**15**	
	1.1	Classification of energy sources	1	1
	1.2	Energy sources and their availability	1	1
	1.3	Conventional energy sources	2	1
	1.4	Non-conventional energy sources	2	1
	1.5	Advantages of renewable energy sources	1	1
	1.6	Practical- Familiarization and operational experience of solar energy measurement instruments	8	5
2	**Solar energy**		**20**	
	2.1	Radiation	1	2
	2.2	Solar constant	2	2
	2.3	Principle of conversion of solar radiation into heat	2	2, 3
	2.4	Solar collectors	3	4
	2.5	Solar photovoltaic system	1	4
	2.6	Greenhouse effect	1	1
	2.7	Practical- Familiarization of solar collectors	10	5
3	**Wind energy**		**20**	
	3.1	Nature of the wind	2	2

	3.2	Wind energy conversion	3	3
	3.3	Site selection considerations	2	4
	3.4	Components of wind energy conversion system	2	4
	3.5	Applications of wind energy	3	4
	3.6	Interconnected systems	2	4
	3.7	Practical- Measurement of wind speed	6	5
4	**Biomass**		**20**	
	4.1	Categories of biomass resources	2	4
	4.2	Biomass conversion technologies	3	4
	4.3	Biogas generation	4	4
	4.4	Community biogas plants	3	4
	4.5	Materials used for biogas generation	2	4
	4.6	Practical- Analysis of performance	6	6

		of a biogas plant		
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50
Assessment methods: Written Exam

Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Non-conventional energy sources- G D Rai, Khanna publishers, chapters 1, 2, 3, 4, 6, 7

SUGGESTED READINGS

1. Non conventional energy sources and utilization (Energy engineering), R K Rajput, 2012, first edition, S. Chand & company ltd.

Semester 2

Course Code	Title of the course
25SACVRE2ST101	Energy and power fundamentals
25SACVRE2SP101	Solar photovoltaic systems
25SACVRE2SP102	Mathematics for Renewable Energy- 2
25SACVRE2MD101	Energy efficient buildings
25SACVRE2AE101	English
25SACVRE2OJ101	OJT
25SACVRE2MT101	Energy and power fundamentals

	DEPARTMENT OF RENEWABLE ENERGY ST. ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM				
Faculty/ Discipline*	Science				
Programme	B. Voc. (Honours) Renewable Energy				
Course Name*	Energy and Power Fundamentals				
Type of Course*	SDC				
Course Code	25SACVRE2ST101				
Course Level*	100-199				
Course Summary	This course introduces the basics of electrical energy and power systems, covering circuit elements, voltage and current sources, and key AC concepts like phasor representation and power. It explores load characteristics and power factor, explaining different types of loads and the importance of improving power factor. The electrical tariff and energy metering module discusses various tariff structures, meter types, and billing methods. It also focuses on energy conservation and management, highlighting the need for energy audits, efficiency standards, and government policies. Overall, the course provides a foundational understanding of power systems, energy consumption, and strategies for efficient energy use.				
Semester*	2	**Credits***		4	**Total Hours***
Course Details	**Learning Approach**	**Lecture***	**Practicum ***	**OJT***	
		4	0	0	60
Pre-requisites, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the basics of electrical energy and power systems	K	PO 1, PO 2
2	Understand the fundamentals of Load Characteristics and Power Factor	U	PO 1, PO 2
3	Analyze the objectives and types of Electrical Tariff and Energy Metering	An	PO 1, PO 2, PO 6
4	Evaluate the need and methods of Energy Conservation and Management	E	PO 1, PO 2, PO 6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	2	0	0	0	0
CO 4	2	2	0	0	0	3	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basics of Electrical Energy and Power Systems**		**15**	
	1.1	DC- Electrical circuit elements (R, L, C), Voltage and current sources	4	1
	1.2	AC- Phasor representation of sinusoidal quantities, Peak and rms values	4	1
	1.3	Concepts of power and Energy, Active power, Reactive power, apparent power	3	1
	1.4	Introduction to Power System: Generation, Transmission, Distribution.	4	1

Module	Units	Course description	Hrs	CO No.
2	**Load Characteristics and Power Factor**		**15**	
	2.1	Types of Loads: Resistive, Inductive, Capacitive	3	2
	2.2	Load Curves: Daily Load Curve-Monthly and Annual Load Curves	4	2
	2.3	Load Factor, Demand Factor, Diversity Factor, Utilization Factor	4	2
	2.4	Power and Power Factor-Importance of improving the Power Factor	4	2

3	**Electrical Tariff and Energy Metering**		**15**	
	3.1	Introduction to Tariff: Objectives and Principles of a Good Tariff	5	3
	3.2	Types of Tariffs: Flat Rate Tariff, Block Rate Tariff, Two-Part Tariff, Maximum Demand Tariff, Time-of-Day Tariff-	5	3
	3.3	Energy Metering: Types of Energy Meters (Analog, Digital, Smart Meters)-Reading and Billing.	5	3
4	**Energy Conservation and Management**		**15**	
	4.1	Need for Energy Conservation	1	4
	4.2	Energy Audit: Types and Methods	5	4
	4.3	Standards and Labels (BEE Star Ratings)	5	4
	4.4	Government Policies on Energy Efficiency	4	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. J.B. Gupta – *A Course in Power Systems,* "Detailed analysis of load factor, plant factor, tariffs, transmission, and distribution".
2. V.K. Mehta & Rohit Mehta – *Principles of Power System,* "Clear explanations of tariff types, load characteristics, and power factor".

3. Kothari and Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2006.

SUGGESTED READINGS

1. Guidebooks from BEE (Bureau of Energy Efficiency), Govt. of India, Book 1: General Aspects of Energy Management and Energy Audit.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Solar photovoltaic systems</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2SP101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100-199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course will introduce solar cells- its construction, characteristics, uses and applications.It also discusses solar photovoltaic system design, battery systems and grid interfacing. Also introduce few topics related to electrical wiring</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Display a comprehensive technological understanding in solar PV components	A	PO1, PO2
2	Understand solar PV system design	U	PO2, PO9
3	Display knowledge and skills to design, analyze, and optimize battery-powered systems for grid integration.	A	PO1, PO2
4	Identify appropriate equipment, construct circuits, follow safety protocols, troubleshoot common faults, and understand electrical standards.	K,U	PO1, PO2,PO5
5	Analyse photovoltaic system performance and design	An	PO1, PO2 PO7
6	Analyze the performance of various PV plants	An	PO1, PO2, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	0	0	0	0	0	0	1	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	2	3	0	0	1	0	0	0	0	0
CO 5	2	2	0	0	0	0	1	0	0	0
CO 6	1	2	0	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Solar Photovoltaic cell**		**20**	
	1.1	Solar Cell and its function, types	2	1
	1.2	Equivalent circuit diagrams of solar cells	2	1
	1.3	Solar Cell Parameters, Efficiency of Solar Cell	2	1
	1.4	Solar PV Module, Types of modules, Rating of Solar PV Module, PV Module Parameters, Efficiency of PV Module	2	1
	1.5	Measuring Module Parameters- Module cable outlets and junction boxes -Wiring symbols	2	1
	1.6	Characteristic I-V curves for modules -Irradiance dependence and temperature characteristics- Hot spots, bypass diodes and shading-Quality certification for modules.	2	1
	1.7	Practical : Familiarize appropriate access equipment and basic roofing techniques for PV module installation, Carry out measurements within module and array	8	1,5,6

Module	Units	Course description	Hrs	CO No.
2	**Solar PV system design**		**20**	
	2.1	Design and functioning of a silicon solar cell	3	2

	2.2	Design options for PV modules- standalone photovoltaic system design	3	2
	2.3	Connection of PV Module in Series and Parallel	3	2
	2.4	Estimation and Measurement of PV Module Power, Selection of PV Module. Maximum Power Point Tracking.	3	2,5
	2.5	Practical : Illuminated IV characteristics of a solar cell – calculation of fill factor and efficiency, Series and parallel connection of solar cells, IV characteristics with series combination of modules, IV characteristics with parallel combination of modules	8	2,5,6
3	**Battery systems and Grid interfacing**		**15**	
	3.1	Batteries- type of batteries	2	3
	3.2	battery parameters-selection and maintenance.	3	3
	3.3	Grid synchronization-voltage considerations and power evacuation	3	3
	3.4	Practicum : Battery management system implementation	7	3,6
4	**Electrical Wiring**		**20**	
	4.1	Types of Wire, Wire Sizing	3	4

	4.2	Junction Box, DC cabling, AC cabling	3	4
	4.3	Array Combiner Box, AC Distribution Box, Energy Metering	3	4
	4.4	Electrical Grounding, Earth Resistance and Insulation Resistance Measurements.	4	4
	4.5	Practicum : Hands on exercises and experiments related to installing and troubleshooting electrical systems	7	4,6
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5

Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

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

SUGGESTED READINGS

1. Non-conventional energy sources- G D Rai, Khanna publishers.
2. Non conventional energy sources and utilization (Energy engineering), R K Rajput, 2012, first edition, S. Chand & company ltd.

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<tr><td>Programme</td><td colspan="5">B. Voc. (honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Mathematics for Renewable Energy- 2</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2SP102</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 -199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a foundational understanding of essential mathematical concepts and their applications. It is designed to strengthen the learner’s analytical and problem-solving skills across a range of mathematical domains such as Logic Gates, Conic Sections,Linear Programming Problem and Graph Theory</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the fundamental concepts of Boolean algebra and its operations.	U	PO1, PO2, PO3
2	Identifying and applying the standard equations of conic sections	A	PO1, PO2
3	Formulating real-world optimization problems as linear programming models	C	PO1, PO2
4	Creating an insight into the basics of graph theory	C	PO1, PO2

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	2	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	2	2	0	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Logic Gates**		**15**	
	1.1	Boolean Functions	3	1
	1.2	Representing Boolean Functions and Logic gates- AND, OR, NOT, XOR, XAND, NAND	3	1
	1.3	Truth table and its Circuits	3	1
	1.4	Practical :Realization of logic gates using diodes and transistors.	6	1
2	**Conic Sections**		**20**	
	2.1	Conic Sections- Standard equations - circle, parabola, ellipse, hyperbola.	6	2
	2.2	Shifting of circle, parabola, ellipse, and hyperbola.	6	2
	2.3	Practical : Plotting different conic sections using Geogebra	8	2
3	**Linear Programming Problem**		**20**	
	3.1	LPP and its mathematical formulation	6	3

	3.2	Graphical method of solving LPP	6	3
	3.3	Practical : Solving LPP and finding the feasible region using Geogebra	8	3
4	**Graph Theory**		**20**	
	4.1	Definitions and examples, connectedness, adjacency	2	4
	4.2	Sub graphs, matrix representation, null graphs	3	4
	4.3	Complete graphs, cyclic graphs, path graphs and wheels	3	4
	4.4	Regular graphs, bipartite graphs, complement of a simple graph.	4	4
	4.5	Practical : Sketching different types of graphs	8	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17

Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Program/ Demonstration	10
Skill and Performance	10
Output	10
Viva	5

References

1. Rosen,Kenneth H. “Discrete Mathematics and its Applications”.
2. Wilson,Robin J.“Introduction to Graph Theory”.
3. R.D. Sharma, Linear Programming Problem.

SUGGESTED READINGS

1. Chartrand, Gary, and Ping Zhang. A First Course in Graph Theory

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc.(honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Energy efficient buildings</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2MD101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100-199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the fundamentals of designing and evaluating buildings with a focus on energy efficiency and sustainability. It covers key concepts such as energy conservation, building envelope design, and the role of natural lighting, ventilation, and insulation in reducing energy demand. Students will learn about various systems affecting building energy performance and develop the skills to create or retrofit buildings that minimize energy consumption while maintaining occupant comfort and environmental responsibility.</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits*</td><td>3</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum*</td><td>OJT*</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Identify key components and systems that influence energy performance in buildings	K, U	PO1
2	Understand the principles of energy conservation and sustainability in building design.	U	PO1
3	Analyze the effect of various passive heating and cooling methods and day lighting.	An	PO2
4	Demonstrate awareness of green building rating systems.	U, A	PO1, PO6
5	Design energy-efficient building layouts to reduce energy consumption.	U, A	PO4, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	0	0	0	0	0	0	0
CO 2	2	0	0	0	0	0	0	0	0	0
CO 3	0	2	0	0	0	0	0	0	0	0
CO 4	1	0	0	0	0	2	0	0	0	0
CO 5	0	0	0	2	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Energy transfer and heat control in buildings**		**20**	
	1.1	Concept of energy efficient buildings	2	1
	1.2	Heat losses and Stack effect	2	1
	1.3	Influence of climate in building design	2	1, 2
	1.4	Thermal design	1	2
	1.5	Heating and cooling load	2	1
	1.6	Zero energy buildings	1	1
	1.7	Practical- Visit an energy efficiency building in nearby area	10	5
2	**Passive solar heating and cooling**		**10**	
	2.1	Principles of solar heating, direct, indirect and isolated heating	2	3
	2.2	Concepts of trombe wall and water wall	1	3
	2.3	Passive cooling, ventilation- design for natural ventilation- reradiation-	2	3

		evaporative cooling- thermal insulation		
	2.4	Air filtration and odour removal in buildings	1	3
	2.5	Practical- Calculate the ventilation size of the classroom/lab	4	3

3	**Day lighting and Green buildings**		**30**	
	3.1	Materials for day lighting, insulation-radiant barrier	2	3
	3.2	Sources of daylighting, building design strategies- daylight factor-components	2	3
	3.3	Daylighting analysis	2	3
	3.4	Electric lighting, illumination requirements in daylighted buildings	2	3
	3.5	Features of green buildings, green materials- integrated ecological design	2	4
	3.6	Sustainable site, landscaping enhancing ecosystem, microclimate	2	4
	3.7	High performance green buildings, economics, management, environment benefits	2	4

	3.8	Practical- Analyze the electrical lighting requirements of the given room	16	3
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**
	B. End Semester Evaluation (ESE) **Theory**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 15	
Assessment methods	
Assignment	5
Seminar/ Quiz/ Group Discussion	5
Test	5

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

Total mark: 35		
Assessment methods: Written Exam		
Duration of Examination: 1 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 20 out of 22
Part B	5 mark	Answer any 3 out of 5

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Understanding and application of concept	10
Data collection and analysis	10
Presentation	10
Viva	5

References

1. Energy efficient building in India- M. Majumdar, Tata energy research institute, ministry of nonconventional energy sources.
2. Solar energy- fundamentals and applications- H P Garg and J Prakash.

SUGGESTED READINGS

1. Means .R.S, “Green Building: Project Planning and Cost Estimating”, Kingston, 2006
2. Kibert .C.J. “Sustainable Construction: Green Building Design”, 2nd edition, Wiley, 2007.

<table>
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ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">On- Job Training</td></tr>
<tr><td>Type of Course*</td><td colspan="5">OJT</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2OJ101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100 - 199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is designed to bridge the gap between academic learning and industry requirements. It provides students with practical exposure and hands-on experience in real-world renewable energy projects and workplaces. Through this learning experience, students apply theoretical knowledge, develop technical and soft skills, understand work ethics, and gain familiarity with industrial practices and safety protocols.</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits*</td><td>2</td><td rowspan="2">Hours/ week*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>5</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	PO1, PO2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	PO8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	PO2, PO7, PO10
4	Communicate effectively and collaborate with professionals and team members.	A, An	PO4, PO9
5	Prepare technical reports and presentations on work experiences and learnings.	C	PO4

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	2	0	0
CO 3	0	2	0	0	0	0	2	0	0	2
CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	3	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

<table>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
<table><tr><td colspan="2">Total mark: 15</td></tr><tr><td colspan="2">Type of assessment</td></tr><tr><td>Feedback from the hosting organization</td><td>5</td></tr><tr><td>Internal supervisor feedback</td><td>10</td></tr></table></td></tr>
<tr><td>B. End Semester Evaluation (ESE)
<table><tr><td colspan="2">Total mark: 35</td></tr><tr><td colspan="2">Type of assessment</td></tr><tr><td>Presentation</td><td>10</td></tr><tr><td>Report</td><td>10</td></tr><tr><td>Viva</td><td>15</td></tr></table></td></tr>
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<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT'S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Energy and Power Fundamentals</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MPC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2MT101</td></tr>
<tr><td>Course Level*</td><td colspan="5">100-199</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the basics of electrical energy and power systems, covering circuit elements, voltage and current sources, and key AC concepts like phasor representation and power. It explores load characteristics and power factor, explaining different types of loads and the importance of improving power factor. The electrical tariff and energy metering module discusses various tariff structures, meter types, and billing methods. It also focuses on energy conservation and management, highlighting the need for energy audits, efficiency standards, and government policies. Overall, the course provides a foundational understanding of power systems, energy consumption, and strategies for efficient energy use.</td></tr>
<tr><td>Semester*</td><td>2</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisite, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall the basics of electrical energy and power systems	K	PO 1, PO 2
2	Understand the fundamentals of Load Characteristics and Power Factor	U	PO 1, PO 2
3	Analyze the objectives and types of Electrical Tariff and Energy Metering	An	PO 1, PO 2, PO 6
4	Evaluate the need and methods of Energy Conservation and Management	E	PO 1, PO 2, PO 6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate I, Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	2	0	0	0	0
CO 4	2	2	0	0	0	3	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basics of Electrical Energy and Power Systems**		**15**	
	1.1	DC- Electrical circuit elements (R, L, C), Voltage and current sources	4	1
	1.2	AC- Phasor representation of sinusoidal quantities, Peak and rms values	4	1
	1.3	Concepts of power and Energy, Active power, Reactive power, apparent power	3	1
	1.4	Introduction to Power System: Generation, Transmission, Distribution.	4	1
2	**Load Characteristics and Power Factor**		**15**	
	2.1	Types of Loads: Resistive, Inductive, Capacitive	3	2
	2.2	Load Curves: Daily Load Curve-Monthly and Annual Load Curves	4	2
	2.3	Load Factor, Demand Factor, Diversity Factor, Utilization Factor	4	2
	2.4	Power and Power Factor-Importance of improving the Power Factor	4	2
3	**Electrical Tariff and Energy Metering**		**15**	

	3.1	Introduction to Tariff: Objectives and Principles of a Good Tariff	5	3
	3.2	Types of Tariffs: Flat Rate Tariff, Block Rate Tariff, Two-Part Tariff, Maximum Demand Tariff, Time-of-Day Tariff-	5	3
	3.3	Energy Metering: Types of Energy Meters (Analog, Digital, Smart Meters)-Reading and Billing.	5	3
4	**Energy Conservation and Management**		**15**	
	4.1	Need for Energy Conservation	1	4
	4.2	Energy Audit: Types and Methods	5	4
	4.3	Standards and Labels (BEE Star Ratings)	5	4
	4.4	Government Policies on Energy Efficiency	4	4
5	**Teacher Specific Content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. J.B. Gupta – *A Course in Power Systems, "*Detailed analysis of load factor, plant factor, tariffs, transmission, and distribution".
2. V.K. Mehta & Rohit Mehta – *Principles of Power System, "*Clear explanations of tariff types, load characteristics, and power factor".
3. Kothari and Nagrath, Basic Electrical Engineering, Tata McGraw Hill, 2nd Edition, 2006.

SUGGESTED READINGS

1. Guidebooks from BEE (Bureau of Energy Efficiency), Govt. of India, Book 1: General Aspects of Energy Management and Energy Audit.

Semester 3

Course Code	**Title of the course**
25SACVRE3ST201	Material science for renewable energy technology
25SACVRE3SP201	Solar thermal technology
25SACVRE3SP202	Aerodynamics for wind turbine generators
25SACVRE3MD201	IKS for renewable energy transformation in Kerala
25SACVRE3AE201	English
25SACVRE3OJ201	OJT
25SACVRE3MP201	Introduction to solar cell and applications

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Material Science for Renewable Energy Technology</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE3ST201</td></tr>
<tr><td>Course Level</td><td colspan="5">200 -299</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the fundamental properties, testing methods, and environmental effects on engineering materials such as metals, polymers, semiconductors, and nanomaterials. It covers the role of materials in renewable energy, including applications of nanomaterials and biodegradable polymers. Emphasis is placed on practical understanding of material behavior, performance, and sustainability for real-world renewable energy systems.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the fundamental properties of various materials and nanomaterials, and their applications in renewable energy, electronics, healthcare, and environmental contexts.	K, U, A	PO2, PO10
2	Gain knowledge of the concepts of stress, strain, and deformation, and analyze the mechanical behavior of materials under various conditions.	K, An, A	PO2
3	Identify and analyze the environmental effects on materials and failure mechanisms of solar materials.	U, An	PO6, PO7
4	To understand natural and synthetic polymers and evaluate their environmental impacts.	U, A	PO2, PO6, PO7

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	2	0	0	0	0	0	0	0	2
CO 2	0	2	0	0	0	0	0	0	0	0
CO 3	0	0	0	0	0	0	2	0	0	0
CO 4	0	2	0	0	0	2	2	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Properties of Materials**		**20 hrs**	
	1.1	Mechanical, Optical, Thermal Electrical and Magnetic Properties of Metals, Alloys, Semiconductors, Polymers, Glass, Nanomaterials and Magnetic Materials	5	1
	1.2	Superconductivity and Applications. Nanomaterials- properties	5	1
	1.3	Nanomaterials in renewable energy, Nanocatalysts in hydrogen generation, Nanocoatings for solar cells, Sensors, Photodetectors, LEDs, Drug delivery and diagnostics (basic overview)	5	1
	1.4	Environmental and military concerns: destructive uses of nanomaterials.	5	1
2	**Testing of Materials**		**15 hrs**	
	2.1	Concepts of Stress and Strain, Hooke's Law, Tension, Compression and Shear	5	2
	2.2	Stress-strain Diagram and Thermal Stresses	4	2
	2.3	Elasticity in Metals and Polymers, Plastic Deformation, Yield Stress, Shear Strength, Strengthening Mechanisms	6	2

3	**Effects on Materials**		**10 hrs**	
	3.1	Environmental Effects - Corrosion, Erosion, Thermal Stress and Weathering Properties of Solar Materials	5	3
	3.2	Effect of Temperature, Fracture Behavior of Various Materials, Failure Analysis of Solar	5	3

		Materials		
4	**Natural and Synthetic Polymers**		**15 hrs**	
	4.1	Classification - Natural and Synthetic	3	4
	4.2	Types - linear, branched, cross-linked, Common polymers - Polyethene, PVC, Nylon, Polyester - Rubber	4	4
	4.3	Natural and synthetic types - Natural rubber: structure, vulcanization, Synthetic rubbers: basic examples (SBR, neoprene)	4	4
	4.4	Environmental impact of plastics – Biodegradable Polymers	4	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

<table>
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B. End Semester Evaluation (ESE)
Theory

<table>
<tr><td colspan="3">Total mark: 70</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 2 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 25 out of 27</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 5 out of 7</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>

Part A can be objective type, fill in the blanks, multiple choice etc.
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</table>

References

1. Ramamrutam S., "Strength of Materials", 16th edition, Danpat Rai Publications, 2010.
2. Callister W.D.., Materials Science and Engineering 6th edition, Wiley India, 2009.

SUGGESTED READINGS

1. Sheckel ford J., F. Muralidham M.K., "Introduction to Materials Science for Engineers", 6th edition, Pearson, 2007.

DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM

Faculty/ Discipline	Science				
Programme	B.Voc. (Honours) Renewable Energy				
Course Name	Solar Thermal Technology				
Type of Course	SDC				
Course Code	25SACVRE3SP201				
Course Level	200 -299				
Course Summary	This course provides a comprehensive overview of solar thermal energy systems, focusing on the principles, design, and applications of technologies that harness solar energy for thermal use. It covers the fundamentals of solar radiation, various types of solar thermal collectors, and energy storage techniques. Students will explore thermal system design for water heating, space heating, industrial process heat, and power generation.				
Semester	3	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	Basic thermodynamics				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recall the basic principles of solar radiation and thermal energy conversion.	K	PO1
2	Explain the working principles and classifications of	U	PO1

	various solar thermal collectors.		
3	Apply heat transfer and thermodynamic concepts to analyze the performance of solar thermal systems.	A	PO1, PO6
4	Analyze the design and efficiency parameters of solar water heating and space heating systems.	An	PO2
5	Understand the principles of energy conservation and sustainability in building design.	U	PO4, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	0	0	0	0	0	0	0
CO 2	2	0	0	0	0	0	0	0	0	0
CO 3	2	0	0	0	0	1	0	0	0	0
CO 4	0	2	0	0	0	0	0	0	0	0
CO 5	0	0	0	2	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Solar Radiation**		**15 hrs**	
	1.1	Sun as the source of radiation- direct and diffuse radiation	2	1
	1.2	Solar constant- variation of radiation- basic earth sun angles- solar time	2	1

	1.3	Basic earth sun angles- solar time	3	1
	1.4	Measurement of solar radiation- Pyranometer, Pyrheliometer, Sunshine recorder.	4	1
	1.5	Practical- Study the hourly Variation of solar radiation.	4	1
2	**Solar Collectors**		**20 hrs**	
	2.1	Flat plate collectors- liquid flat plate collectors- materials for flat plate collector	2	2
	2.2	Heat loss- factors affecting the efficiency and improvement- effect of inclination and dust	2	2
	2.3	Flat plate air heating collectors- types- two pass solar air heater- overlapped glass plate air heater- matrix air heater- honeycomb porous bed air heater	2	2
	2.4	Solar pond	1	2
	2.5	Tubular solar energy collectors- concentric tube collectors	2	2
	2.6	Solar concentrating collectors- parameters- classifications- cylindrical and compound parabolic collectors	3	2
	2.7	Mountings- tracking requirement of compound parabolic concentrating collectors- point focusing solar concentrators- central power receiver. systems- heliostat- materials	2	2
	2.8	Practical- 1. Effect of tilt angle on solar thermal collector efficiency of a flat plate collector 2. Thermosyphonic mode of flow in flat plate collector and evaluation of parameters.	6	2, 3

	Solar Thermal Applications		**20 hrs**	
	3.1	Solar water heating- swimming pool heating- built in storage type- separate collector and storage type-	2	4

3		natural circulation- forced circulation		
	3.2	Solar cookers- types- solar desalination- simple solar still- basics- solar disinfection	2	4
	3.3	Solar dryers- basics- types (qualitative idea only)- Solar furnace- types- components- designs	3	4
	3.4	Solar greenhouse- greenhouse design- orientation and tilt- modes of heat transfer- glass or plastic greenhouse- Brace greenhouse design- KISR design	3	4
	3.5	Practical- 1. Evaluation of efficiency in solar still 2. Demonstration of solar cooker and dryer	10	3, 4
4	**Solar Heating and Cooling of Buildings**		**20 hrs**	
	4.1	Passive solar heating- direct gain- thermal storage wall- attached greenhouse- thermal storage roof- convective loop	3	5
	4.2	Passive cooling- shading- ventilation- evaporation- radiation cooling- ground coupling- dehumidification	2	5
	4.3	Active solar heating- building form and functions- general aspects- components- solar collector- thermal storage system- heat supply system- control systems- heating load and sizing	3	5
	4.4	Qualitative ideas of solar refrigerator and air conditioning	2	5
	4.5	**Practical**: Estimation of ventilation parameters of a building Analyze the heating and cooling requirements of the given building	10	5
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
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<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
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Practical
<table>
<tr><td colspan="2">Total Mark: 15</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Involvement</td><td>5</td></tr>
<tr><td>Punctuality</td><td>5</td></tr>
<tr><td>Record</td><td>5</td></tr>
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B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Solar energy- fundamentals and applications, H P Garg and J Prakash, McGraw Hill Education (India) Pvt. Ltd. Chapter 1, 2, 3, 4, 5, 6, 7, 11, 13.

SUGGESTED READINGS

1. Solar Energy, Fundamentals, Design, Modelling and Applications, G N Tiwari, Narosa Publishing House.

<table>
<tr><td></td><td colspan="6">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline</td><td colspan="6">Science</td></tr>
<tr><td>Programme</td><td colspan="6">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="6">Aerodynamics for wind turbine generators</td></tr>
<tr><td>Type of Course</td><td colspan="6">SDC</td></tr>
<tr><td>Course Code</td><td colspan="6">25SACVRE3SP202</td></tr>
<tr><td>Course Level</td><td colspan="6">200 -299</td></tr>
<tr><td>Course Summary</td><td colspan="6">This course introduces the basic principles of aerodynamics as applied to wind energy systems. It covers how wind interacts with turbine blades to generate power. Key topics include airflow patterns, lift and drag forces, blade design, Betz's limit, and performance analysis.</td></tr>
<tr><td>Semester</td><td>3</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="6">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Understand the evolution of wind energy, basic wind power concepts, turbine performance parameters, and the classification and working of horizontal and vertical axis wind turbines.	U, An, A	PO1, PO2, PO3, PO10
2	Grasp fundamental fluid mechanics, airfoil behavior, and aerodynamic theories to analyze rotor design and wind turbine performance.	An, A, E	PO1, PO 2
3	learn about wind behavior influenced by environmental and local effects, and understand methods and instruments for wind measurement and classification.	U , An, A	PO2, PO3, PO 6
4	Analyze wind data using statistical models, interpret turbine performance through power curves and coefficients, and understand control strategies including pitch, yaw, and turbine speed regulation.	A, An, E	PO1, PO2, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	2	0	0	0	0	0	0	2
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	0	2	2	0	0	2	0	0	0	0
CO 4	2	2	0	0	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Wind Energy**	**15 hrs**	
	1.1	History of wind energy	2	1
	1.2	Wind Generation, Kinetic energy of wind, Wind turbine power and torque, Tip speed ratio, Betz limit.	3	1
	1.3	Classification of wind turbines, Horizontal axis wind turbines, Vertical axis wind turbines.	2	1
	1.4	Practical: Measurement of Wind Speed and Direction, Power Output	8	1
2		**Aerodynamics of turbine**	**20 hrs**	
	2.1	Fluid Mechanics Basics-Conservation laws: mass, momentum, and energy-Bernoulli's equation and pressure fields	4	2
	2.2	Air foil Theory: Air foil geometry-Lift and drag forces characteristics - Reynolds number effects - Axial momentum theory, Blade element theory, Strip theory	4	2
	2.3	Rotor Design and performance analysis.	4	2
	2.4	Practical: Study of Wind Turbine Components and using Q blade software for design Airfoil and blade.	8	2

3		**Analysis of wind regimes**	**20 hrs**	
	3.1	The wind- Coriolis effect, Local effects, Wind shear, Turbulence, Acceleration effect.	5	3

	3.2	Measurement of wind, Ecological indicators – Putnam classification	3	3
	3.3	Anemometers, Wind vane.	2	
	3.4	Practical: Study of Wind Turbine Components and using Q blade software	10	3
4	**Performance and Optimization**		**20 hrs**	
	4.1	Average wind speed, Wind rose, Distribution of wind velocity	5	4
	4.2	Statistical models for wind data analysis: Weibull distribution, Rayleigh distribution, Constant speed turbine and variable speed turbines.	5	4
	4.3	Power curve- Performance Analysis and Power Coefficients -Tip Speed Ratio (TSR) - Capacity factor and power curves	2	4
	4.4	Control Strategies and Yaw Aerodynamics: Pitch and yaw control - Stall-regulated vs. pitch-regulated turbines.	4	4
	4.5	Practical: Visit to wind farm or test facility	4	4
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table>
Practical
<table>
<tr><td colspan="2">Total Mark: 15</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Involvement</td><td>5</td></tr>
<tr><td>Punctuality</td><td>5</td></tr>
<tr><td>Record</td><td>5</td></tr>
</table>
</td></tr>
</table>

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

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

SUGGESTED READINGS

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

	DEPARTMENT OF RENEWABLE ENERGY ST. ALBERT’S COLLEGE (AUTONOMOUS) ERNAKULAM				
Faculty/ Discipline*	Science				
Programme	B. Voc. (Honours) Renewable Energy				
Course Name*	IKS for renewable energy transformation in Kerala				
Type of Course*	MDC				
Course Code	25SACVRE3MD201				
Course Level*	200 - 299				
Course Summary	To introduce students to the rich traditions of Indian Knowledge Systems (IKS), their relevance to present-day renewable energy technologies, and how traditional wisdom—particularly from regions like Kerala—can be integrated with modern approaches for sustainable development.				
Semester*	3	**Credits***		3	**Total Hours***
Course Details	**Learning Approach**	**Lecture***	**Practicum ***	**OJT***	
		3	0	0	45
Pre-requisites, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the principles and practices of Indian Knowledge Systems.	R, U, A, An	PO4
2	Appreciate Kerala's role in advancing sustainable, traditional energy and agricultural practices.	R,U,A,An	PO1
3	Analyze how IKS can be integrated with modern renewable energy technologies.	U,An,A	PO2, PO3, PO4
4	Combine Kerala's traditional ecological methods with modern sustainable technologies.	U, A, An	PO3, PO4

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX*

CO/ PO	PO1	PO2	PO3	PO4	PO5	PO6	PO7	PO8	PO9	PO10
CO1	2	1	2	2	0	0	0	0	0	0
CO2	1	0	0	0	0	0	0	0	0	0
CO3	2	2	2	2	0	0	0	0	0	0
CO4	0	0	2	2	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	
1	**Introduction to IKS**		**15**	
	1.1	Overview of IKS, Historical evolution of IKS across India, with emphasis on Kerala’s contributions:	3	1
	1.2	Kerala’s IKS legacy -Siddha and Ayurveda, traditional water management systems, temple-based astronomy.	5	1
	1.3	Traditional calendars (*Panchangam*), solar-lunar calculations used for agricultural and energy-related decisions	4	1
	1.4	Frameworks for integrating IKS with modern renewable energy policies.	3	1, 4
2	**Integration of IKS and Modern Technologies 15**			

	2.1	Solar Energy: Ancient Indian and Kerala-based astronomical systems for sun-tracking -*Surya Namaskara*, solar temples like Konark and Thrissur Pooram alignments.	5	2
	2.2	Integration of ancient solar wisdom with modern solar PV and thermal System	5	2
	2.3	Traditional Kerala architecture (*Nalukettu*) for passive solar lighting and ventilation.	5	2, 4
3	**Sustainable Agriculture and Energy**		**15**	
	3.1	Biomass and Bioenergy-Use of cow dung, coconut shells, and agricultural waste in Kerala homes for cooking and heating.Practices in Kerala's farming communities.	6	3
	3.2	Transition to modern biogas plants and community-scale biomass energy systems. Traditional biogas	5	3
	3.3	Modern Efforts: Kerala State Electricity Board (KSEB)'s initiatives in solarization and green energy corridors.	4	3, 4
4	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Leverage a blended learning approach with a mix of lectures, interactive discussions.</td></tr>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table><tr><td colspan="2">Total Mark: 25</td></tr><tr><td colspan="2">Assessment methods</td></tr><tr><td>Assignment</td><td>10</td></tr><tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr><tr><td>Test</td><td>10</td></tr></table></td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory
<table><tr><td colspan="3">Total mark: 50</td></tr><tr><td colspan="3">Assessment methods: Written Exam</td></tr><tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr><tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr><tr><td>Part A</td><td>1 mark</td><td>Answer any 30 out of 32</td></tr><tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr></table>Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

1. Introduction to Indian Knowledge System: Concepts and Applications"Authors: B. Mahadevan, Balakrishna Pisupati, K.S. Kannan Publisher: PHI Learning.
2. "Science and Technology in Ancient India" Debiprasad Chattopadhyaya People's Publishing House.
3. Non-Conventional Energy Resources"Author: G.D. Rai, Khanna Publishers

SUGGESTED READINGS

1. "Kerala: Exploring Future Frontiers of Development"Editor: K.P. Kannan Publisher: CDS & UNDP.
2. AICTE Booklet on Indian Knowledge Systems https://iksindia.org.
3. MNRE Reports (Ministry of New and Renewable Energy, Indiahttps://mnre.gov.in.
4. National Innovation Foundation Reports (Traditional Technologies)https://nif.org.in

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">On- Job Training</td></tr>
<tr><td>Type of Course*</td><td colspan="5">OJT</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE3OJ201</td></tr>
<tr><td>Course Level*</td><td colspan="5">200 - 299</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is designed to bridge the gap between academic learning and industry requirements. It provides students with practical exposure and hands-on experience in real-world renewable energy projects and workplaces. Through this learning experience, students apply theoretical knowledge, develop technical and soft skills, understand work ethics, and gain familiarity with industrial practices and safety protocols.</td></tr>
<tr><td>Semester*</td><td>3</td><td colspan="2">Credits*</td><td>2</td><td rowspan="2">Hours/ week*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td>5</td></tr>
</table>

Pre-requisites, if any	Nil

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall fundamental concepts, tools, and procedures related to renewable energy systems as applied during the training.	K	PO1, PO2
2	Demonstrate awareness of workplace ethics, safety practices, and SOPs in the renewable energy sector.	U	PO8
3	Operate and maintain renewable energy equipment and systems under industry supervision.	A	PO2, PO7, PO10
4	Communicate effectively and collaborate with professionals and team members.	A, An	PO4, PO9
5	Prepare technical reports and presentations on work experiences and learnings.	C	PO4

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	2

CO 4	0	0	0	2	0	0	0	0	1	0
CO 5	0	0	0	2	0	0	0	0	0	0

‘0’ is No Correlation, ‘1’ is Slight Correlation (Low level), ‘2’ is Moderate Correlation (Medium level) and ‘3’ is Substantial Correlation (High level).

Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA)

Total mark: 15	
Type of assessment	
Feedback from the hosting organization	5
Internal supervisor feedback	10

B. End Semester Evaluation (ESE)

Total mark: 35	
Type of assessment	
Presentation	10
Report	10
Viva	15

	DEPARTMENT OF RENEWABLE ENERGY ST. ALBERT’S COLLEGE (AUTONOMOUS) ERNAKULAM				
Faculty/ Discipline	Science				
Programme	B.Voc (Honours) in Renewable Energy				
Course Name	Introduction to solar cells and applications				
Type of Course	MPC				
Course Code	25SACVRE3MP201				
Course Level	200 - 299				
Course Summary	This course introduces the fundamentals of solar cells, including their working principles, types, and materials used. It covers practical applications in energy systems and highlights the role of solar technology in sustainable development.				
Semester	3	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamentals of solar energy, including solar radiation properties, measurement techniques, and the advantages and limitations of solar energy.	K, U	PO1, PO2, PO10
2	Explain the working principles of solar cells, including semiconductor physics, the photovoltaic effect, and I-V characteristics, along with factors affecting performance.	U, An	PO2, PO3, PO10
3	Identify and compare different types of solar cells, including traditional crystalline, thin-film, and emerging solar technologies.	U, An	PO1, PO3, PO7
4	Apply knowledge of solar cells in various real-world applications such as residential systems, solar gadgets, grid-tied and off-grid setups.	A, Ap,	PO2, PO4, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	2
CO 2	0	2	2	0	0	0	0	0	0	2
CO 3	2	0	2	0	0	0	2	0	0	0
CO 4	0	2	0	2	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Basics of Solar Energy**	**15 hours**	
	1.1	Introduction to renewable energy	2	1
	1.2	Solar radiation and its properties	2	1
	1.3	Solar spectrum and measurement	2	1
	1.4	Advantages and limitations of solar energy	1	1
	1.5	Practical: Study the hourly Variation of solar radiation.	8	1
2		**Solar Cell Fundamentals** **20 hours**		
	2.1	Working principle of a solar cell	2	2
	2.2	Semiconductor materials used	3	2
	2.3	PN junction and photovoltaic effect	3	2
	2.4	I-V characteristics of solar cells- Efficiency and factors affecting performance.	4	2

	2.5	Practical: I-V Characteristics of a Solar Cell	8	2

3		**Types of Solar Cell**	**15 hours**	
	3.1	Crystalline silicon solar cells - Thin-film solar cells (CdTe, CIGS, a-Si)	4	3
	3.2	Emerging technologies (Perovskite, Organic, Dye-sensitized).	3	3
	3.3	Practical: Compare different types of small solar cells.	8	3
4		**Applications of Solar Cells**	**25 hours**	
	4.1	Solar panels for homes and buildings	6	4
	4.2	Solar-powered lights and gadgets-	6	4
	4.3	Solar farms and grid-connected systems - Off-grid solar applications (pumps, chargers, etc.)	7	4
	4.4	Practical: Assemble a basic solar-powered LED light.	6	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

	Total mark: 35 **Duration of Examination: 2 hrs** **Assessment methods** Theory/ Procedure — 10 Skill and Performance — 10 Calculation and Result — 10 Viva — 5

References

1. Solar Energy: Principles of Thermal Collection and Storage – *S. P. Sukhatme and J. K. Nayak*
2. Text Book: Photovoltaic Systems – *James P. Dunlop*

SUGGESTED READINGS

1. Physics of Solar Cells – *Peter Würfel*.
2. Solar Photovoltaics: Fundamentals, Technologies and Applications – *Chetan Singh Solanki*

Semester 4

Course Code	Title of the course
25SACVRE4ST201	Sustainable development and climate changes
25SACVRE4SP201	Hydro power system
25SACVRE4SP202	Biomass conversion system
25SACVRE4SE201	Data analytic and computational techniques
25SACVRE4VA201	Environmental education
25SACVRE4IN201	Internship
25SACVRE4MP201	Solar heating and cooling techniques

	DEPARTMENT OF RENEWABLE ENERGY **ST. ALBERT’S COLLEGE (AUTONOMOUS)** **ERNAKULAM**				
Faculty/ Discipline	Science				
Programme	B.Voc (Honours) Renewable Energy				
Course Name	Sustainable development and climate changes				
Type of Course	SDC				
Course Code	25SACVRE4ST201				
Course Level	200 -299				
Course Summary	This course introduces the principles of sustainable development and the science of climate change. It explores the interdependence of environmental, social, and economic systems, the impacts of global warming, and the strategies for mitigation and adaptation.				
Semester	4	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		4	0	0	60 hours
Prerequisite, if any	Nil				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the principles, evolution, and legal framework of sustainable development from global and Indian perspectives.	U, An	PO1, PO2, PO6,PO7
2	Explain the causes, scientific evidence, and regional impacts of climate change on ecosystems, health, and economies.	U, E	PO2, PO1, PO6, PO7
3	Apply climate-responsive and resource-efficient design principles to promote sustainable building practices.	U, S	PO3,PO2, PO7, PO10
4	Analyze water quality parameters and sustainable treatment methods for effective water management and reuse.	An, A	PO2, PO3, PO6

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	2	1	0	0	0
CO 2	2	2	0	0	0	2	1	0	0	0
CO 3	0	2	3	0	0	0	2	0	0	1
CO 4	0	2	2	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Fundamentals of Sustainable Development**	**14 hours**	
	1.1	Concept and evolution of sustainable development.	3	1
	1.2	Triple bottom line: Economic viability, Social equity, and Environmental protection, Global and Indian perspectives on sustainability.	4	1
	1.3	Overview of key Environmental Legislations in India: The Environment Protection Act (1986),The Air (Prevention and Control of Pollution) Act (1981),The Water (Prevention and Control of Pollution) Act (1974),Biological Diversity Act (2002).	7	1
2		**Climate Change – Causes and Impacts**	**16 hours**	
	2.1	Basics of climate systems-Natural vs. anthropogenic climate change	2	2
	2.2	The greenhouse effect and key GHGs, Evidence of climate change: temperature rise, sea level changes, glaciers, and weather anomalies.	5	2
	2.3	Ozone layer depletion- Causes of Ozone Layer Depletion- Consequences of Ozone Layer Depletion	4	2
	2.4	Regional impacts of climate change in India (Himalayan region, coastal zones),.	5	2

Module	Units	Course description	Hrs	CO No.
3		**Sustainable Design**	**16 hours**	
	3.1	Concepts of climate-responsive and resource-efficient design	2	3
	3.2	Orientation, Thermal Mass, Insulation, Ventilation, Shading - Material Selection, Water Efficiency, Energy Efficiency, Waste Reduction, Indoor Environmental Quality	5	3
	3.3	Examples of Climate-Responsive and Resource-Efficient Design, Green Construction	4	3

	3.4	IGBC and GRIHA certification systems, Introduction to LEED certification framework.	5	3
4		**Sustainable Water Management** **14 hours**		
	4.1	Basics of water quality: physical, chemical, and biological characteristics	3	4
	4.2	Wastewater generation sources and classifications	2	4
	4.3	Primary, secondary, and tertiary treatment processes (Activated sludge process, Granular filtration,Reverse Osmosis)	3	4
	4.4	Sustainable water management and reuse in agriculture and industry.	2	4
	4.5	Energy Planning Tools – ENPEP, MARKAL, LEAP, MAED.	4	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

	B. End Semester Evaluation (ESE) **Theory** **Total mark: 70** **Assessment methods: Written Exam** **Duration of Examination: 2 hrs** **Pattern of Examination: Non-MCQ** Part A – 1 mark – Answer any 25 out of 27 Part B – 5 mark – Answer any 5 out of 7 Part C – 10 mark – Answer any 2 out of 4 Part A can be objective type, fill in the blanks, multiple choice etc.

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

References

1. Environmental Studies by Erach Bharucha.
2. Climate Change and Environment by S. K. Agarwal

SUGGESTED READINGS

1. Energy Efficient Buildings in India by Mili Majumdar (TERI).
2. Wastewater Engineering by P. N. Modi.
3. Down to Earth (CSE) Reports and Articles.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Hydropower System</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE4SP201</td></tr>
<tr><td>Course Level</td><td colspan="5">200 -299</td></tr>
<tr><td>Course Summary</td><td colspan="5">This provides a comprehensive understanding of hydropower, covering its basic principles, types of plants, major components, and recent innovations in the field. It highlights the role of hydropower in sustainable energy development, particularly in rural electrification. Through practical experiments, case studies, and assignments, students gain both theoretical knowledge and hands-on experience in hydropower systems and technologies.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamental principles, global trends, and environmental implications of hydropower, and recognize its role in clean and rural energy development.	K,U	PO2, PO6, PO7
2	To classify different types of hydropower plants and identify the key components and site selection criteria based on hydrological and geographical factors	U,A	PO2, PO3
3	Describe the components and working principles of hydropower plants, including turbine types, generators, control systems, and supporting infrastructure.	U,A,An	PO1, PO2
4	Explore modern innovations and sustainable technologies in hydropower, including advanced turbine designs, hybrid systems, and digitalization, while recognizing their environmental and operational benefits.	U, An	PO6, PO7, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	2	0	0	0	2	2	0	0	1
CO 2	0	2	2	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	0	0	0	0	0	2	2	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Fundamentals of Hydropower**	**15 hrs**	
	1.1	Introduction to Hydropower- Definition, principles, and historical development, Water energy to mechanical to electrical conversion (simple flow)	2	1
	1.2	Global Status of Hydropower: Trends, developments, and capacity distribution. Importance of hydropower in rural and clean energy development Advantages and Disadvantages of Hydropower Systems. Environmental Issues and Sustainability in Hydropower Projects	5	1
	1.3	Practical: Compare Solar, Wind, and Water Models, Making Electricity with Water, water flow measurement.	8	1
2		**Types of Hydropower Projects and Planning**	**20 hrs**	
	2.1	Classification of Hydropower Plants: Small, Medium, and Large Hydro, Run-of-the-River and Reservoir-based Projects	4	2
	2.2	Hydrological Cycle and Basics of Hydrology, Selection Criteria for Hydropower Plant Sites, Hydrological and Geographical Factors	4	2
	2.3	Essential Elements of a Hydropower Project: Reservoir, intake, penstock, powerhouse, tailrace- Basic idea of rainfall and water flow measurement, Introduction to terms: Notch, Weir, Flume (no technical detail).	4	2
	2.4	Practical : Measurement of Water Flow Using V-Notch Weir	8	2

3	**Components and Working of Hydropower Plants 20 hrs**			
	3.1	Components of Hydropower Plants- Hydraulic Turbines: Types (Impulse and Reaction), Theory, and Operational Aspects, Turbine Selection and Efficiency Considerations	4	3
	3.2	Types of Generators: Synchronous and Induction, Transformers, Protection and Control Systems,	4	3
	3.3	Transmission and Distribution Systems, Supporting Infrastructure: Dam, Spillway, Surge Chambers, Penstock, Tailrace	4	3
	3.4	Practical: Identify and Label Components of a Mini Hydro Plant Model, Case Study Presentation on Indian Hydropower Stations	8	3
4	**Innovations and Modern Technologies in Hydropower 20 hrs**			
	4.1	Hydro Generators with Controlled Rotors, Variable Speed Hydro Power Generation	3	4
	4.2	Fish- Friendly Hydropower Technologies and Turbine Design	4	4
	4.3	Control Technologies : Passive, Active & Magneto-Rheological Techniques, Digitalization of Hydropower Plant Operations, Floating Solar-Hydro Hybrid Systems, Electric Energy Storage Integration- Hydropower in India	3	4
	4.4	Famous hydropower stations (Tehri, Bhakra Nangal, etc.) - Environmental Awareness: Importance of clean rivers, Eco-friendly and sustainable project planning.	4	4
	4.5	Practical: Demonstration of Electrical Safety Devices.	6	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. S.K. Singal, R.P. Saini, and M.P. Sharma, Renewable Energy Sources – Hydropower.
2. Renewable Energy: Power for a Sustainable Future – Godfrey Boyle (Oxford University Press).
3. Hydropower Engineering Handbook – John S. Gulliver and Roger E. A. Arndt

SUGGESTED READINGS

1. Introduction to Renewable Energy – Vaughn C. Nelson and Kenneth L. Starcher

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Biomass Conversion Systems</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE4SP202</td></tr>
<tr><td>Course Level*</td><td colspan="5">200 -299</td></tr>
<tr><td>Course Summary</td><td colspan="5">Biomass Energy is a crucial part of sustainable and renewable energy systems, this course includes technical, environmental, and practical aspects of biomass energy.</td></tr>
<tr><td>Semester*</td><td>4</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the types, properties, processing, and applications of biomass as a renewable energy source, and assess its potential in sustainable energy systems.	U, A, An	PO1, PO7
2	Understand and analyze the physical, thermal, and chemical properties of biomass to evaluate its suitability for various renewable energy applications.	U, A, An	PO2, PO6
3	Understand biological biomass conversion processes such as biomethanation and fermentation, and analyze biogas plant types, their socio-economic viability, and environmental impacts.	U , A, An	PO1, PO3, PO7
4	Understand and analyze chemical conversion processes such as hydrolysis, hydrogenation, solvent extraction, and synthesis of biofuels and chemicals from biomass. To identify the biomass resources and study biogas generation	U, A, An, C	PO3, PO4, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	0	0	0	1	0	0	0
CO 2	0	2	0	0	0	2	0	0	0	0
CO 3	2	0	2	0	0	0	1	0	0	0
CO 4	0	0	2	2	0	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Biomass**		**20**	
	1.1	Types of biomass, advantages and disadvantages in use of biomass as energy,	3	1
	1.2	Physical and thermal properties of biomass, chemical composition.	3	1
	1.3	Sources of biomass Size reduction, Briquetting, Drying, Storage and handling of biomass.	3	1
	1.4	Current biomass applications and trends.	3	1
	1.5	Practical: Identification of different biomass sources in environment, Estimation of fixed carbon of the given biomass	8	1

2	**Thermo chemical conversion**		**20**	
	2.1	Effect of pressure, temperature, steam and oxygen.	3	2
	2.2	Combustion,Incineration,gasification, pyrolysis, hydrothermal liquefaction.	3	2
	2.3	Thermochemical conversion of lignocellulosic biomass	3	2
	2.4	Fixed and fluidized bed Gasifiers-Partial gasification of biomass by CFB.	3	2
	2.5	Practical: Estimation of moisture and ash content for different types of biomass,	8	2

3	**Biological conversion**		**15**	
	3.1	Biodegradation - Biochemistry and process parameters of biomethanation -. Biomethanation Process -	2	3
	3.2	Types of biogas plants-continuous type , dome type,floating drum type -KVIC, fixed dome type -Janata model. Advantages and Disadvantages.	3	3
	3.3	Economics of biogas plants with their environmental and social impacts - Bioconversion of substrates into alcohol - Methanol & ethanol Production.	3	3
	3.4	Practical: Estimation of total solid and volatile solid in different types of biomass	7	3
4	**Chemical conversion**		**20**	
	4.1	**Chemical conversion**: Hydrolysis & hydrogenation	4	4
	4.2	Study of Solvent extraction of hydrocarbons	4	4
	4.3	Biocrude and biodiesel - Chemicals from biomass.	5	4
	4.4	Practical: Determination of density of the given biomass, Understand biomass to biogas pathway-Slurry mixing, gas collection dome	7	4
5	**Teacher specific content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 25</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr>
<tr><td>Test</td><td>10</td></tr>
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Practical
<table>
<tr><td colspan="2">Total Mark: 15</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Involvement</td><td>5</td></tr>
<tr><td>Punctuality</td><td>5</td></tr>
<tr><td>Record/ Report</td><td>5</td></tr>
</table>
</td></tr>
</table>

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Non-conventional Energy Sources; G.D.Rai; 2011; Fifth Edition, Khanna Publishers.

SUGGESTED READINGS

1. Renewable energy sources and emerging technologies by D.P.Kothari,K.C. Singal, Rakesh Ranjan.
2. "Biomass and Bioenergy" – B. H. Khan, Publisher: Tata McGraw Hill

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Data Analytics and Computational Techniques</td></tr>
<tr><td>Type of Course</td><td colspan="5">SEC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE4SE201</td></tr>
<tr><td>Course Level</td><td colspan="5">200-299</td></tr>
<tr><td>Course Summary</td><td colspan="5">Data analytics and computational techniques are relevant across a wide range of industries, contributing to improved decision-making,operational efficiency and innovation. As technology continues to advance,the importance of data analytics is likely to grow,shaping the way businesses and organizations operate in the future.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains*	PO No
1	Represent and interpret raw data using appropriate classification, tabulation methods, and graphical tools such as bar diagrams, pie charts, and frequency graphs.	U, A, An, E	PO1,PO2
2	Compute and interpret various descriptive statistical measures such as measures of central tendency and dispersion including mean, median, mode, percentiles, and standard deviation.	U, A, An, E	PO2
3	Apply fundamental concepts of probability, including events, theorems, and conditional probability, to solve real-life and theoretical problems.	U, A, An, E	PO1, PO2, PO3, PO10
4	Experiencing different graphing tools in mathematics	S	PO2

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	0	0	0	0	0	0	0	0
CO 3	2	2	2	0	0	0	0	0	0	1
CO4	0	2	0	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Data representation**	**15**	
	1.1	Raw data, classification and tabulation of data, frequency tables, contingency table;	7	1
	1.2	Diagrams - Bar diagrams, sub divided bar diagrams, Pie diagrams, Graphs - frequency polygon , frequency curve, ogives.	8	1,4
2		**Descriptive statistics**	**15**	
	2.1	Percentiles, deciles, quartiles, arithmetic mean, median, mode, geometric mean and harmonic mean.	8	2
	2.2	range,Mean deviation, variance, standard deviation, quartile deviation,	7	2

3		**Probability**	**15**	
	3.1	Random experiment, sample space. definitions of probability,	4	3
	3.2	Events, types of events, independence of events,	4	3
	3.3	Addition theorem, conditional probability,	3	3
	3.4	Multiplication theorem, Baye's theorem.	4	3

4	**Teacher specific content**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE) Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Fundamentals of Mathematical Statistics" by S.C. Gupta and V.K. Kapoor.
2. "Probability and Statistics" by Murray Spiegel (Schaum's Outline Series).
3. "Introduction to Probability and Statistics" by William Mendenhall.
4. "Statistics for Engineers and Scientists" by William Navidi.
5. NPTEL Course: *"Probability and Statistics"* – [IIT Kanpur or IIT Madras]

SUGGESTED READINGS

1. Fundamentals of Statistics" – S.C. Gupta,Publisher: Himalaya Publishing House
2. Statistical Methods" – S.P. Gupta,Publisher: Sultan Chand & Sons

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Environmental Education</td></tr>
<tr><td>Type of Course</td><td colspan="5">VAC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE4VA201</td></tr>
<tr><td>Course Level</td><td colspan="5">200- 299</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course offers an overview of environmental education, focusing on key issues like pollution, biodiversity loss, and sustainable resource management. It covers environmental laws, policies, and movements in India while highlighting effective teaching strategies. Students are equipped to promote environmental awareness and sustainability through education.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the objectives, nature, and characteristics of environmental education and recognize the causes and socio-economic impacts of environmental degradation.	U, K	PO1, PO3, PO6, PO7
2	Identify different types of environmental pollution, their causes, effects, and mitigation strategies, along with understanding climate change phenomena	U, An	PO2, PO3, PO6, PO7
3	Analyze major environmental movements and legal-political efforts in India and globally aimed at environmental protection.	R, An	PO1, PO4, PO5, PO6
4	Develop and apply appropriate teaching methods and assessment tools to promote environmental awareness in learners	A, S	PO4, PO5, PO8, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	2	0	0	2	2	0	0	0
CO 2	0	2	2	0		2	2	0	0	0
CO 3	2	0	0	2	2	2	0	0	0	0
CO 4	0	0	0	3	2	0	0	1	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Environmental Education and Degradation**		15	
	1.1	Objectives, and Nature of Environmental Education, Characteristics of Environmental Education	3	1
	1.2	Environmental education at Primary,Secondary and Higher Education level.	4	1
	1.3	Factors of degradation of environment – adverse socio – economic impacts of degradation of environment, Impact of Science and technology on environment degradation of resources	4	1
	1.4	National resource center for environmental education.	4	1
2	**Environmental Pollution and Consequence**		12	
	2.1	Environmental Pollution- Types of Environmental Pollution- Causes of Environmental Pollution- Effects of Environmental Pollution	4	2
	2.2	Green house effect- Enhanced Greenhouse Effect- Adaptation Strategies	2	2
	2.3	Ozone layer depletion- Causes of Ozone Layer Depletion- Consequences of Ozone Layer Depletion	2	2

	2.4	Factors responsible for flora and fauna extinction – Causes for forest fire- measures of prevention	4	2

3	**Environmental Policies and Movements in India**		**18**	
	3.1	Environmental Movements for the Protection of India-Chipko Movement (1973),Silent Valley Movement (1978),Appiko Movement (1983)	4	3
	3.2	Environmental Policies in India-National Environment Policy,National Conservation Strategy and Policy Statement on Environment and Development	4	3
	3.3	Environmental Laws in India-Environment (Protection) Act,National Green Tribunal (NGT) Act	4	3
	3.4	International Efforts for Environmental Protection, Paris Agreement (2015) – The Rio Summit 1992 – Kyoto conference	4	4
	3.5	Global- Renewable Energy Initiatives	2	4
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Sharma, R. A. (2008). Environmental Education. Meerut: R.LallBooksDepot.
2. Reddy, P. K.,& Reddy, N. D.(2001). Environmental Education. Hyderabad:Neelkamal Publications.
3. Singh,Y. K. (2009). Teaching of environmental science. New Delhi: APH Publishing Corporation.

SUGGESTED READINGS

1. Ian Paulford., Hugh Flowers., 2006. Environmental Chemistry at a Glance. Blackwell.
2. Harrison R.M. 1993. Pollution: Causes, Effects and Control. Royal Society of Chemistry.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Internship</td></tr>
<tr><td>Type of Course</td><td colspan="5">Internship</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE4IN201</td></tr>
<tr><td>Course Level</td><td colspan="5">200 - 299</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is designed to immerse students in real-world work environments through internships, enabling them to connect academic learning with industry practices. It facilitates hands-on experience, the application of classroom knowledge, and the development of practical skills. Through this internship or lab-based training, students gain professional exposure, explore career paths, and understand organizational culture, tools, and practices essential for their future careers.</td></tr>
<tr><td>Semester</td><td>4</td><td colspan="2">Credits</td><td>2</td><td rowspan="2">Hours/week</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>Internship</td></tr>
<tr><td>0</td><td>0</td><td>2</td><td></td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Recall fundamental concepts, tools, and procedures relevant to the field of study as applied during the internship experience.	K, E	PO1, PO2
2	Demonstrate awareness of professional ethics, workplace safety practices, and standard operating procedures in the chosen industry or organization.	U, S, C	PO8
3	Perform assigned tasks using appropriate methods, tools, or equipment under supervision, contributing to organizational goals.	I, S	PO2, PO7, PO10
4	Communicate effectively, collaborate with team members, and engage professionally within a real-world work environment.	S, A, Ap	PO4, PO9

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	2	0	0
CO 3	0	2	0	0	0	0	2	0	0	2
CO 4	0	0	0	2	0	0	0	0	1	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

<table>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)

<table>
<tr><td colspan="2">Total mark: 15</td></tr>
<tr><td colspan="2">Type of assessment</td></tr>
<tr><td>Feedback from the hosting organization</td><td>5</td></tr>
<tr><td>Internal supervisor feedback</td><td>10</td></tr>
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<tr><td>B. End Semester Evaluation (ESE)

<table>
<tr><td colspan="2">Total mark: 35</td></tr>
<tr><td colspan="2">Type of assessment</td></tr>
<tr><td>Presentation</td><td>10</td></tr>
<tr><td>Report</td><td>10</td></tr>
<tr><td>Viva</td><td>15</td></tr>
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</table>

DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT'S COLLEGE (AUTONOMOUS) ERNAKULAM

Faculty/ Discipline	Science				
Programme	B.Voc (Honours) in Renewable Energy				
Course Name	Solar Heating and Cooling Techniques				
Type of Course	MPC				
Course Code	25SACVRE4MP201				
Course Level	200 -299				
Course Summary	Students will understand the principles and technologies of solar heating and cooling systems. They will be able to design and evaluate efficient solar thermal applications for sustainable energy use.				
Semester	4	**Credits**		4	**Total Hours**
Course Details	**Learning Approach**	**Lecture**	**Practical**	**OJT**	
		3	1	0	75 hours
Pre-requisites, if any	**Nil**				

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the fundamentals of solar radiation and evaluate the performance of various solar thermal collectors.	U, E	PO1, PO2
2	Design and analyze solar water heating systems for both domestic and industrial applications.	A, An, C	PO2, PO3, PO10

3	Explain and assess solar space heating and cooling techniques, including passive and active systems	U, E	PO1, PO2, PO6
4	Evaluate the techno-economic aspects, policies, and life cycle of solar thermal applications in different sectors.	E, An	PO1, PO7 ,PO8

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	2	0	0	0	0	0	0	2
CO 3	2	2	0	0	0	2	0	0	0	0
CO 4	2	0	0	0	0	0	2	2	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Basics of Solar Thermal Systems**		**20 hrs**	
	1.1	Solar radiation fundamentals: solar angles, radiation components	4	1
	1.2	Solar thermal collectors: flat plate, evacuated tube collectors	4	1
	1.3	Heat transfer fluids and materials - Efficiency and performance evaluation of collectors.	4	1

	1.4	Practical: Evaluation of Total Heat loss Coefficient in the thermosyphonic mode of flow with fixed input parameters	8	1
2	**Solar Water Heating Systems**		**20 hrs**	
	2.1	Domestic and industrial water heating	3	2
	2.2	Active vs. passive systems - System components: storage tanks, pumps, heat exchangers	4	2
	2.3	Design, sizing, and performance analysis	5	2
	2.4	Practical: Evaluation of Total Heat loss Coefficient in the thermosyphonic mode of flow with different radiation levels.	8	2

3	**Solar Space Heating and Cooling Techniques**		**20 hrs**	
	3.1	Passive heating techniques: thermal mass, insulation, glazing	3	3
	3.2	Active space heating: forced air and hydronic systems	2	3
	3.3	Solar-assisted cooling systems: absorption cooling, desiccant cooling -Building-integrated solar thermal systems.	7	3
	3.4	Practical: Case study on solar cooling system or passive heating design.	8	3
4	**Applications, Economics, and Policies**		**15 hrs**	
	4.1	Applications in buildings, industries, and agriculture	3	4
	4.2	Economic analysis: cost–benefit, payback period, incentives	3	4
	4.3	National and international solar thermal policies-Maintenance, durability, and lifecycle assessment.	3	4
	4.4	Practical : Economic analysis of a solar thermal project	6	4
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50
Assessment methods: Written Exam

Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Duffie, J.A., & Beckman, W.A.
   Solar Engineering of Thermal Processes, 4th Edition, Wiley, 2013.
2. *Solar Energy: Principles of Thermal Collection and Storage*, 3rd Edition, Tata McGraw Hill, 2008.
3. Garg, H.P., & Prakash, J.
   Solar Energy: Fundamentals and Applications, Tata McGraw Hill, 2005

SUGGESTED READINGS

1. *Solar Energy - Fundamentals, Design, Modelling and Applications,* G. N. Tiwari

Semester 5

Course Code	Title of the course
25SACVRE5ST301	Tidal, nuclear and geothermal energy systems
25SACVRE5EP301	Energy storage systems
25SACVRE5EP302	Green Hydrogen Manufacturing and Applications
25SACVRE5SP301	Grid integration and smart grid technologies
25SACVRE5SE301	Softwares for renewable energy system design
25SACVRE5VA301	Industrial Health and Safety
25SACVRE5MT301	Novel renewable energy sources

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Tidal, nuclear and geothermal energy systems</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5ST301</td></tr>
<tr><td>Course Level</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides an in-depth understanding of alternative renewable energy sources such as tidal power, ocean thermal energy, nuclear fusion, and geothermal energy. It covers the working principles, components, operation methods, and site requirements of each system, along with their advantages, limitations, and applications. A comparative analysis is included to evaluate the most suitable renewable energy option for Kerala, promoting region-specific energy planning and sustainability awareness.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60 hours</td></tr>
<tr><td>Pre-requisite, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	To understand tidal power generation systems, and to analyze their advantages, limitations, and practical feasibility.	U, An	PO1,PO2
2	To acquire the ability to understand the principles and working of Ocean Thermal Energy Conversion systems.	U, E, A	PO2,PO3
3	To understand fundamentals of nuclear fusion, identify the requirements & confinement methods for fusion, and evaluate the working and feasibility of thermonuclear reactors.	U, E, An	PO1, PO2, PO6
4	To acquire an understanding of the nature and types of geothermal fields and resources.	U, E, K	PO1, PO2, PO3

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	1	0	0	0	0
CO 2	0	2	1	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	2	0	0	0	0
CO 4	1	2	1	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Tidal Power 15 hrs**		
	1.1	Introduction, Basic Principle of Tidal Power, Components of Tidal Power Plants,	6	1
	1.2	Operation Methods of Utilization of Tidal Energy - Simple Single Basin Tidal System and Double Basin Tidal System	6	1
	1.3	Requirements, Storage, Advantages and Limitation of Tidal Power Generation.	3	1
2		**Ocean Thermal Energy Conversion 15 hrs**		
	2.1	Ocean Thermal Energy Conversion	4	2
	2.2	Methods of Ocean Thermal Electric Power Generation - Open Cycle OTEC System, Closed OTEC Cycle System	6	2
	2.3	Heat Exchangers, Bio-fouling, Site-Selection, Energy Utilization	5	2

3		**Nuclear power 15 hrs**		
	3.1	Introduction, The Basic: Nuclear Fusion and Reactions	3	3
	3.2	Requirements for Nuclear Fusion, Plasma Confinement - Magnetic-Confinement Fusion, Inertial-confinement Fusion,	6	3
	3.3	Working of a thermonuclear reactor, Advantages and disadvantages of Nuclear Fusion	6	3
4		**Geothermal Energy 15 hrs**		
	4.1	Geothermal field, Nature of Geothermal Fields, Geothermal Sources – Hydrothermal Resources	5	4
	4.2	Vapour Dominated Systems, Liquid-Dominated Systems, Geo-pressured Resources, Hot Dry Rock Resources, Magma Resources	6	4

	4.3	Advantages and Disadvantages of Geothermal Energy, Applications of Geothermal Energy	4	4
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**
	B. End Semester Evaluation (ESE) **Theory**

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Non-Conventional Energy Sources by G D Rai

SUGGESTED READINGS

1. Energy Technology - Nonconventional, Renewable & Conventional S. Rao and Dr.
2. B. B. Parulekar, Khanna Publishers, ISBN No. 81-7409-040-1.
3. Solar Energy Utilization G. D. Rai, Khanna Publishers, ISBN-81-7409-073-8.
4. Nonconventional energy sources, Domkundwar, Dhanpat rai & Co.

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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Energy Storage Systems</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5EP301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces various energy storage systems including mechanical, electrical, chemical, thermal, and electromagnetic methods. It covers their working principles, implementation, and applications in areas like transportation and power systems..</td></tr>
<tr><td>Semester*</td><td>5</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the principles and applications of mechanical and electrical energy storage systems. Understand the principles and applications of mechanical and electrical energy storage systems.	U	PO1, PO 2
2	Explain advanced chemical and biological energy storage methods, including hydrogen-based systems.	U	PO 2, PO 6
3	Analyze thermal energy storage techniques using sensible and latent heat with practical applications	An	PO 2, PO 7
4	Describe electromagnetic storage technologies like SMES and supercapacitors, including their working and use cases.	U	PO 2, PO 3

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	0	0	0	2	0	0	0	0
CO 3	0	2	0	0	0	0	2	0	0	0
CO 4	0	2	2	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Mechanical and Electrical**		**22**	
	1.1	Mechanical energy storage - pumped hydroelectric, compressed air, flywheel	10	1
	1.2	Electrical storage - the lead acid battery.	4	1
	1.3	Practical: Charging and discharging characteristics of a lead acid battery	8	5
2	**Advanced energy storage systems**		**20**	
	2.1	Chemical storage - storage via hydrogen, ammonia, reversible chemical reactions.	5	2
	2.2	Hydrogen storage, hydrogen as an alternative fuel for motor vehicles	5	2
	2.3	Biological storage.	3	2
	2.4	Practical : Hydrogen Generation via Electrolysis	7	5
3	**Thermal energy storage**		**18**	
	3.1	Sensible heat & latent heat systems	3	3
	3.2	Sensible heat & latent heat systems-implementation,	4	3
	3.3	working and applications.	4	5

	3.4	Practical : Latent Heat Storage Using Phase Change Material (PCM)	7	5
4	**Electromagnetic energy storage**		**15**	
	4.1	SMES, Super capacitors	5	4
	4.2	Basic principles and applications.	2	5
	4.3	Practical : Charge and discharge characteristics of a supercapacitors	8	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15
Assessment methods

Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Non - conventional energy sources- G D Rai, Khanna publishers.
2. R. A. Huggins – Energy Storage: Fundamentals, Materials and Applications

SUGGESTED READINGS

1. Non conventional energy sources and utilization (Energy engineering), R K Rajput, 2012, first edition, S. Chand & company ltd.

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<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Green Hydrogen Manufacturing and Applications</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5EP302</td></tr>
<tr><td>Course Level</td><td colspan="5">300 - 399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces green hydrogen, its production, storage, and applications in energy, industry, and transport. It covers clean technologies for a sustainable future.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the significance of hydrogen as an energy carrier by analyzing its types, properties, and comparison with conventional fuels.	K, U, An	PO1, PO2
2	Explain and compare various green hydrogen production technologies including electrolysis methods and their integration with renewable energy sources.	U, An	PO1, PO2, PO3
3	Explain and compare various green hydrogen production technologies including electrolysis methods and their integration with renewable energy sources.	U, A	PO1, PO2, PO3
4	Identify and evaluate diverse applications of green hydrogen in power, industry, and mobility sectors, including fuel cell technologies.	E, A	PO2, PO6, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	2	2	2	0	0	0	0	0	0	0
CO 3	2	2	2	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	2	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Introduction to Hydrogen as an Energy carrier**	**14 hrs**	
	1.1	History and significance of hydrogen energy, Types of hydrogen (gray, blue, green, pink, etc.)	3	1
	1.2	Thermodynamic and physicochemical properties, Comparison with other fuels (energy density, emissions)	3	1
	1.3	Practical : Demonstration of hydrogen generation via metal-acid reaction.	8	1
2		**Green Hydrogen Production Technologies**	**17 hrs**	
	2.1	Electrolysis principles (Alkaline Electrolysis, PEM (Proton Exchange Membrane) Electrolysis, Solid Oxide Electrolysis (SOEC), Water sources for electrolysis:	3	2
	2.2	Freshwater, seawater, Renewable energy integration (solar PV, wind, hydro)	3	2
	2.3	Overview of photoelectron chemical and thermochemical methods (introductory level).	3	2
	2.4	Practical : Water source comparison– Compare electrolysis efficiency using freshwater vs. tap water (discussion on seawater challenges).	8	2
3		**Hydrogen Storage and Transportation**	**18 hrs**	
	3.1	Physical storage methods	3	3
	3.2	Compressed, liquefied, Material-based storage	4	3
	3.3	Pipelines, cylinders, tankers, Safety regulations and standards (ISO, BIS).	3	3
	3.4	Practical : Metal hydride simulation model– Use visuals or demo kits showing absorption and release of hydrogen in metal hydride canisters.	8	3

4	**Applications of Green Hydrogen**		**26 hrs**	
	4.1	Power generation and grid balancing	5	4
	4.2	Industrial applications (ammonia production, steel, refineries),	3	4
	4.3	Fuel cells: types and applications (PEMFC, SOFC, AFC), Mobility	4	4
	4.4	hydrogen vehicles (FCEVs), infrastructure, Emerging technologies	4	4
	4.5	synthetic fuels, hydrogen blending in natural gas.	4	4
	4.6	Practical : Video + Discussion: Hydrogen Use in Industry	6	4

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)
Lectures, Demonstration, Animations, Presentations, Discussions.</td></tr>
<tr><td rowspan="2">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table><tr><td colspan="2">Total Mark: 25</td></tr><tr><td colspan="2">Assessment methods</td></tr><tr><td>Assignment</td><td>10</td></tr><tr><td>Seminar/ Quiz/ Group Discussion</td><td>5</td></tr><tr><td>Test</td><td>10</td></tr></table>Practical
<table><tr><td>Total Mark: 15</td></tr><tr><td>Assessment methods</td></tr></table></td></tr>
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Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

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

SUGGESTED READINGS

1. U.S. Department of Energy – Hydrogen and Fuel Cells Basics- energy.gov/eere/fuelcells

<table>
<tr><td colspan="6">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Grid Integration and Smart grid techniques</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5SP301</td></tr>
<tr><td>Course Level</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course gives an overview of how traditional power systems are evolving into smarter, more efficient networks. It covers the connection between smart grids, smart cities, and emerging technologies. Key concepts related to smaller power systems like microgrids and their operation are introduced. The course also touches on how renewable energy sources are brought into the power system.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practicum</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the structure and functioning of power generation, transmission, distribution, and substations.	U	PO1, PO2
2	Describe the components and operation of rooftop solar PV power plants and assess their performance.	U	PO1, PO2, PO7
3	Compare traditional and smart grids in terms of technology, efficiency, and communication systems.	A	PO1, PO2, PO3
4	Explain the operation and benefits of smart meters, AMR, AMI, and IEDs in smart substations. Analyze power quality issues and grid integration challenges for distributed renewable systems.	U,A	PO2, PO6, PO7

* {options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	2	0	0	0
CO 3	2	2	2	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	2	2	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Basics of Power Grid**	**15 hrs**	
	1.1	Load, Electrical grid, Generation, transmission and distribution	2	1
	1.2	Substation: Basic layout, substation	2	1
	1.3	Components: protection and metering equipment,	2	1
	1.4	Major faults, earthing-synchronization.	1	1
	1.5	**Practicum:** 1. Study different components of grid and smart grid.	8	1
2		**Microgrid Systems**	**20 hrs**	
	2.1	Microgrid definition, Classification – AC, DC and Hybrid microgrids	3	2
	2.2	Structure of microgrid – Three-layer structure.	2	2
	2.3	Modes of operation of micro grid – Islanded mode and grid connected mode	2	2
	2.4	Control of AC microgrid, DC microgrid and Hybrid microgrids	3	2
	2.5	Issues and challenges of microgrid systems	2	2
	2.6	**Practicum:** 1. Examine the microgrid integration with renewable energy systems. 2. Visit the grid integration of a local solar on-grid system.	8	2

3		**Introduction to Smart Grid**	**20 hrs**	
	3.1	Evolution of electric grid, Definitions, Need for smart grid.	4	3
	3.2	Smart grid drivers, Functions of smart grid, Opportunities and barriers of smart grid.	4	3
	3.3	Difference between conventional grid and smart grid.	2	3
	3.4	Information and Communication Technology in Smart Grid.	2	3
	3.5	**Practicum:** 1. 1. Examine the application of Information and Communication Technologies (ICT) in smart grid systems.	8	3
4		**Introduction to smart meters**	**20 hrs**	
	4.1	Electricity tariff, Real Time Pricing- Automatic Meter Reading (AMR) - System, Services and Functions, Components of AMR Systems.	4	4
	4.2	Advanced Metering Infrastructure (AMI). Intelligent Electronic Devices (IED) and their application for monitoring & protection:	4	4
	4.3	Digital Fault Recorder (DFR), Digital Protective Relay (DPR),	4	4
	4.4	Circuit Breaker Monitor (CBM), Smart substations, Substation automation.	2	4
	4.5	**Practicum:** 1. Familiarize with key terminology and metrics used in power quality assessment. 2. Study the role and functioning of automation systems in modern power distribution and substations.	6	4

5	**Teacher specific content**

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Principles of Power System, V. K. Mehta, Rohit Mehta, S. Chand Publications.
2. Grid Integration of Solar Photovoltaic Systems By Majid Jamil, M Rizwan, D P Kothari.
3. Stuart Borlase, Smart grids- Infrastructure technology and solutions, CRC Press. Ie, 2013
4. Microgrids: Modeling, control and applications Joseph M Guerrero, Ritu Kandari

SUGGESTED READINGS

1. Smart Grid: Technology and Applications – Janaka Ekanayake et al, Wiley.
2. Electric Power Substations Engineering – *John D. McDonald, CRC Press.*
3. Smart Metering Design and Applications – *Gerd Heber, Hubert Fuchs, Springer*

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Softwares for renewable energy system design</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SEC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5SE301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces students to essential software tools used in the design and simulation of renewable energy systems. It covers the basics of AutoCAD for drafting, PVsyst for solar system analysis, HOMER for hybrid energy modeling, and RETScreen for energy project feasibility</td></tr>
<tr><td>Semester*</td><td>5</td><td colspan="2">Credits*</td><td>3</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>2</td><td>1</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the interface, tools, and functionalities of AutoCAD for technical drawing and design.	U	PO2, PO10
2	Apply AutoCAD tools to create 2D building layouts and annotate solar PV components.	A	PO2, PO3, PO10
3	Develop detailed rooftop solar PV system layouts including module placement, cabling, and SLD using AutoCAD.	C	PO2, PO3
4	Utilize advanced AutoCAD features such as 3D modeling and parametric constraints for customized designs	An	PO1, PO2, PO10
5	Use PVSol software for simulating and designing stand-alone and grid-connected solar PV systems.	A	PO2, PO4, PO10
6	Design PV systems using SolarEdge software and generate performance reports with system details.	C	PO2, PO4, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	2	0	0	0	0	0	0	0	2
CO 2	0	2	2	0	0	0	0	0	0	2
CO 3	0	2	2	0	0	0	0	0	0	0
CO 4	2	2	0	0	0	0	0	0	0	2
CO 5	0	2	0	2	0	0	0	0	0	2
CO 6	0	2	0	2	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to autocad**		**20**	
	1.1	Overview of autocad software, history and versions, drawing & editing tools, precision drawing techniques, advanced editing tools	4	1
	1.2	Practical: Interface Overview: Ribbon, Menus, Toolbars -Understanding the workspace-Basic Drawing Tools :Line, Circle, Arc, Rectangle, Polygon-Polyline vs Line-Ellipse, Spline-Using Object Snaps (OSNAP)	4	1,2
	1.3	Modifying Tools: Move, Copy, Rotate-Mirror, Offset- Trim, Extend-Scale, Stretch-Fillet, Chamfer-Precision Drawing and Editing: Grid, Snap, Ortho mode-Polar Tracking	4	2
	1.4	Construction lines and Ray-Advanced Drawing Tools: Multi Line and Multiline Styles-Region and Boundary-Hatch and Gradient-Divide and Measure-Annotation and Dimensioning: Text: Single-line and Multiline -Text Style	4	1,3
	1.5	Dimensioning types: linear, aligned, radial, angular -Layouts and Printing: Model Space vs Paper Space-Creating Layouts and Viewports-Title Blocks and Borders.	4	3

Module		Hrs	
2	**Advanced techniques & Solar PV system design using autocad**	**20**	

	2.1	Practical drawing of building plans using autocad, draft solar drawing using autocad	3	2
	2.2	Drawing techniques, 3D modelling, parametric constraints, customization & automation	3	4
	2.3	Practical: Introduction to Solar PV Systems :Basics of solar energy and PV technology-Types of solar PV systems: On-grid, Off-grid, Hybrid-Key components	4	2
	2.4	Solar panels, inverters, batteries, charge controllers, etc- Overview of system design and layout requirements-Drawing Solar PV System Layouts: Rooftop layout and solar panel arrangement	3	3
	2.5	String sizing and module interconnections-DC cabling layout-AC cabling and switchgear layout	4	3
	2.6	Single Line Diagram (SLD) and Wiring Diagrams: Creating SLD for on-grid and off-grid PV systems	3	3
3	**PV Sol and Solar Edge fundamentals**		**20**	
	3.1	PV Sol components. Quick guide - working on projects, operating instructions & workflow.user interface, menu, speed button bar, load & save file, simulation, Quick design- stand- alone system, grid connected systems	4	5
	3.2	Inverter- grid connected & stand alone systems. SolarEdge-Introduction, project designing -choosing a location, defining modules & orientation, generating system report	4	5

	3.3	Practical: Hands - on - training in PVSol, Hands - on - training in Solar edge	12	6
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Practical**

Total Mark: 25	
Assessment methods	
Involvement	10
Punctuality	10
Record	5

<table>
<tr><td></td><td>

B. End Semester Evaluation (ESE)

Practical

Total mark: 50	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Flow chart/ Demonstration	15
Skill and Performance	15
Result/ Output	10
Viva	10

</td></tr>
</table>

References

1. Be a professional autocad designer - Engr. James Okorie.
2. CADArtifex, Sandeep Dogra & John Willis , "A Power Guide for Beginners and Intermediate Users".
3. P. S. Gill (S.K. Kataria & Sons, ISBN 978-93-5014-577-7), "Learning AutoCAD".
4. P Vsol pro version 5.5 Design& simulation PVsystem manual - Dr. Valentin Energie Software GmbH.
5. Solar edge- site designer V2.3

SUGGESTED READINGS

1. Autocad reference guide - Dorothy Kent, New Riders Publishing

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Industrial Health and Safety</td></tr>
<tr><td>Type of Course</td><td colspan="5">VAC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5VA301</td></tr>
<tr><td>Course Level</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">The course emphasizes health risks, hazard recognition, and safety in renewable energy work environments.Safe design and operation of renewable energy infrastructure.EHS planning, audits, documentation, and training strategies.</td></tr>
<tr><td>Semester</td><td>5</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Explain the need for developing Environment, Health, and Safety (EHS) systems in Industry	U, An	PO1, PO 2, PO6, PO7
2	Implement safety practices to ensure worker safety at renewable energy sites.	U, E	PO1, PO2, PO6, PO7
3	Describe the key components of an EHS policy and the need for documentation in RE projects.	U, S	PO2, PO3, PO7, PO10
4	Conduct basic EHS audits and risk assessments for renewable energy systems.	An, A,S	PO2, PO3, PO6

* {options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX*

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	3	2	0	0	0	2	1	0	0	0
CO 2	2	3	0	0	0	2	1	0	0	0
CO 3	0	2	3	0	0	0	2	0	0	1
CO 4	0	3	2	0	0	2	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Environment, Health & Safety**		**20**	
	1.1	Importance of Environment, Health & Safety (EHS) in Industry	5	1
	1.2	Environmental Laws-Indian Acts, Regulations, and Codes of Practice	5	1
	1.3	International initiatives and national regulations relevant to renewable energy sites - OSHA, ILO, MNRE guidelines	5	1
	1.4	Categories of workplace health hazards: physical (noise, radiation), chemical, ergonomic and biological	5	1
2	**Workplace and System Safety for Renewable Installations**		**10**	
	2.1	Safe layout of renewable energy sites (rooftop solar, wind farms, biomass plants)	3	2
	2.2	Importance of ventilation, HVAC in control rooms and battery storage areas	3	2
	2.3	Electrical safety: grounding, isolation, maintenance in solar PV and wind turbine systems	4	2
3	**Risk Management and Environmental Safety Techniques**		**15**	
	3.1	Health and Safety Policies and Documentation-10 essential safety documents	5	3
	3.2	Risk Assessment and Audits-Principles and process of hazard identification and risk	5	4

		evaluation, Safety inspections, audits, and their reporting procedures		
	3.3	Incident Investigation, Quality and Environmental Management-Introduction to ISO 45001 and ISO 14001 standard	5	4
4		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

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B. End Semester Evaluation (ESE)
Theory

<table>
<tr><td colspan="3">Total mark: 50</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 1.5 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 10 out of 12</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 4 out of 6</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>

Part A can be objective type, fill in the blanks, multiple choice etc.
</td></tr>
</table>

References

1. Occupational Health and Safety Management: A Practical Approach, Author: Charles D. Reese, Publisher: CRC Press
2. Fundamentals of Occupational Safety and Health, Author: Mark A. Friend, James P. Kohn, Publisher: Bernan Press.
3. Introduction to Health and Safety at Work, Author: Phil Hughes, Ed Ferrett Publisher: Routledge.

SUGGESTED READINGS

1. Safety and Health in the Renewable Energy Industry, *(ILO / NIOSH guidelines)*
   Source: International Labour Organization / NIOSH.
2. Renewable Energy Systems: A Smart Energy Systems Approach to the Choice and Modeling of 100% Renewable Solutions, *Author:* Henrik Lund *Publisher:* Academic Press.

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<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline*</td><td colspan="5">Renewable Energy</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Novel renewable energy sources</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MPC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE5MT301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course includes novel renewable energy technologies such as advanced hydrogen production, innovative fuel cell systems, and modern geothermal and ocean energy applications. It also covers recent advancements in magnetohydrodynamic (MHD) energy conversion and highlights emerging trends in renewable energy, supporting the transition to cleaner and more efficient power production.</td></tr>
<tr><td>Semester*</td><td>5</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	To explain the properties, production methods, storage, and applications of hydrogen energy	U, A	PO1, PO2,PO3 ,PO7
2	To describe the components, working principles, and types of fuel cells, and compare them with conventional batteries	U, K	PO1,PO2 ,PO3,PO 7
3	To identify geothermal and ocean energy resources, describe their conversion technologies, and discuss their advantages and applications	U, An	PO1,PO2 ,PO3,PO 7
4	To outline the principles and types of magnetohydrodynamic (MHD) energy conversion systems and explain their benefits and applications	U, A, An	PO1,PO2 ,PO3

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	1	2	2	0	0	0	2	0	0	0
CO 2	1	2	2	0	0	0	2	0	0	0
CO 3	1	2	2	0	0	0	2	0	0	0
CO 4	1	2	2	0	0	0	0	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Hydrogen energy**		**15 Hrs**	
	1.1	Introduction, Properties of hydrogen,	2	1
	1.2	Hydrogen production – Electrolysis, Iodine-sulfur cycle,	3	1
	1.3	Coal gasification, Bio photolysis,	2	1
	1.4	Photo electrolysis	2	1
	1.5	Hydrogen storage	2	1
	1.6	Hydrogen transportation	2	1
	1.7	Applications	2	1

2	**Fuel cell systems**		**15**	
	2.1	Introduction - Components, Principle of working	3	2
	2.2	Battery versus fuel cell	2	2

	2.3	Classification of fuel cells – Types of fuel cells: Alkaline fuel cell	2	2
	2.4	Solid oxide fuel cell, Phosphoric acid fuel cell,	2	2
	2.5	Molten carbonate fuel cell,	2	2
	2.6	Proton exchange membrane fuel cell	2	2
	2.7	Application of fuel cells	2	2

3	**Geothermal and Ocean energy 15Hrs**			
	3.1	Geothermal fields, Geothermal sources	2	3
	3.2	Geothermal energy powerplant,	2	3
	3.3	Advantages and disadvantages, Applications of geothermal energy.	3	3
	3.4	Ocean energy resources	2	3
	3.5	Ocean thermal energy conversion	2	3
	3.6	Tidal energy conversion	2	3
	3.7	Wave energy conversion	2	3

3	**Magneto hydrodynamic (MHD) energy conversion 15Hrs**	

	4.1	Principles of MHD power generation	2	4
	4.2	MHD power generator,	2	4
	4.3	Classification – Open cycle systems, Closed cycle systems	4	4
	4.4	Advantages of MHD systems	1	4
	4.5	Gas conductivity	2	4
	4.6	Types of ionization	2	4
	4.7	Super conducting magnetic energy storage (SMES) systems	2	4

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 30	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	10
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 70		
Assessment methods: Written Exam		
Duration of Examination: 2 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 25 out of 27
Part B	5 mark	Answer any 5 out of 7
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Non-conventional energy sources; G.D. Rai; 2011; Fifth Edition, Khanna Publishers
2. Fuel Cell and Their Applications; Kordesch, K and G.Simader; 1996; First Edition; Wiley-VCH, Germany.

SUGGESTED READINGS

1. Non-conventional Energy Sources and Utilization (Energy Engineering); R.K. Rajput; 2012; First Edition.; S. Chand & Company Ltd.
2. Fuel Cell and Their Applications; Kordesch, K and G.Simader; 1996; First Edition; Wiley-VCH, Germany.
3. Hydrogen and Fuel Cells: Emerging Technologies and Applications; Bent Sorensen; 2005; Illustrated Edition Elsevier Academic Press, UK.

Semester 6

Course Code	Title of the course
25SACVRE6EP301	Power electronics
25SACVRE6EP302	Photovoltaic module installation
25SACVRE6SP301	Wind power technology
25SACVRE6SE301	Renewable energy policies and business models
25SACVRE6VA301	Energy conservation techniques
25SACVRE6PR301	Project
25SACVRE6MT301	Energy Management & Auditing

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<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Power electronics</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6EP301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300 - 399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive introduction to the principles and applications of power electronics. It focuses on the understanding and analysis of power semiconductor devices and their role in energy conversion. Students will explore the operation and characteristics of rectifiers, inverters, and AC voltage controllers. Through laboratory experiments, students will gain hands-on experience in implementing and analyzing power electronic systems.</td></tr>
<tr><td>Semester*</td><td>6</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Basics of electronics</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the operation of power semiconductor devices	U	PO1
2	Analyse the performance of power semiconductor diodes and transistors	An	PO1, PO2
3	Analyse the working of thyristors	An	PO1, PO2
4	Evaluate the performance of rectifiers, choppers, inverters, and AC voltage controllers	E	PO2
5	Design power electronic converters for various renewable energy applications	A	PO2, PO7

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	0	0	0	0	0	0	0	0	0
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	0	0	0	0	0
CO 5	0	2	0	0	0	0	1	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to power electronics**		**15**	
	1.1	Concepts of power electronics, applications, advantages and disadvantages	3	1
	1.2	Power electronic systems	2	1
	1.3	Power semiconductor devices	2	1
	1.4	Types of power electronic converters	2	1
	1.5	Power electronic modules	2	1
	1.6	Practical- familiarization of various power electronics devices	4	5
2	**Power semiconductor diodes and transistors**		**20**	
	2.1	Characteristics of power diodes, VI characteristics, reverse recovery characteristics	2	2
	2.2	Types of power diodes- general purpose, fast recovery and schottky diodes	2	2
	2.3	Power transistors, BJT, steady state characteristics, switching performance, power MOSFETs, characteristics, comparison of MOSFET with BJT	4	2

	2.4	Insulated gate bipolar transistor, structure and working, characteristics, switching, applications	4	2
	2.5	Practical- 1. Characteristics of TRIAC and DIAC 2. Characteristics of MOSFET	8	5
3	**Thyristors**		**15**	
	3.1	Static VI characteristics, turn on methods, switching characteristics, gate characteristics, thyristor ratings	2	3
	3.2	Thyristor mounting techniques- series and parallel operation	2	3
	3.3	Qualitative ideas of silicon controlled switch	1	3
	3.4	Light activated Thyristors, diac and triac	2	3
	3.5	Practical- Characteristics of Thyristor	8	5
4	**Phase controlled rectifiers and Inverters**		**25**	
	4.1	Principle of phase control, basics of half wave circuits, full wave controlled converters, single phase full wave converters, three phase converter systems using diodes and thyristors, dual convertors	6	4
	4.2	Operating principle of single phase voltage source inverters- three phase bridge inverters-	5	4

		voltage control in single phase inverters		
	4.3	Types of AC voltage controllers- integral cycle control- single phase voltage controller	4	4
	4.4	Practical- Single phase AC controller using TRIAC and Thyristors	10	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure	10
Skill and Performance	10
Calculation and Result	10
Viva	5

References

1. Power electronics- P S Bimbhra, Khanna Publishers, Chapter 1, 2, 4, 6, 8, 9

SUGGESTED READINGS

1. A textbook of Applied electronics, R S Sedha, 2005, S. Chand and Co.

<table>
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Photovoltaic module installation</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE2EP102</td></tr>
<tr><td>Course Level</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive understanding of photovoltaic (PV) module installation covering fundamental concepts of solar cells and PV modules, including efficiency, circuit diagrams, and spectral sensitivity. It explores inverters used in solar systems, such as grid-connected and self-commutated inverters, along with wiring, cabling, and essential electrical components. A dedicated section on site surveys and shading analysis helps learners assess shading impacts using sun path diagrams, software tools, and installation strategies to minimize losses. The course also focuses on system selection, sizing, and protection, guiding participants through inverter selection, cable sizing, and protective mechanisms like grounding and surge protection. Practical applications include using simulation software, installing essential PV components, and troubleshooting real-world scenarios. By the end, learners will be equipped to plan, install, and optimize solar PV systems for maximum efficiency and reliability.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand and analyze solar cells and their characteristics	U, An	PO 1, PO 2, PO 10
2	Understand the concepts of inverters	U	PO 1, PO 2,
3	Analyze the Site and create site Surveys with Shading Analysis	An, C	PO 1, PO 2, PO 8, PO 10
4	Apply the analysis reports for selection, sizing and Protection of PV Systems	A	PO 1, PO 2, PO 5, PO 10

* {options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX*

CO/ PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	2
CO 2	2	2	0	0	0	0	0	0	0	0
CO 3	2	2	0	0	0	0	0	2	0	2
CO 4	2	2	0	0	0	2	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Solar Cells and PV modules**		**18 hrs**	
	1.1	Solar cell types-Equivalent circuit diagrams of solar cells - Spectral sensitivity -Efficiency of solar cells and PV modules	4	1
	1.2	Types of modules-Design options for PV modules -Module cable outlets and junction boxes -Wiring symbols	3	1
	1.3	Characteristic I-V curves for modules -Irradiance dependence and temperature characteristics	3	1
	1.4	Hot spots, bypass diodes and shading-Quality certification for modules	2	1
	1.5	Practical- Familiarization of different types of solar cells (monocrystalline, polycrystalline, thin-film) and measure their I-V characteristics under varied lighting conditions.	6	1
2	**Inverters**		**17 hrs**	
	2.1	PV array combiner/junction boxes, string diodes and fuses	1	2
	2.2	Grid-connected inverters -Wiring symbol and method of operation -Grid-controlled inverters -Self-commutated inverters - characteristic curves and properties of grid-connected inverters	3	2
	2.3	Cabling, wiring and connection systems - Module and string cables -Connection systems	3	2
	2.4	- DC main cable -AC connection cable -Direct current load switch (DC main switch) -AC switch disconnector	2	2

	2.5	Practical- Module Assembly & Wiring: Try assembling small PV panels, working with junction boxes, cable outlets, and wiring according to standard symbols. Practical-Site Visits & Real-World Observations- Observe working PV installations to understand best practices in wiring, inverters, and switching mechanisms.	8	2

3	**Site Surveys and Shading Analysis**		**20 hrs**	
	3.1	On-site visit and site survey -Consulting with the customer	1	3
	3.2	Shadow types-Temporary shading -Shading resulting from the location -Shading resulting from the building -Shading analysis	2	3
	3.3	Using a site plan and sun path diagram-Using a sun path diagram on acetate Shade analysis tools using software-Shading,	3	3
	3.4	PV-array configuration and system concept -Connection in series -& in parallel-Comparison of connection concepts	3	3
	3.5	Shading with free-standing/rack-mounted PV arrays -Reducing the mutual shading losses of rack-mounted PV modules -Checklists for building survey	3	3
	3.6	Practical- 1.Series vs. Parallel Connection Experiments- Wire PV modules in both configurations and measure how shading affects voltage and current output. 2. Building Survey & Installation Checklist Practice: Conduct surveys for different rooftops or ground-mounted sites and create detailed installation checklists.	8	3
4	**Selection, Sizing and Protection**		**20 hrs**	
	4.1	Planning and Sizing Grid-Connected Photovoltaic Systems-System size and module choice	1	4
	4.2	System concepts -Central inverter, Sub-array and string, module inverter-Inverter installation site	2	4

	4.3	Sizing the inverter -Choosing the number and power rating of inverters -Determining the number of strings -Sizing using simulation programs	2	4
	4.4	Selecting and sizing cables for gridtied PV systems -Cable voltage ratings -Cable current carrying capacity -Minimizing the cable losses/voltage drops	2	4
	4.5	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	3	4
	4.6	Lightning protection, earthing/grounding and surge protection	2	4
	4.7	Practical- 1.Simulation-Based Sizing: Use software tools like PVsyst, Helioscope, or HOMER to simulate real-world PV system sizing. 2. Lightning & Surge Protection Installation: Set up earthing/grounding systems and lightning arrestors for real-world protection.	8	4
5		**Teacher specific content**		

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)
Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record	5

	B. End Semester Evaluation (ESE) **Theory** **Total mark: 50** **Assessment methods: Written Exam** **Duration of Examination: 1.5 hrs** **Pattern of Examination: Non-MCQ** Part A — 1 mark — Answer any 15 out of 17 Part B — 5 mark — Answer any 3 out of 5 Part C — 10 mark — Answer any 2 out of 4 Part A can be objective type, fill in the blanks, multiple choice etc. **Practical** **Total mark: 35** **Duration of Examination: 2 hrs** **Assessment methods** Theory/ Procedure/ Understanding — 10 Skill and Performance/ Data collection — 10 Calculation/ Analysis and Result — 10 Viva — 5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

1. Principles of Power System,V.K.Mehta, RohitMehta,S.Chand Publications.
2. Grid Integration of Solar Photovoltaic Systems ByMajidJamil, MRizwan, DPKothari.
3. Stuart Borlase, Smart grids- Infrastructure technology and solutions,CRC Press.Ie, 2013.
4. Solar Photovoltaics: Fundamentals, Technologies and Applications – *Chetan Singh Solanki, PHI*

Learning.

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

SUGGESTED READINGS

1. Smart Grid: Technology and Applications – Janaka Ekanayake et al. Wiley.
2. Electric Power Substations Engineering – *John D. McDonald CRC Press.*
3. Smart Metering Design and Applications – *Gerd Heber, Hubert Fuchs Springer.*

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Faculty/ Discipline</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Wind Power Technology</td></tr>
<tr><td>Type of Course</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6SP301</td></tr>
<tr><td>Course Level</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces the fundamentals of wind energy systems, including the components and operation of wind electric generators and wind pumps. It covers environmental impacts, benefits, and life cycle analysis of wind power.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>4</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>1</td><td>0</td><td>75 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the components, working principles, and classifications of wind electric generators including their grid integration and power regulation.	U, Ap	PO1, PO2,PO10
2	Analyze the working and limitations of wind pumps including dynamic effects and rotor-pump mismatch characteristics	U, An	PO1,PO 2, PO3
3	Evaluate the environmental impacts and benefits of wind energy systems, including avian impact, noise, and life cycle emissions.	An, E	PO2,PO 6, PO7
4	Assess the economic aspects of wind energy projects considering factors such as initial investment, operation costs, payback period, and incentives.	E, Ap	PO1,PO 2, PO4
5	Demonstrate practical knowledge through hands-on identification, analysis, and layout design of wind turbine systems and environmental assessments.	Ap, C	PO2, PO3, PO7

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)}

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	2
CO 2	2	2	2	0	0	0	0	0	0	0
CO 3	0	2	0	0	0	2	2	0	0	0
CO 4	2	2	0	1	0	0	0	0	0	0
CO 5	0	2	2	0	0	0	2	0	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1		**Wind electric generators**	**20 hrs**	
	1.1	Wind electric generator components: Tower, Rotor, Pitch, Gear box, Safety brakes, Nacelle, Yaw, Generator - Induction generator, Synchronous generator, Transformer,	6	1
	1.2	Grid integration, Power regulation, Wind farms - Offshore and Onshore	6	1
	1.3	Practical: 1. Measurement of wind speed using an anemometer by adjusting the variable frequency drive 2. Demonstration of wind energy training system with the charge controller 3. Evaluate the cut in speed of the wind turbine. 4. Evaluate the tip speed ratio at different wind speed.	8	5
2		**Wind pumps**	**19 hrs**	
	2.1	Wind powered piston pumps, Limitations of wind driven piston pumps	5	2
	2.2	The hysteresis effect, Mismatch between the rotor and pump characteristics	4	2
	2.3	Dynamic loading of the pump's lift rod, Wind electric pump	2	2
	2.4	Practical: Study of Limitations of Wind-Driven Piston Pumps	8	5

	Wind Energy and Environment	**19 hrs**	

3	3.1	Environmental benefits of wind energy, Environmental problems of wind energy	5	3
	3.2	Avian issues, Noise emission, Visual impact	4	3
	3.3	Electromagnetic interference, Life cycle analysis - Net energy analysis, Life cycle emission.	2	3
	3.4	Practical: Wind Farm Layout & Environmental Impact Study	8	5
4		**Economics of wind energy**	**17 hrs**	
	4.1	Factors influencing the wind energy economics	4	3
	4.2	Site specific factor, Machine parameters, Incentives and exemptions, Energy market;	4	3
	4.3	Cost of wind energy - Initial investment, Operation and maintenance costs, Payback period, Benefit cost ratio.	3	3
	4.4	Practical: Site-Specific Economic Comparison.	6	5
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lectures, Demonstration, Animations, Presentations, Discussions.
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) **Theory**

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

Practical

Total Mark: 15	
Assessment methods	
Involvement	5
Punctuality	5
Record/ Report	5

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 15 out of 17
Part B	5 mark	Answer any 3 out of 5
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

Practical

Total mark: 35	
Duration of Examination: 2 hrs	
Assessment methods	
Theory/ Procedure/ Understanding	10
Skill and Performance/ Data collection	10
Calculation/ Analysis and Result	10
Viva	5

References

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

SUGGESTED READINGS

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.

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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Renewable energy policies and business models</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SEC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6SE301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides a comprehensive understanding of renewable energy policies, covering global and Indian frameworks, key legislation, and institutional structures. It explores regulatory instruments, incentives, and mechanisms supporting renewable energy adoption, along with diverse business models and financing strategies. Case studies and local policy analysis deepen students' insights into practical applications and challenges in the renewable energy sector.</td></tr>
<tr><td>Semester*</td><td>6</td><td colspan="2">Credits*</td><td>3</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
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COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the evolution of global and Indian renewable energy policies and evaluate the role of national and international policy frameworks in promoting sustainable energy development.	U, E	PO1, PO2, PO7, PO10
2	Analyze key regulatory mechanisms and incentives supporting renewable energy deployment in India, with emphasis on case studies from various states.	A, An, I	PO1, PO2, PO3, PO6, PO7
3	Examine different business models and financing options for renewable energy projects and assess their effectiveness through real-world examples.	A, An, E	PO1, PO2, PO3, PO5, PO9
4	Critically review Kerala's renewable energy policy and enhance policy literacy through expert interactions and research-based presentations.	E, C, Ap	PO1, PO4, PO6, PO9, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	2	0	0	2
CO 2	2	2	2	0	0	2	2	0	0	1
CO 3	2	2	2	0	2	0	0	0	2	1
CO 4	2	0	0	2	0	2	0	0	2	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Renewable Energy Policy Frameworks**		**15**	
	1.1	Evolution of renewable energy policies – global overview (EU, US, China)	3	1
	1.2	India's renewable energy development milestones, National policies: Electricity Act 2003, National Electricity Policy, NAPCC, Institutional framework: MNRE, IREDA, SECI, State Nodal Agencies	7	1
	1.3	International climate agreements: UNFCCC, Kyoto Protocol, Paris Agreement, State Action Plans on Climate Change (SAPCC), INDCs	5	1

2	**Regulatory Instruments and Policy Mechanisms**		**15**	
	2.1	Renewable Purchase Obligations (RPOs), Renewable Energy Certificates (RECs), Feed-in Tariff vs Competitive Bidding Mechanism	4	2
	2.2	Net Metering and Gross Metering, Policy support for rooftop solar, EV policies, FAME scheme, Incentives: Capital Subsidies, Accelerated Depreciation, Generation-based Incentives	6	2
	2.3	Case studies: Tamil Nadu, Gujarat, and Kerala policy analysis	5	2,4

3	**Business Models and Financing Mechanisms**		**15**	
	3.1	Business Models: BOO, BOOT, IPP, ESCO, Community-based,PPP Models in RE	5	3,4
	3.2	Corporate Power Purchase Agreements (PPAs), Peer-to-Peer trading, Sources of finance: Equity, Debt, Green Bonds	5	3
	3.3	CSR,Multilateral financing: World Bank, ADB, Green Climate Fund, Case studies: Solar parks, mini-grids, distributed solar in Kerala	5	3
5	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

	B. End Semester Evaluation (ESE) **Theory** **Total mark: 50** **Assessment methods: Written Exam** **Duration of Examination: 1.5 hrs** **Pattern of Examination: Non-MCQ** Part A — 1 mark — Answer any 10 out of 12 Part B — 5 mark — Answer any 4 out of 6 Part C — 10 mark — Answer any 2 out of 4 Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. MNRE Policy Guidelines and White Papers
2. Renewable Energy Policy and Politics" – Karl Mallon
3. IRENA and IEA Reports
4. TERI Energy & Environment Yearbook
5. OECD & IRENA Reports on Business Models
6. World Bank & ADB publications on RE finance
7. CERC/SERC Orders and Guidelines

SUGGESTED READING

1. Renewable energy policies, project management and economics for wind and solar power (India) - Dr. Sapan Thapar, Springer, Singapore.

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
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<tr><td>Programme</td><td colspan="5">B.Voc (Honours) Renewable Energy</td></tr>
<tr><td>Course Name</td><td colspan="5">Energy Conservation Techniques</td></tr>
<tr><td>Type of Course</td><td colspan="5">VAC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6VA301</td></tr>
<tr><td>Course Level</td><td colspan="5">300 -399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course provides foundational knowledge of energy conservation, including legislation, audit and management techniques, and practical methods for conserving energy in electrical, thermal, and building systems.</td></tr>
<tr><td>Semester</td><td>6</td><td colspan="2">Credits</td><td>3</td><td rowspan="2">Total Hours</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture</td><td>Practical</td><td>OJT</td></tr>
<tr><td>3</td><td>0</td><td>0</td><td>45 hours</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains	PO No
1	Understand the importance of energy conservation and methods of waste minimization.	U, An	PO1, PO2, PO6, PO10
2	Analyze and apply energy management principles and audit techniques using appropriate instruments and methodologies.	An, A, S	PO2, PO3,PO5
3	Identify and evaluate energy conservation opportunities in electrical and thermal systems	An	PO1, PO2, PO7, PO10
4	Recommend and implement energy-efficient solutions for residential and commercial buildings.	C, A	PO1, PO3, PO8

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	2	0	0	0	1
CO 2	0	2	2	0	2	0	0	0	0	0
CO 3	2	2	0	0	0	0	2	0	0	2
CO 4	2	0	2	0	0	0	0	2	0	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
1	**Introduction to Energy Conservation**		**8**	
	1.1	Introduction Energy conservation & its importance - The Energy Conservation Act 2001 & its features	2	1
	1.2	Waste Minimization & Resource Conservation -Need of waste minimization - Waste minimization method & its classification	4	1
	1.3	Effects of waste environment & Role of pollution control board - Case study.	2	1
2	**Energy Audit and Instrument**		**20**	
	2.1	Energy Management & Audit - Definition and Objective of Energy Management - Principle of Energy Management - Energy Management skills	3	2
	2.2	Energy Manager-Responsibilities & Duties To Be Assigned Under Energy Conservation Act 2001	3	2
	2.3	Energy Audit -Types & Methodology - Energy Audit Reporting format	3	2
	2.4	Energy Audit Instruments- Principal And Working of Electrical Measuring Instruments (Voltmeter, Ammeter ,Power Factor Meter)	4	2
	2.5	Flue Gas Analyzer , Temperature Measurement- Contact Type Methods, Non-Contact Type Methods)	5	2
	2.6	Pressure And Velocity Measurement (Bourdon Gauge, Manometers, Anemometer	2	2

3	**Energy Conservation Methods in Electrical and Thermal System**		**17**	
	3.1	Motors - Power factor improvement techniques	3	3
	3.2	Effects of harmonics - Star-Delta conversion techniques - Variable speed drive (VSD)	5	3
	3.3	Energy conservation in electric furnaces, Pumps, Compressors, Fans, Blowers ,Lighting systems	3	3
	3.4	Energy conservation in HVAC systems .Boiler & furnace - Steam distribution system – Waste heat recovery	4	3
	3.5	Energy Conservation in Housing & Commercial Building in Lighting System	2	4
4	**Teacher specific content**			

Teaching and Learning Approach	**Classroom Procedure (Mode of transaction)** Lecture, Presentations, Group Discussions
Assessment Types	**MODE OF ASSESSMENT**
	A. Continuous Comprehensive Assessment (CCA) Theory

Total Mark: 25	
Assessment methods	
Assignment	10
Seminar/ Quiz/ Group Discussion	5
Test	10

B. End Semester Evaluation (ESE)
Theory

Total mark: 50		
Assessment methods: Written Exam		
Duration of Examination: 1.5 hrs		
Pattern of Examination: Non-MCQ		
Part A	1 mark	Answer any 10 out of 12
Part B	5 mark	Answer any 4 out of 6
Part C	10 mark	Answer any 2 out of 4

Part A can be objective type, fill in the blanks, multiple choice etc.

References

1. Energy Conservation in the Chemical & Allied Industries; S.K. Awasthi; 1989; South Asian Publishers, New Delhi.
2. Energy Management Handbook; Wayne C. Turner; 2001; Fairmont Press

SUGGESTED READINGS

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

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<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">PROJECT</td></tr>
<tr><td>Type of Course*</td><td colspan="5">PROJECT</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6PR301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300 - 399</td></tr>
<tr><td>Course Summary</td><td colspan="5">The Project Course is designed to equip students with practical knowledge, problem-solving abilities, and research skills through hands-on project work. It involves the application of theoretical concepts to real-world challenges, encouraging innovation, teamwork, and independent thinking.Students undertake projects in collaboration with academic mentors, industries, or research institutions, allowing them to explore solutions to domain-specific problems using tools, technologies, and methodologies aligned with their field of study. This course serves as a platform for enhancing technical competencies, exploring career interests, and gaining insights into professional practices.</td></tr>
<tr><td>Semester*</td><td>6</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Hours/ week*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>0</td><td>4</td><td>0</td><td>8</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Nil</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Apply theoretical knowledge to analyze and solve real-world problems through the execution of domain-specific projects.	An, E	PO1, PO2
2	Demonstrate the ability to design and implement project solutions using appropriate tools, technologies, and methodologies relevant to their field.	E, C	PO8
3	Collaborate effectively in teams or work independently to manage project tasks, timelines, and deliverables in a professional setting.	C, S	PO2, PO7, PO10
4	Communicate project outcomes clearly through technical documentation and presentations, while reflecting on professional and ethical responsibilities.	E	PO4, PO9

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	0	0	0	0	0	0	3	0	0
CO 3	0	2	0	0	0	0	2	0	0	3
CO 4	0	0	0	2	0	0	0	0	1	0

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

<table>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
<table>
<tr><td colspan="2">Total mark: 30</td></tr>
<tr><td colspan="2">Type of assessment</td></tr>
<tr><td>Commitment and Involvement</td><td>5</td></tr>
<tr><td>Periodic progress review</td><td>10</td></tr>
<tr><td>Report</td><td>15</td></tr>
</table></td></tr>
<tr><td>B. End Semester Evaluation (ESE)
<table>
<tr><td colspan="2">Total mark: 70</td></tr>
<tr><td colspan="2">Type of assessment</td></tr>
<tr><td>Relevance of the topic</td><td>10</td></tr>
<tr><td>Review of literature</td><td>10</td></tr>
<tr><td>Implementation/ Results</td><td>10</td></tr>
<tr><td>Presentation</td><td>20</td></tr>
<tr><td>Viva Voce</td><td>20</td></tr>
</table></td></tr>
</table>

<table>
<tr><td></td><td colspan="5">DEPARTMENT OF RENEWABLE ENERGY
ST. ALBERT’S COLLEGE (AUTONOMOUS)
ERNAKULAM</td></tr>
<tr><td>Faculty/ Discipline*</td><td colspan="5">Science</td></tr>
<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">Energy Management & Auditing</td></tr>
<tr><td>Type of Course*</td><td colspan="5">MPC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE6MT301</td></tr>
<tr><td>Course Level*</td><td colspan="5">300-399</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course introduces various energy sources, the global and Indian energy scenario, and the link between energy use and economic growth. It covers energy management and the role of Energy Managers under the Energy Conservation Act 2001. It also includes the use of key instruments for measuring electrical, thermal, and fluid parameters in energy audits.</td></tr>
<tr><td>Semester*</td><td>6</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">Total Hours*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum *</td><td>OJT*</td></tr>
<tr><td>4</td><td>0</td><td>0</td><td>60</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Fundamentals of Energy Sources</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the concept and importance of energy in modern society.	U, K	PO3, PO6, PO7, PO10
2	Apply core principles of energy management and auditing.	K, A	PO4, PO6, PO7, PO10
3	Know the legal role of Energy Managers and how to check and report energy use.	An, S	PO1, PO5, PO6, PO7
4	Learn to use and understand basic energy audit instruments	U, A, S	PO1, PO2, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap) }

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	0	0	1	0	0	2	2	0	0	1
CO 2	0	0	0	2	0	2	2	0	0	1
CO 3	1	0	0	0	1	2	1	0	0	0
CO 4	1	2	0	0	0	0	0	0	0	2

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

COURSE CONTENT

Content for Classroom transaction (Units)

Module	Units	Course description	Hrs	CO No.
	Module I-Energy and Policies		**10**	
1	1.1	Introduction - Types of Energy Sources	2	1
	1.2	World Energy Scenario	2	1
	1.3	Indian Energy Scenario- Energy V/S Economic Growth	4	1
	1.4	Energy Policies, Pricing & Reforms.	2	1
2	**Module II-Energy Management & Audit-**		**20**	
	2.1	Energy Management & Audit - Definition and Objective of Energy Management - Principle of Energy Management	4	2
	2.2	Energy Management Skills - Energy Management Strategies	4	2
	2.3	Energy Audit- Types & Methodology- Reporting Format	4	2
	2.4	Understanding Energy Carts - Bench Marking & Energy Performance	4	2
	2.5	Matching Energy to Requirement Maximizing System - Fuel & Energy Substitution.	4	2
	Module III-Energy Manager-Responsibilities & Duties		**15**	

3	3.1	Energy Manager-Responsibilities & Duties To Be Assigned Under Energy Conservation Act 2001	2	3
	3.2	Accountability Motivation Of Employees	3	3
	3.3	Requirements For Energy Action Planning – Information System, Marketing & Communicating - Planning &Training	4	3
	3.4	Energy Planning Tools – ENPEP, MARKAL, LEAP, MAED.	4	3
	3.5	Policy Framework for Promotion of Renewable In India – FIP, FIIA	2	3
	Module IV-Energy Audit Instruments		**15**	
4	4.1	Energy Audit Instruments - Principal And Working of Electrical Measuring Instruments (Voltmeter, Ammeter ,Power Factor Meter)	3	4
	4.2	Flue Gas Analyzer , Temperature Measurement- Contact Type Methods, Non-Contact Type Methods	4	4
	4.3	Pressure And Velocity Measurement (Bourdon Gauge, Manometers, Anemometer)	4	4
	4.4	Flow Measurement Of Steam, Water And Air -Humidity Measurement And Leak Detectors	4	4
5	**Teacher Specific Content**			

<table>
<tr><td>Teaching and Learning Approach</td><td>Classroom Procedure (Mode of transaction)

Lecture, Presentations, Group Discussions</td></tr>
<tr><td rowspan="3">Assessment Types</td><td>MODE OF ASSESSMENT</td></tr>
<tr><td>A. Continuous Comprehensive Assessment (CCA)
Theory
<table>
<tr><td colspan="2">Total Mark: 30</td></tr>
<tr><td colspan="2">Assessment methods</td></tr>
<tr><td>Assignment</td><td>10</td></tr>
<tr><td>Seminar/ Quiz/ Group Discussion</td><td>10</td></tr>
<tr><td>Test</td><td>10</td></tr>
</table>
</td></tr>
<tr><td>B. End Semester Evaluation (ESE)
Theory
<table>
<tr><td colspan="3">Total mark: 70</td></tr>
<tr><td colspan="3">Assessment methods: Written Exam</td></tr>
<tr><td colspan="3">Duration of Examination: 2 hrs</td></tr>
<tr><td colspan="3">Pattern of Examination: Non-MCQ</td></tr>
<tr><td>Part A</td><td>1 mark</td><td>Answer any 25 out of 27</td></tr>
<tr><td>Part B</td><td>5 mark</td><td>Answer any 5 out of 7</td></tr>
<tr><td>Part C</td><td>10 mark</td><td>Answer any 2 out of 4</td></tr>
</table>
Part A can be objective type, fill in the blanks, multiple choice etc.</td></tr>
</table>

References

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

SUGGESTED READINGS

1. Renewable Energy Sources and Emerging Technologies ,D.P. Kothari. K.C. Singal , Rakesh Ranjan, PHI Learning Pvt. Ltd.
2. BEE India (www.beeindia.gov.in).
3. LEAP (www.energycommunity.org)

Semester 7&8

Course Code	Title of the course
25SACVRE7SN401	APPRENTICESHIP
25SACVRE7SR401	RESEARCH INTERNSHIP

<table>
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<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">APPRENTICESHIP</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE7SN401</td></tr>
<tr><td>Course Level*</td><td colspan="5">400 - 499</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course aims to provide advanced industry-oriented practical experience to learners in the field of sustainable energy systems. Building on prior foundational and intermediate-level skills, this phase focuses on real-time problem-solving, project execution, and professional integration within renewable energy sectors such as solar, wind, bioenergy, and energy efficiency. Students work closely with industry professionals, handle advanced tools and software, and participate in installation, commissioning, auditing, and maintenance of energy systems. This apprenticeship is designed to nurture job-ready graduates with leadership, technical, and entrepreneurial capabilities.</td></tr>
<tr><td>Semester*</td><td>7 & 8</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">No. of days*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum*</td><td>OJT*</td></tr>
<tr><td>0</td><td>28</td><td>0</td><td>280</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Technical knowledge base</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Recall key national and international policies, standards, and procedures relevant to renewable energy project execution.	K	PO1, PO2
2	Demonstrate a sound understanding of workplace safety protocols, industry regulations, and project documentation standards.	U	PO2, PO7
3	Apply advanced theoretical and practical knowledge in renewable energy technologies during live industrial projects and site work.	A	PO1, PO2, PO3, PO10
4	Analyze and troubleshoot performance issues in existing renewable energy systems and suggest effective solutions.	An	PO2, PO3, PO5
5	Evaluate the techno-economic feasibility of renewable energy projects using appropriate tools and standards.	E	PO7, PO10
6	Design and implement small-scale renewable energy systems independently or as part of a project team.	S, C	PO2, PO3, PO5, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)}

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	2	0	0	0	0	0	0	0	0
CO 2	0	2	0	0	0	0	2	0	0	0
CO 3	1	2	2	0	0	0	0	0	0	2
CO 4	0	2	2	0	2	0	0	0	0	0
CO 5	0	0	0	0	0	0	2	0	0	1
CO 6	0	2	1	0	2	0	0	0	0	1

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	MODE OF ASSESSMENT
	A. Continuous Comprehensive Assessment (CCA)

Total mark: 90	
Type of assessment	
Commitment, Punctuality & Professional conduct	20
Monthly progress reviews & Logbook maintenance	25
Skill development and Application	25
Interim Report	20

	B. End Semester Evaluation (ESE)

Total mark: 210	
Type of assessment	
Feedback & Evaluation report from Host organization	50
Skill demonstration/ Summary of work exposure	40
Final report/ Learning portfolio	40
Domain knowledge and experience communication (Presentation)	40
Viva voce	40

Note:

This assessment framework is intended as a guiding structure for evaluation of apprenticeship performance. However, in order to remain responsive to the evolving needs of industry and society, the evaluation criteria may be revised from time to time. Such changes aim to enhance the relevance, effectiveness and fairness of the assessment process.

<table>
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<tr><td>Programme</td><td colspan="5">B. Voc. (Honours) Renewable Energy</td></tr>
<tr><td>Course Name*</td><td colspan="5">RESEARCH INTERNSHIP</td></tr>
<tr><td>Type of Course*</td><td colspan="5">SDC</td></tr>
<tr><td>Course Code</td><td colspan="5">25SACVRE7SR401</td></tr>
<tr><td>Course Level*</td><td colspan="5">400 - 499</td></tr>
<tr><td>Course Summary</td><td colspan="5">This course is designed to foster research aptitude and innovation among students by engaging them in a structured research project or investigation in collaboration with academic institutions, research centers, or industry R&D units. This internship provides learners with the opportunity to explore emerging trends, evaluate performance of renewable technologies, or develop innovative solutions to sector-specific challenges. The course emphasizes critical thinking, scientific methodology, data collection, analysis, and technical writing, preparing students for roles in R&D, higher studies, or innovation-driven startups.</td></tr>
<tr><td>Semester*</td><td>7 & 8</td><td colspan="2">Credits*</td><td>4</td><td rowspan="2">No. of days*</td></tr>
<tr><td rowspan="2">Course Details</td><td rowspan="2">Learning Approach</td><td>Lecture*</td><td>Practicum*</td><td>OJT*</td></tr>
<tr><td>0</td><td>20</td><td>0</td><td>200</td></tr>
<tr><td>Pre-requisites, if any</td><td colspan="5">Proficiency in softwares, basic knowledge of energy auditing</td></tr>
</table>

COURSE OUTCOMES (CO)

CO No.	Expected Course Outcome	Learning Domains *	PO No
1	Understand the research process, including problem identification, literature review, and methodology formulation.	U	PO1, PO2
2	Apply theoretical concepts to investigate a defined research problem in the renewable energy domain.	A	PO2, PO3, PO6, PO10
3	Analyze experimental or simulation data using appropriate scientific or engineering tools.	An	PO2
4	Critically evaluate existing technologies or systems and propose data-driven improvements or alternatives.	E	PO2, PO6
5	Design and develop experimental setups, small-scale prototypes, or simulation models relevant to the chosen research topic.	C	PO3, PO5, PO10
6	Document research findings in the form of a technical report or research paper and present it effectively.	I	PO5, PO9, PO10
7	Identify new or unexplored opportunities for innovation or process improvement in renewable energy technologies.	C, S, Ap	PO1, PO2, PO5, PO10

{options: Remember (K), Understand (U), Apply (A), Analyse (An), Evaluate (E), Create (C), Skill (S), Interest (I) and Appreciation (Ap)}

CO-PO ARTICULATION MATRIX

CO/PO	PO 1	PO 2	PO 3	PO 4	PO 5	PO 6	PO 7	PO 8	PO 9	PO 10
CO 1	2	1	0	0	0	0	0	0	0	0
CO 2	0	2	2	0	0	1	0	0	0	1
CO 3	0	2	0	0	0	0	0	0	0	0
CO 4	0	2	0	0	0	2	0	0	0	0
CO 5	0	0	2	0	0	2	0	0	0	1

CO 6	0	0	0	0	3	0	0	0	2	1
CO 7	2	1	0	0	2	0	0	0	0	3

'0' is No Correlation, '1' is Slight Correlation (Low level), '2' is Moderate Correlation (Medium level) and '3' is Substantial Correlation (High level).

Assessment Types	**MODE OF ASSESSMENT**

A. Continuous Comprehensive Assessment (CCA)

Total mark: 60	
Type of assessment	
Commitment, Punctuality & Professional conduct	10
Monthly progress reviews & Logbook maintenance	15
Skill development and Application	15
Interim Report	20

B. End Semester Evaluation (ESE)

Total mark: 140	
Type of assessment	
Feedback & Evaluation report from Host organization	40
Skill demonstration/ Summary of work exposure	20
Final report/ Learning portfolio	25
Domain knowledge and experience communication (Presentation)	25
Viva voce	30

Note:

This assessment framework is intended as a guiding structure for evaluating research internship performance. However, in order to remain responsive to the evolving needs of industry, academia and society, the evaluation criteria may be revised from time to time. Such changes aim to enhance the relevance, effectiveness and fairness of the assessment process.